

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Allocation and Service Rules for the)	
1675-1680 MHz Band)	WT Docket No. 19-116
)	RM-11681
To: The Commission)	
)	

COMMENTS OF LIGADO NETWORKS LLC

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I. INTRODUCTION AND EXECUTIVE SUMMARY

The Commission’s proposal to reallocate spectrum in the 1675-1680 MHz band for co-primary use between incumbent federal operations and new, non-federal commercial use represents an important step on the path to creating a 5G future.¹ Reallocating this band to shared commercial use promotes the public interest, encourages investment in the development and deployment of 5G, and can be accomplished in a manner that both maintains the National Oceanic and Atmospheric Administration’s (“NOAA”) important use of this band and also provides NOAA’s weather information to a range of other interested parties. Ligado therefore urges the Commission to move swiftly to adopt nearly all of the rules the NPRM proposes and to designate the 1675-1680 MHz band for auction.

As the Commission considers the issues raised in this proceeding, it should seek to establish final rules for the 1675-1680 MHz band that maximize the band’s value, both for the

¹ See *In the Matter of Allocation and Service Rules for the 1675-1680 MHz Band, Notice of Proposed Rulemaking*, WT Docket No. 19-116 (rel. May 13, 2019) (hereinafter *NPRM*).

Treasury and for the public interest. The highest and most valuable use of this spectrum will be as part of a broader plan to make 40 megahertz of critical lower mid-band spectrum available for 5G, as Ligado proposes to do. Ligado is willing to be a robust bidder and meet any reasonable reserve price, but only if its long-pending License Modification Applications are approved. In that context, the Commission should align the rules for this five megahertz band to reflect the role it can play in a larger spectrum plan, thereby unleashing the band's full potential and enabling it to have an impact on 5G that far exceeds its relatively small size.

The Commission should proceed in setting this band to auction knowing that new commercial use of this band will not disrupt any existing use by Federal entities and that those unregistered entities who have been listening in on the band will be able to obtain the same information—while everyone with internet access will be able to access it for the first time. To address incumbent use by Federal entities, the Commission has correctly identified the protection zones that will safeguard NOAA's ongoing operations, and Ligado supports the proposed rules at Section 27.1410. The Commission should be clear in its order that entities that are not registered and not the designated recipients of the NOAA space station signal are not, as a legal matter, entitled to any protection in this band. However, even though these non-Federal entities lack a legal claim to the spectrum, including a reliance interest, Ligado nevertheless agrees with the Commission that a content delivery system ("CDS") provides an effective, efficient, and highly reliable means through which non-Federal users can continue to receive NOAA data—which provides the public interest benefit of dramatically reducing the financial and logistical hurdles currently required to access this information via satellite, thus making this vital data available, for the first time, to thousands of institutions and millions of Americans.

Another essential step to maximize the value of this spectrum is to ensure that the final licensing, operating, and technical rules for the 1675-1680 MHz band align with those for the adjacent 1670-1675 MHz band to enable the creation of a contiguous ten-megahertz block. In this regard, Ligado endorses the proposed rules on license size, license term, and buildout requirements. In two important areas, however, the NPRM would produce a suboptimal result:

- **First**, the Commission should adopt a *nationwide license area* and not use partial economic areas (“PEAs”).
- **Second**, the technical rules should *allow use of the band for uplink, downlink, or time division duplex (“TDD”)* (instead of the proposed downlink), since the adjacent 1670-1675 MHz has that flexibility.

In addition to these two technical changes, the most important step to maximize the value of this spectrum for 5G and to enable a successful auction is to approve Ligado’s License Modification Applications. As Ligado’s auction economists and its representatives recently told the Bureau staff, Ligado cannot bid in a robust way in an auction for this band if the License Modification Applications have not been approved.²

* * *

The Commission deserves commendation for rightly acknowledging that winning the 5G race requires focusing more attention on mid-band spectrum. All of the Commissioners who have made statements in approving the NPRM have recognized this pressing need.³ This

² Letter from Gerard J. Waldron, Counsel, Ligado Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 19-116; IB Docket No. 11-109; IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091 (June 14, 2019) (hereinafter *June 14, 2019 Ex Parte*).

