

# Spectrum Financial Consulting, LLC

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Via Electronic Filing

Monday, July 22, 2018

Ms. Marlene H. Dortch, Secretary  
Federal Communications Commission  
445 Twelfth St., S.W.  
Washington, D.C. 20554

Re: **Allocation and Service Rules for the 1675–1680 MHz Band, WT Docket No. 19–116, RM-11681**

Dear Ms. Dortch:

I, Stephen Wilkus, managing partner and Chief Technology Officer of Spectrum Financial Partners, LLC (SFP) and founder of Spectrum Financial Consulting, LLC (SFC), hereby submit these comments in the captioned Proceeding.<sup>1</sup> In summary, I:

1. Commend the Commission in planning for this auction of 1675 – 1680 MHz, particularly in light of the continued growth in wireless traffic;
2. Support the allocation of a single 5 MHz block;
3. Support the allocation as flexible use, for downlink, uplink or TDD use;
4. Support a nation-wide license or one for the Continental US, with Puerto Rico, US Virgin Islands, Guam, Northern Mariana Islands Possessions and Territories perhaps separately licensed;
5. Recognize that these rules are consistent and will be properly compliant with US Codes such as 47 U.S.C §309(j)(3)-(4).

## Introduction and Standing

I was a bidder in auction 102 and I am part owner in 23 radio spectrum licenses. Near the end of my 27 years in Bell Laboratories I was a director in the Wireless Chief Technology Office, advising North American operators on spectrum, standards, technology and equipment matters. I have over 30 years experience in FCC technical matters and in contributing comments to FCC filings for AT&T, Lucent, Alcatel-Lucent, SFP and myself and have filed declarations on behalf of Dish and Ligado. I have been invited as a subject matter expert to participate as a panelist at several FCC workshops.<sup>2,3,4</sup> I have published numerous Journal articles on radio propagation and have authored and edited whitepapers at IWPC and 4GAmericas (now 5GAmericas)

<sup>1</sup> See *In the Matter of Allocation and Service Rules for the 1675-1680 MHz Band, Notice of Proposed Rulemaking*, WT Docket No. 19-116 (released May 13, 2019) (hereafter NPRM). Available on-line on 7/1/2019 at: <https://www.fcc.gov/ecfs/filing/05132467403342>.

<sup>2</sup> Alcatel Lucent presentation at FCC forum on the future of wireless band plans of July 16, 2012, available at: <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting71612/PANEL2.2-Wilkus-Alcatel-Lucent.pdf> (last accessed June 25, 2018).

<sup>3</sup> FCC Receiver Workshop of March 12, 2012 available on-line as of 6/25/2019 at: <https://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session3/SESSION-3-4-Wilkus-ALU.pdf>

<sup>4</sup> FCC Learn Workshop on Incentive Auctions of May 3, 2013, agenda available on-line, last accessed June 26, 2018 <https://ecfsapi.fcc.gov/file/7022421551.pdf>

and have been an invited speaker at many wireless symposia and workshops.<sup>5</sup> I hold more than 10 patents in the radio and communications fields, and have served on three working groups of the Commerce Spectrum Management Advisory Committee (“CSMAC”) helping to enable the coordinated transition of federally used spectrum for commercial use such as in AWS-3 bands. In short, I am a recognized expert in radio issues including filter technology, propagation measurements, mobile satellite, interference and general radio industry issues, their analysis, mitigation and economics.