³ See *NPRM* at Statement of Chairman Ajit Pai, Statement of Commissioner Brendan Carr, Statement of Commissioner Jessica Rosenworcel.

imperative has also not escaped the attention of the President, who recently underscored that America must build on its lead in high- and low-band spectrum “through innovation and investment in America’s mid-band spectrum and wireless cell site infrastructure.”⁴

The emphasis on the need to make more mid-band spectrum available reflects a growing understanding of mid-band spectrum’s value.⁵ Given its “balanced coverage and capacity characteristics,” mid-band spectrum “has become a target for 5G buildout.”⁶ Yet despite—or perhaps because of—its importance, mid-band spectrum remains a scarce resource. That scarcity makes prompt approval of the Commission’s proposal to put the 1675-1680 MHz band for auction—and to capture the highest and most valuable use of that band—all the more pressing.

II. SHARED USE OF THIS BAND WILL NOT DISRUPT INCUMBENT FEDERAL USE.

The NPRM correctly asks how current federal earth stations in, and adjacent to, the 1675-1680 MHz band can be protected from harmful interference.⁷ Ligado has furnished the Commission with ample evidence over the years on how dedicating the 1675-1680 MHz band to shared commercial use can be done in a manner that fully protects incumbent federal users, including, in particular, NOAA. NOAA’s use of this band consists of two key components: NOAA’s radiosonde (weather balloon instrument) operations, and NOAA’s operations involving

⁴ Remarks of President Donald J. Trump, *United States 5G Deployment* (Apr. 12, 2019), available at <https://www.whitehouse.gov/briefings-statements/remarks-president-trump-united-states-5g-deployment/>.

⁵ See Chairman Ajit Pai, *Scoring a Victory for 5G* (June 20, 2018), <https://www.fcc.gov/news-events/blog/2018/06/20/scoring-victory-5g> (“Our spectrum strategy calls for making low-band, mid-band, and high-band airwaves available for flexible use.”).

⁶ Federal Communications Commission, *The FCC’s 5G FAST Plan* (rel. Sep. 28 2018), <https://www.fcc.gov/5G>.

⁷ See NPRM at ¶ 18.

Geostationary Operational Environmental Satellite (“GOES”) operations. For each of these two key functions, clear and actionable solutions exist to protect NOAA’s operations. These solutions are entirely familiar to the Commission and are ones NOAA itself has espoused.

A. As the Commission Accurately Explains, NOAA’s Radiosonde Operations Are Being Moved to a Different Band.

In May 2014, the National Telecommunications and Information Administration (“NTIA”) informed the Commission that NOAA radiosondes would have to be relocated out of the 1675-1683 MHz band to accommodate the transition necessary as a result of the AWS-3 auction.⁸ As of June 2019, this work is well underway. Consistent with the NTIA plan, NOAA began transitioning radiosondes operations out of the 1675-1680 MHz band and into the 401-406 MHz band in 2016, and this relocation is scheduled to be completed by 2021.⁹ Thus, NOAA’s radiosonde operations, once a key feature of NOAA’s use of 1675-1680 MHz, will not be affected by shared commercial use of that spectrum when those operations commence. Instead, they will be able to operate safely in their new spectral location.

B. As the Commission Accurately Indicates, Protection Zones Can Guard Against Impacts to NOAA’s Current and Future Operations in the 1675-1680 Band.

NOAA’s other use of 1675-1680 MHz involves satellites NOAA uses to collect weather data and transmit that data to various ground stations through its GOES operations.¹⁰ The NPRM asks for comment on the appropriate methodology to protect the incumbent federal earth

⁸ National Telecommunications and Information Administration, *Notice of Estimated Relocation or Sharing Costs and Timelines for the 1695-1710 MHz and 1755-1780 MHz Bands* (May 13, 2014) available at <https://www.ntia.doc.gov/fcc-filing/2014/notice-estimated-relocation-or-sharing-costs-and-timelines-1695-1710-mhz-and-1755-17>.

⁹ See *NPRM* at ¶ 8. Some information NOAA has provided indicates this relocation will take until 2022 to complete. See NOAA Standard Form 1449 SECTION C - Description/Specification - Supplies or Services/Prices (Nov. 13, 2017), at ¶ 1.5.1.

¹⁰ See *NPRM* at ¶¶ 8–9.

stations from harmful interference and asks specifically about the establishment of protection zones.

Ligado commends the Commission for focusing on protection zones and agrees that they offer the most effective means of protecting NOAA's GOES operations. In 2013, Ligado worked with NOAA to commission a comprehensive engineering assessment to determine the feasibility of a commercial wireless operator sharing the 1675-1680 MHz band with NOAA. The assessment also identified the technical and operational parameters under which such operation could occur. Alion Science and Technology ("Alion"), an organization selected based on NOAA's recommendation, conducted the assessment in 2013 and 2014 and concluded that NOAA facilities could be adequately protected. Among other things, the conclusions in the Alion report indicate that GOES operations can be protected from shared commercial use of the 1675-1680 MHz band through the creation of protection and coordination zones.¹¹

Ligado therefore agrees with the Commission's proposed rule that the commercial licensee of this spectrum should be obligated to successfully coordinate base station operations with Federal Government entities operating meteorological satellite earth station receivers within the 14 protection zones currently set forth in note US88 of the U.S. Table of Allocations ("U.S. Table"), including the radius for each such protection zone.¹² Ligado further agrees with the

¹¹ See Alion Science and Technology, *Assessment of the Potential for LightSquared Broadband Base Stations in the 1670-1680 MHz Band To Interfere with Select NOAA Legacy Ground Locations* (Feb. 2014), filed as attachment to Letter from Jeff Carlisle, Executive Vice President for Regulatory Affairs and Public Policy, LightSquared Subsidiary LLC, to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11681; IB Docket No. 12-340; IBFS File Nos. SAT-MOD-20120928-00160, SAT-MOD- 201220928-00161, SES-MOD-20121001-00872 (Apr. 14, 2014).

¹² See *NPRM* at Appendix A, § 27.1410(a). See also 47 C.F.R. § 2.106.

Commission's proposal that non-Federal and Federal users coordinate to facilitate effective coexistence between these federal users and commercial licensees.¹³

In addition, Ligado recognizes that certain additional planned federal earth stations may be built in the future, but to maximize the value and usability of the spectrum, the Commission must identify those additional planned federal earth stations no later than the issuance of the auction notice. The NPRM suggests that federal earth stations in the 1675-1680 MHz band may be added subject to approval by NTIA and in compliance with a coordination process that will be announced jointly by the Commission and NTIA via Public Notice.¹⁴ To give potential bidders the vital information they need to make informed bids, the FCC should require NOAA to identify those future earth stations prior to the auction. This approach would enable new sites to be added while at the same time giving parties the certainty they need to submit a well-informed bid for the band and licensee(s) the information they need to deploy their network(s).

The NPRM notes that NOAA is currently conducting a study under the Spectrum Pipeline Act that may address the protection methodology necessary to make this band available on a shared basis.¹⁵ The relevance of that process to the pending NPRM is far from clear. The NPRM identified the 14 sites to be protected. The protection zone methodology also has been identified by the Alion assessment. NOAA has enough information now to comment on the NPRM. The NOAA study may enable NOAA to identify those unregistered entities which have been listening in on this band, but the solution for those eavesdroppers, whether that number is roughly 100 as Ligado's research has uncovered or twice that amount, has been proposed in the

¹³ *See id.* at ¶ 18.

¹⁴ *See id.* at Appendix A, § 27.1410(b).

¹⁵ *See id.* at ¶ 17.

NPRM: require use of a CDS to distribute the same data using 21st Century technology.