Spectrum Financial Consulting, LLC (SFC) commends the FCC’s effort to add the 1675 to 1680 MHz band for use in wireless radio service on a shared use basis and generally supports the captioned NPRM. In the following section, I make some observations about the relative growth in wireless traffic and the availability of allocated spectrum to support this continued growth, and then proceed to address several of the questions specifically raised in the NPRM, particularly the question of the geographic license service area size where I recommend a nation-wide license, in agreement with Ligado’s comments.<sup>6</sup>

### Motivation for Additional Spectrum

The reallocation of this spectrum is a good-government effort in accordance with multiple Administrations to reallocate the 1675 to 1680 MHz band in budget proposals dating from 2014 through 2019 Fiscal Years that all proposed that the Commission reallocate the 1675-1680 MHz band for non-federal use.<sup>8</sup> Most recently, in the FCC Fiscal Year 2020 Budget, the Commission stated, “The Budget proposes that the FCC either auction or use fee authority to assign spectrum frequencies between 1675-1680 megahertz for flexible use by 2020, subject to sharing arrangements with Federal weather satellites.” And further, “The proposal is expected to raise \$600 million in receipts over 10 years.”<sup>9</sup>

Congress has enacted a sequence of bills to authorize the Commission to reallocate, fund the relocation and permit the auctioning of spectrum in the Commercial Spectrum Enhancement Act of 2004 (CSEA), as well as Title VI of the Middle Class Tax Relief and Job Creation Act of 2012, and Title X of the Bipartisan Budget Act of 2015 (Spectrum Pipeline Act).<sup>10</sup> Most recently, on March 23, 2018 Congress passed the Repack Airwaves Yielding Better Access for Users of Modern Services Act of 2018 (RAY BAUM’S Act).<sup>11</sup> The RAY BAUM’S Act specifically requires the NTIA to make available “100 megahertz below the frequency of 6000 megahertz shall be identified for use on an exclusive, licensed basis for commercial mobile use.” This NPRM will help meet these Congressional directives.

Allocating this additional spectrum is particularly important given the continued impressive growth in mobile traffic. In the most recently published survey of the US wireless industry for calendar year 2018 (released in June 2019) the CTIA reported 82%

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<sup>5</sup> Publication list available at:

[https://scholar.google.com/scholar?hl=en&as\\_sdt=0%2C33&q=Stephen+Wilkus&btnG=](https://scholar.google.com/scholar?hl=en&as_sdt=0%2C33&q=Stephen+Wilkus&btnG=)

<sup>6</sup> See Comments of Ligado, WT Docket No. 19-116 with declaration by Brattle Group, “Choosing an Appropriate Geographic License Size,” by Coleman Bazelon, June 21, 2019, filed: June 21, 2019 available as of 7/1/2019 at: <https://ecfsapi.fcc.gov/file/10621258324775/Ligado%20Comments%20on%201675-1680%20MHz%20NPRM%20%5B6.21.19%5D.pdf>

<sup>8</sup> *ibid*, ¶5.

<sup>9</sup> FCC Fiscal Year 2020 Budget Estimates to Congress, March 2019. Available on-line at: <https://docs.fcc.gov/public/attachments/DOC-356607A1.pdf>

<sup>10</sup> The Bipartisan Budget Act of 2015, 129 Stat 584, Sec. 1001 (2015) (The Spectrum Pipeline Act) requires the NTIA to identify 30 MHz of spectrum for reallocation from federal to commercial or shared use by no later than Jan. 1, 2022, excluding spectrum between 1675 and 1695 MHz, available on-line at: <https://www.congress.gov/114/plaws/publ74/PLAW-114publ74.pdf>

<sup>11</sup> RAY BAUM’S Act of 2018, Pub. L. No. 115-141, Division P, §603(a) (2018). Available on-line at: <https://www.congress.gov/115/plaws/publ141/PLAW-115publ141.pdf>

growth in mobile data traffic.<sup>12</sup> Even voice traffic saw a growth spurt of 9.6% from 2017 to 2018 and text SMS plus MMS messaging increased 15.8%.

This continues the astounding growth in wireless traffic over nearly 4 decades. The data-only traffic growth rate for the last decade has averaged 113% per year, essentially doubling every 0.97 years since 2008.<sup>13</sup> I show this as the orange line and data points in Figure 1, below. The growth in wireless traffic has exceeded 5 orders of magnitude in the last 20 years so it is best to look at this on a logarithmic (Log) scale as used in this figure. This has the benefit that exponential growth appears as a straight line and we can see the growth rate as the slope of that line.

Spectrum has been the most cost effective way to address this growth in demand, compared with adding base stations, growing at about 3.2% this past decade (though the number of base stations grew about 8% in 2018), and increasing efficiency through signal processing approaches including MIMO and generational increments. Yet, the amount of spectrum available to US mobile operators has been growing at just 8.8% per year from 1979 to 2019 (doubling every 8.6 years), as shown in blue in Figure 1, below.

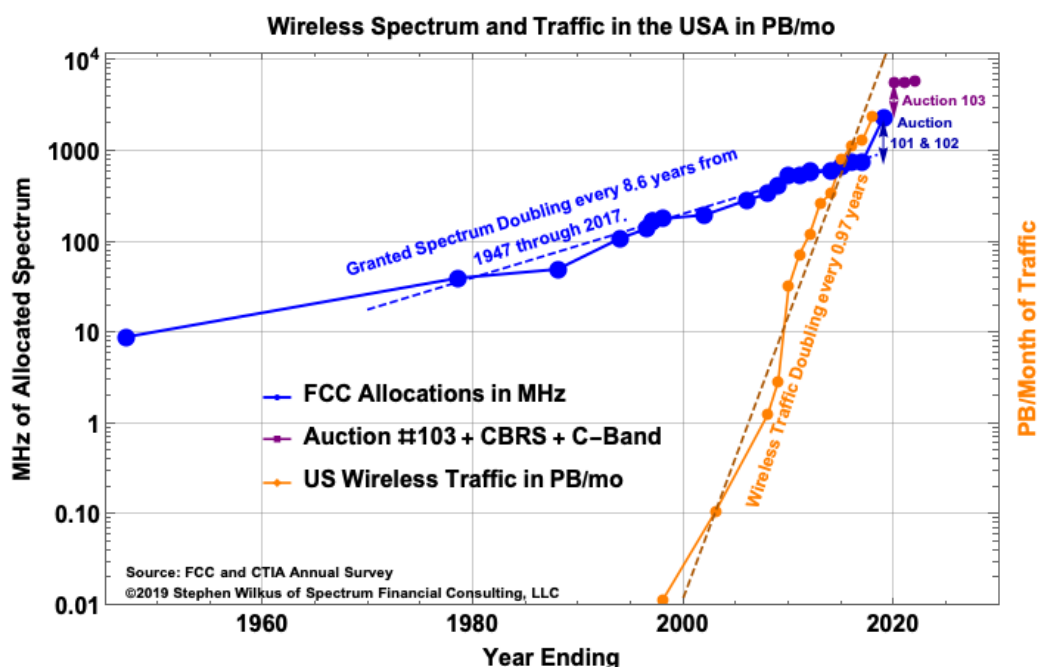


Figure 1 – Comparison of growth in Wireless Data Traffic (shown in orange) and the growth in Aggregate Spectrum Bandwidth Licensed for mobile and flexible use applications. This does not include WiFi or whitespace spectrum. The units of the two curves are different but they happen to share the same numerical scale nicely, so the slopes are most relevant but when the curves cross is coincidental.

The amount of spectrum available to mobile phones has tripled this past year thanks to the mm-wave auction #101 and #102 which will help unleash new capacity in 5G wireless networks, at least in dense urban areas and stadia where mm-wave propagation and penetration difficulties are less troublesome. Even with the upcoming auction 103 of even higher frequency mm-Wave bands, the unrelenting growth in traffic threatens to continue to outpace the growth in spectrum allocations.

<sup>12</sup> See CTIA 2019 Annual Survey Highlights, June 20, 2019, available at: <https://www.ctia.org/news/2019-annual-survey-highlights>

<sup>13</sup> Though it should be noted that more recent years has seen the growth rate drop down to just 14% from 2016 to 2017, and the total traffic including Voice, SMS, MMS plus Data-only has averaged 46% CAGR since 1998 by my calculations based upon past CTIA Survey Reports.