Ligado does not doubt the results of the study will be useful to NOAA, but its relevance to the Commission's decision on the NPRM has not been established. The potential of delay caused by the NOAA study is obvious, given that this spectrum was first proposed for auction in 2014 and the Commission was directed by Office of Management and Budget to complete the auction by 2020 yet NOAA only started the study last year. Finally, with respect to the timing of the study, Ligado notes that conflicting information exists as to when the study will be complete. Publicly-available information indicates the study will conclude by the fall of 2019,¹⁶ while other sources have informally indicated the study may not conclude until the second quarter of 2020. After having six years to do so, the Commission should meet the fiscal year 2020 deadline for completing the auction of this band as required by the Presidential Budget,¹⁷ and put all parties on notice that it intends to meet that deadline.

III. NON-FEDERAL USERS CAN CONTINUE TO RECEIVE THE INFORMATION THEY NOW OBTAIN BY LISTENING IN ON NOAA'S BAND.

The NPRM states that, in addition to Federal users, a variety of non-Federal users have been listening in on the 1675-1680 MHz band to obtain the data NOAA distributes to its earth stations. The NPRM inquires whether the Commission should identify such non-Federal users and how to ensure these non-Federal users continue to have access to NOAA data if commercial operations are permitted in this band.¹⁸ As a threshold matter, the NPRM does not explain why a head count is necessary, and a brief analysis shows that knowing that the number and identity of

¹⁶ David G. Lubar, STIWG, National Oceanic and Atmospheric Administration, *Spectrum Regulatory Issues* (Mar. 22, 2018), at 8.

¹⁷ Office of Management and Budget, Executive Office of the President, Budget of the United States Government, Fiscal Year 2020 (2019), at 10, *available at* <https://docs.fcc.gov/public/attachments/DOC-356607A2.pdf>.

¹⁸ *See NPRM* at ¶ 19.

the users does not inform the Commission’s consideration of a suitable alternative for these users. (NOAA has said that such a number may not even be not knowable, so the exercise could become its own excuse for delay.) Based on its research, Ligado understands that approximately 100 non-Federal users have been taking advantage of the data NOAA makes available in this band.¹⁹ Even if that number is wrong by a factor of two, or ten, it does not change the legal and policy questions before the Commission: do these entities have any legal claim to continue to listen in on someone else’s transmission (clearly No), and if not, then for policy reasons should the Commission use a CDS to meet their needs while at the same time making this valuable data available to thousands of institutions and millions of Americans (clearly Yes).

A. Non-Federal Users Have No Legal Claim to Continue to Listen In On This Spectrum.

Ligado urges the Commission to be clear and explicit—regardless of other considerations that may prompt the Commission to provide a substitute content delivery system for these non-Federal users—that these unregistered entities have *no legal claim* under the Communications Act, 47 U.S.C. § 301, or under the Commission’s Rules, to protection for their unregistered earth stations that are not identified in the U.S. Table. These interests, which have been listening in on this band for some time, no doubt have benefitted from accessing data being sent in the clear, but that creates neither a legal right for interference protection nor a reliance interest.²⁰ These

¹⁹ See Letter from Gerard J. Waldron, Counsel, Ligado Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission, RM-11681, IB Docket No. 12-340, IBFS File Nos. SES-MOD-2012001-00872, SAT-MOD-20120928-00160, and SAT-MOD-20120928-00161 (Nov. 5, 2015).

²⁰ See 47 U.S.C. § 301; *Cassell v. FCC*, 154 F.3d 478, 486 (D.C. Cir. 1998) (no reliance interest where parties invested in the absence of legal right); *Restoring Internet Freedom*, Declaratory

entities lack any legal status whatsoever: they are not licensed to use the band, they are not registered recipients of the band's communications, and they are not identified in the Table of Allocations²¹. They are, quite simply, eavesdroppers—and are therefore not entitled to any protections licensees or even registrants might receive.