The infusions of mm-wave spectrum in auctions 101 through 103 is vital to adding capacity in the dense urban and dense venues like stadia where connections have near line of sight paths, but there remains the problem of adding capacity in suburban and rural areas as well. In these environments, low band (like the 600 MHz spectrum allocated in auction 1002) and the mid-band spectrum such as this 1675–1680 MHz block of spectrum are vitally important. As Commissioner Rosenworcel pointed out, “recent commercial launches of 5G service in the United States are confirming what we already know—that commercializing the millimeter wave will not be easy, given its propagation challenges. The network densification these airwaves require is costly. If we want to serve everywhere in the country—and not create communities of 5G haves and 5G have-nots—we are going to need a healthy mix of airwaves that provide both coverage and capacity. That means we need mid-band spectrum.”<sup>14</sup>

The Commission is to be praised for adding to all these bands, particularly the low and mid-band spectrum such as this 1675–1680 MHz block.

#### *1675-1680 MHz Band Plan*

The NPRM solicited comments on the plan to use this band for downlink operations (from the base stations to the user equipment).<sup>15</sup>

The single 5 MHz block of spectrum from 1675 to 1680 MHz should be flexibly allocated for uplink, downlink or TDD, just as with the adjacent 1670 to 1675 MHz block. This permits market forces to determine the optimal interference coordination with incumbents and adjacent users of the spectrum.

In deploying 5G NR, a 10 MHz wide unified carrier can have 52 Sub-carriers, each 15 kHz wide vs 25 in 5 MHz, leading to a 4% added usable bandwidth and capacity thanks to the removal of a guard band as seen in Figure 2, below. I calculate a peak downlink capacity of 53.5 Mbps in each of the independent 5 MHz blocks, compared with 111 Mbps in the single 10 MHz unified block, for a 4% increase in peak throughput.<sup>16</sup>

#### *Uplink, Downlink, or TDD*

Reversing the uplink or downlink direction of adjacent blocks of spectrum would be unworkable among uncoordinated users of the blocks due to interference with the adjacent 5 MHz block, but post-auction free market agreements can best coordinate these issues based upon the commercial advantages reached through post-auction agreements among nation-wide license holders. Market forces would be less effective, perhaps even stymied, if this 1675–1680 MHz block were to be licensed by any other geographic allocation (than nation-wide).

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<sup>14</sup> Comments by Commissioner Rosenworcel, April 12, 2019 in Public Notice FCC-19-13, available on-line at: <https://www.fcc.gov/document/fcc-seeks-comment-bidding-procedures-third-5g-spectrum-auction>

<sup>15</sup> *ibid.* ¶22, page 10.

<sup>16</sup> This assumes 2 layers, 256 QAM, 14% Overhead and Ts of 0.00714286 mSec , scalingFactor=1 and SCS=15 kHz in the equations of 3GPP TS 38.306.

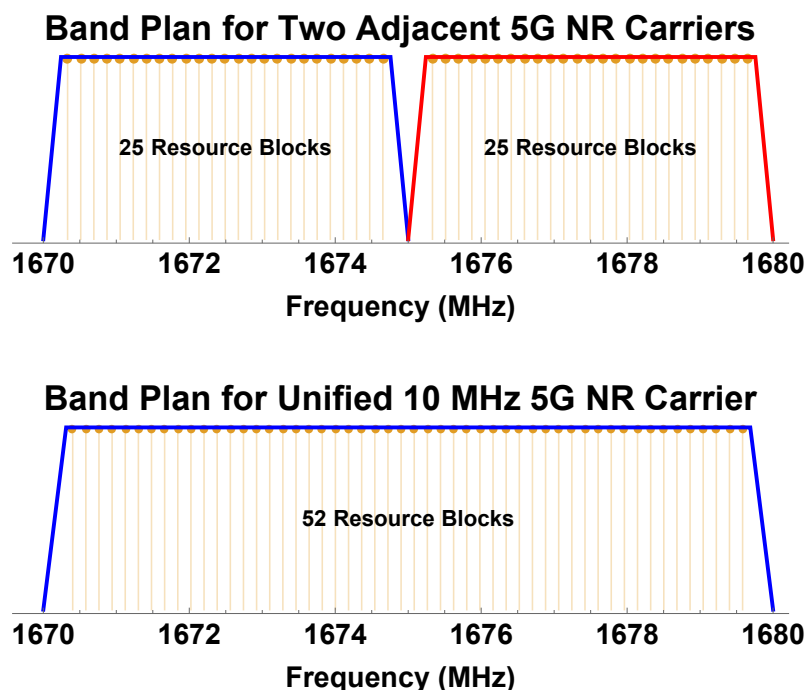


Figure 2- Illustration of 5G NR guard bands for two 5 MHz carriers operated by independent licensees vs. a unified carrier owned and operated by a single license holder. The 3GPP 5G NR standard places two additional resource blocks in the unified 10 MHz carrier providing a 4% increase in spectrum resources.

### Spectrum Block Size (5 MHz)

While the LTE standard supported a block size as small as 1.4 MHz, 5 MHz is the minimum bandwidth specified in the 5G NR standards.<sup>17</sup> This is a strong reason not to break the 1675–1680 MHz band into a smaller block size. Any smaller size would be limited to 4G LTE operations and IoT applications, strangling the license holder's ability to stay current with 5G NR developments and carrier aggregation with other emerging 5G carriers.

### License and Service Area Size – I recommend a single nationwide license

The Commission proposes to use the 416 Partial Economic Areas (PEAs) as the geographic bounds of the licenses, but the NPRM asks for comments on this choice of geographic extent of the license(s) to be auctioned. I recommend, instead, choosing the same geographic extent as in the adjacent 1670–1675 MHz spectrum shown in the Figure 2, above. There are several important technical and policy reasons for this:

1. Auctioning a nation-wide license encourages a new competitive entrant among nationwide mobile operators.
2. The spectrum is more fully utilized without the intervening guard band. As shown in Figure 2 above, there are 4% more resource blocks with 24 additional sub-carriers available to a nation-wide holder of both 1670–1675 and 1675–1680 MHz, compared with two separate 5 MHz block holders.
3. Just as with carrier aggregation, there are performance advantages for an operator that can aggregate multiple contiguous blocks of spectrum, these

<sup>17</sup> See, e.g. 3GPP TS 38.101-1 v15.6.0 (2019-6) §5.3.2, available on-line as of July 8, 2019 at: <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3283>



include both higher capacity as with (2) above as well as statistical multiplexing benefits for bursty traffic.

4. Trunking efficiencies are improved with additional resource blocks (RBs are effectively trunks). At a 2% blocking goal, the 25 RBs in a 5 MHz block support an offered load of 17.5 channels while the 52 RBs in a 10 MHz block supports 42, an improvement of 20% over the sum of two independent 5 MHz blocks.<sup>18</sup>
5. Network operators are strongly motivated to deploy the same radio plan throughout their coverage area. This permits a common equipment plan throughout all their base stations, helping to manage their spares inventory, simplify their training programs for field installers and maintenance teams and their antenna, power amplifier, duplexer filters and similar purchases. The learning curve teaches that the cost of a large number of base station equipment is about 15% less than the cost of two half-sized sets of similar but different equipment.<sup>19</sup>
6. Historical Auctions such as in #96 (H-Block) and the current ownership of the 700 MHz E block (Manifest Wireless L.L.C., aka Dish) and AT&T's WCS band (2305–2320 MHz & 2345–2360 MHz) holdings reveal a “natural monopoly” for nation-wide allocations for relatively narrow band allocations particularly those that have deployment difficulties. I elaborate on this below.