The NPRM states plainly that the 1675-1680 MHz band is currently allocated in the U.S. Table as part of the 1675-1690 MHz band on a co-primary basis to the Meteorological Aids (MetAids, or radiosondes) and the Meteorological Satellite (MetSat, or space-to-earth) services.²² In turn, as the NPRM also makes clear, NTIA has assigned this band to NOAA, which, as discussed above, uses the band for its weather tracking and monitoring capabilities.²³ Because this band is not allocated to non-Federal users, much less assigned to any of the non-Federal entities seeking protection, and because these entities are not identified in the U.S. Table, they are entitled to no protection when they listen in on the spectrum at 1675-1680 MHz.²⁴ Nor are these non-Federal entities licensees or registered receive-only earth stations—the two types of entities the Commission has indicated may be afforded protection from harmful interference.²⁵

Ruling, Report and Order, and Order, 33 FCC Rcd. 311, 407 (2018) (no reliance interest arises from investment where entities acted without a clear legal entitlement for doing so).

²¹ See 47 C.F.R. § 2.106 FN US88.

²² See *NPRM* at ¶ 8.

²³ See *id.* The NPRM also identifies additional federal users that receive the NOAA data, including the National Weather Service and the National Aeronautics and Space Administration.

²⁴ Indeed, the NTIA Redbook explicitly states that, “within the jurisdiction of the United States Government, use of the radio frequency spectrum for radio transmissions for telecommunications or for other purposes shall be made by United States Government stations only as authorized by the Assistant Secretary.” See NTIA, *Manual of Regulations and Procedures for Federal Radio Frequency Management* (Redbook), at 7.1, available at https://www.ntia.doc.gov/legacy/osmhome/redbook/7_5_10.pdf.

²⁵ See Public Notice, *International Bureau and Wireless Telecommunications Bureau Seek Focused Additional Comment in 3.7-4.2 GHz Band Proceeding*, GN Docket No. 18-122, RM-11791, RM-11778 (rel. May 3, 2019) (hereinafter *C-Band May Public Notice*).

B. Despite This Lack of a Legitimate Claim, the NPRM Makes Clear That a Content Delivery System Can Meet the Needs of Non-Federal Users.

Notwithstanding the fact that non-Federal users listening in on this band are not legally entitled to any protection, to the extent the Commission seeks comment on an alternate means of delivering the NOAA data currently broadcast in the 1675-1680 MHz band to these non-Federal users,²⁶ Ligado agrees that developing a CDS is a highly effective solution. As Ligado recently explained in detail, a CDS can deliver the NOAA data non-Federal users currently access via dedicated earth stations in a faster and more reliable way than they currently receive it.²⁷ The CDS Ligado has already established, which currently provides NOAA data to George Mason University (“GMU”) and the University of Oklahoma, delivers concrete and extensive evidence of this system’s benefits.²⁸

In its recent filing, Ligado compared the existing system of receiving NOAA data, which is quite costly and time consuming, with a CDS. Obtaining this data via a satellite dish costs over \$125,000 and takes months to install and obtain the necessary permissions. With a CDS, obtaining the same data with comparable reliability and latency is fast, easy, and cheap.

As the record establishes, a CDS could increase by orders of magnitude the number of users that have access to the NOAA data—without any meaningful sacrifice in reliability or latency. With regard to reliability, employing both a multi-region and multi-cloud strategy for a CDS results in an availability of 99.999875 percent.²⁹ This result is superior to the 99.988%

²⁶ See *NPRM* at ¶ 20.

²⁷ See Letter from Gerard J. Waldron, Counsel, Ligado Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 19-116 (June 13, 2019).

²⁸ See *id.* at 3–5.

²⁹ See *id.* at 4.

availability that NOAA represents the GRB service offers. With regard to latency, a system optimally architected in close coordination with NOAA could result in a latency of as low as one second.³⁰ In the more than two years that Ligado’s CDS has been operational, it has delivered over 294 million files and 193 terabytes of data with zero delivery errors.