We have seen past auctions of similarly limited bandwidth go to a small number or even to a single bidder as in auction 96 (H-Block). In Figure 4 below I show how that auction of the single pair of 5 MHz blocks (1915–1920 MHz & 1995–2000 MHz) was won on a nation-wide basis by the single bidder, American H Block Wireless L.L.C. (Dish Networks), bidding against a collection of 21 other bidders. The upper 5 MHz block was adjacent to the nationwide 20 MHz of uplink spectrum that made this spectrum more valuable to this particular bidder who won the nationwide collection of licenses, just as I expect will happen if the 1675–1680 MHz spectrum is auctioned off piece-meal, whether in Basic Economic Areas (BEAs) as in auction 96 or as Partial Economic Areas (PEAs) as the NPRM proposes to do in the upcoming auction.

In auction 96 the final winning bidder paid over 7 times the opening bid amounts even though no other competing bidder bid on any property more than 33 times out of the 167 rounds (an indication that they were not dedicated to acquiring licenses in a focused area of interest). Keep in mind, as economists who design auctions recognize, a high payment in an auction, is not, by itself, a sign of an auction's success, the “Highest and Best” allocation isn't *determined* by the auction proceeds rather the bids signal the way to approach the “Highest and Best” allocation. This is why auction designers often use the “second price rule” as a way of allocating the penalty cost for other bidders to the winner as a way of maximizing social welfare,<sup>20</sup> as was appropriately done in the assignment phase of the recent auctions 1002, 101 and 102.

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<sup>18</sup> This is based on the Erlang-B blocking formula, which is famously used for voice traffic, but is also applicable for a scheduler of digital data packets assuming Poisson arrival rates and exponentially distributed packet sizes. Blocking here results in allocating the traffic to a later Resource Block (RB).

<sup>19</sup> “Models for forecasting cost evolution of components and technologies,” Borgar T. Olsen and Kjell Stordahl, pg.138 ISSN 0085-7130 © Telenor ASA 2004 *Teletronikk 4.2004*.

<sup>20</sup> Diakonikolas I., Papadimitriou C., Pierrakos G., Singer Y. (2012) “Efficiency-Revenue Trade-Offs in Auctions,” Czumaj A., Mehlhorn K., Pitts A., Wattenhofer R. (eds) Automata, Languages, and Programming. ICALP 2012. Lecture Notes in Computer Science, vol 7392. Springer, Berlin, Heidelberg. Available on-line as of July 16, 2019 at: <http://www.iliasdiakonikolas.org/papers/auctions-pareto.pdf>.

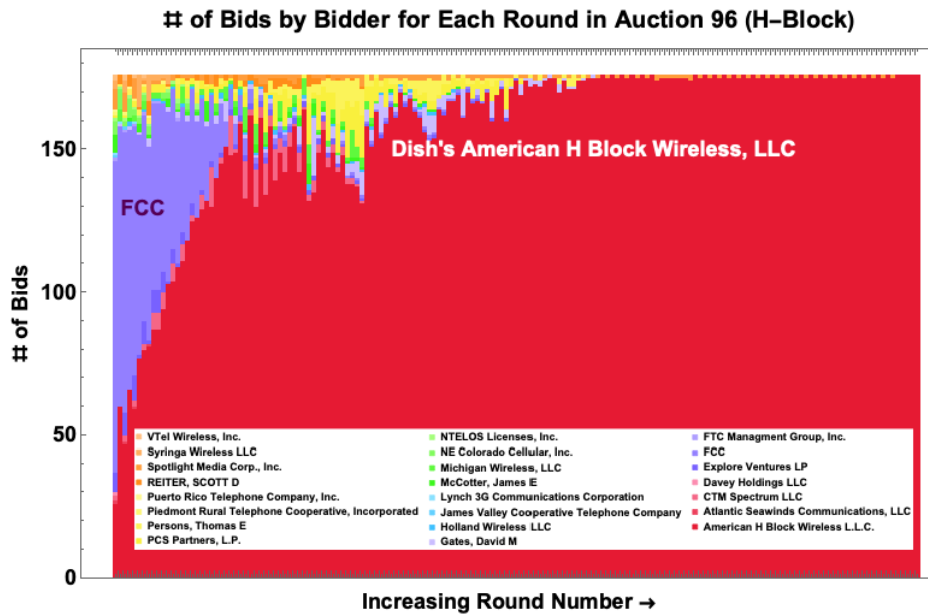


Figure 3 – The progress of winners in auction #96 (H-Block) through 167 rounds showing how the winning provisional bids for the 176 of American H Block L.L.C. (aka Dish Networks) grow to include all 176 BEA regions of the nation.

The same accumulation of all regional licenses in the Continental US has also occurred in the case of the 6 MHz of lower 700 MHz E and D block, and the WCS band (2305–2320 MHz & 2345–2360 MHz) by AT&T and its holding companies. The effective amount of spectrum usable in the WCS band is actually somewhat less than suggested by the allocation due to interference mitigation methods of working with the interstitial Satellite Digital Audio Radio Service (SDARS) band used by Sirius/XM. The effective amount of spectrum usable in the H-block auction was similarly limited to the upper block of spectrum since the lower block is more constrained by the narrow duplex gap (1920 to 1930 MHz).

What we see in these four examples is that these relatively narrow allocations of 5 or 6 MHz (as in the case of H-block and 700 MHz D&E blocks) as well as the wider but tightly constrained 2 x 15 MHz of WCS spectrum, is that these relatively narrowband licenses are not attractive for use in modern 4G or 5G mobile systems unless they are acquired on a nationwide basis.

### Consistent with U.S. Code

This recommendation for a single nation-wide license (or similarly, a single Continental US license and separate licenses for the Gulf of Mexico, Puerto Rico plus the US Virgin Islands, and Guam-Northern Mariana Islands) is consistent with the dictates of 47 U.S.C §309(j)(3)-(4)<sup>21</sup> insofar as a nationwide license will likely supply the winning bidder with spectrum needed for new competitors to enter nation-wide service without undue and artificially high costs. Keep in mind that the point of the auction is not to maximize the revenue to the general fund but to identify and assign the resource to the “highest and best use.” That this may not be attractive to “small businesses, rural telephone companies, and businesses owned by members of minority groups and women” is only true to the extent that these entities are not interested in nationwide business opportunities in a particular auction. A minority owned or small business that is interested and has the means to bid nationally is free to do so. Granting licenses to

<sup>21</sup> 47 U.S.Code Title 47 Chapter 5, Subchapter III Part I, Section 309 (j)(3)-(4) available on line as of July 13, 2019 at: <https://www.govinfo.gov/content/pkg/USCODE-2010-title47/pdf/USCODE-2010-title47-chap5-subchapIII-partI-sec309.pdf>

what is likely to be a new entrant in the wireless service industry advances the goal of increasing competition in the industry.

In addition, the US Code dictates that the auctions promote the “development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas, without administrative or judicial delays,” something that a nation-wide license can best accomplish. The US Code also stipulates that the design of auctions of spectrum should “avoid<ing> excessive concentration of licenses and by disseminating licenses among a wide variety of applicants...” This goal can be accomplished by auctioning this band to an emerging nation-wide license holder. This is all the more important given the possibility of the merger of T-Mobile & Sprint which threatens to reduce the number of competing nation-wide operators from 4 to 3.

Note that I am a small license holder with only 23 licenses covering slightly less than 100 counties in the US, with a keen sense of the importance of competition among nation-wide operators.

## Conclusion

While fully supportive of the Commission’s NPRM, I trust that these responses to the questions raised in the NPRM will insure a timely and successful auction that will be followed by quick deployment and commercialization of a service of great use to the American public.

Pursuant to Section 1.1206(b)(2) of the Commission’s rules, an electronic copy of this letter is being filed for inclusion in the above-referenced dockets and file. If you have any questions about this filing, please contact me; I am at your service.

Respectfully Submitted,  
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