To access the CDS, users would only need an Internet connection. As Ligado has previously explained, many highly reliable, dedicated Internet products are available on the market, and given the position of the non-Federal users as major companies and research universities, they likely already have service-level agreements with their broadband provider that themselves use parallel processes to guarantee extremely high levels of uptime.³¹ Therefore, last mile delivery should not negatively impact delivery of the NOAA data via CDS.

Moreover, any user with such a connection can immediately access the CDS for the mere cost of maintaining the connection and server space. Users will therefore be able to benefit from all of the CDS’s advantages for what GMU has called a “tiny” cost as compared to acquiring an earth station. This means that a CDS will increase the total number of users with access to this data, providing students and more scientists with access to this data. GMU has explained that it, “look[s] forward to continuing our collaboration with Ligado and seeing how much we can

³⁰ *See id.* at 3.

³¹ *See Letter from Gerard J. Waldron, counsel, Ligado Networks, to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 19-116 (June 5, 2019); Letter from Gerard J. Waldron, counsel, Ligado Networks, to Marlene S. Dortch, Secretary, Federal Communications Commission, RM-11681; IB Docket No. 11-109; IBFS File Nos. SESMOD20151231-00981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091 (Mar. 1, 2017).*

achieve to excite students with this new, zero-cost source of high quality, real-time NOAA data.”³²

It is not surprising, given the experience described above, that NOAA itself uses this 21st Century technology to make vital weather data available to the public as a complement to satellite distribution.³³ Indeed, Ligado has previously expressed hope that NOAA could undertake this CDS itself.³⁴ To the extent the 1675-1680 MHz band proceeds to auction and Ligado makes a winning bid, Ligado commits to support the development, funding, and operation of a broader scale CDS with the features discussed above, either in coordination with NOAA or on its own, to serve all of the users who currently listen in on the NOAA data.

IV. THE COMMISSION SHOULD ENSURE THAT FINAL LICENSING, OPERATING, AND TECHNICAL RULES ALIGN WITH THOSE FOR THE ADJACENT BAND TO MAXIMIZE THE POTENTIAL OF BOTH BANDS.

While the 1675-1680 MHz band is relatively small on its own, as Commissioner Carr acknowledged,³⁵ its significance far exceeds the five megahertz of which it consists. This band can be combined with the neighboring 1670-1675 MHz band to create a ten megahertz

³² *June 13, 2019 Ex Parte* at Exhibit B.

³³ See National Oceanic and Atmospheric Association, *Big Data Project*, available at <https://www.noaa.gov/big-data-project> (last visited June 21, 2019) (“The NOAA Big Data Project (BDP) was created to explore the potential benefits of storing copies of key observations and model outputs in the Cloud to allow computing directly on the data without requiring further distribution. Such an approach could help form new lines of business and economic growth while making NOAA's data more easily accessible to the American public.”).

³⁴ Reply Comments of Ligado Networks, RM-11681 (Aug. 11, 2016), at 24 (“In order to meet the needs for distribution of real-time data feeds, Ligado has proposed that the 1675-1680 MHz band auction winner be required—unless NOAA undertakes this activity itself—to establish a robust CDN for distributing the NOAA data.”).

³⁵ See *NPRM* at Statement of Commissioner Brendan Carr (“The 5 MHz before us is a small sliver of spectrum, to be sure. But if it’s combined with adjacent and nearby channels, we could have a 40 MHz block that offers high-throughput at great distance. These are excellent characteristics for next-gen mobile broadband.”).

contiguous block, which will enable the Commission to extract the maximum value and benefit from both bands. In turn, that ten megahertz block can play a vital role in a larger 40 megahertz plan for terrestrial operations. Enabling the five megahertz of the 1670-1675 MHz band to be an integral part of the 40 megahertz plan will unlock the highest and best use of the spectrum. Accordingly, the licensing, operating, and technical rules for the 1670-1675 MHz band should all be tailored to facilitate this optimal use.

A. The Commission Has Proposed Useful License Size, License Term, and Buildout Requirements For This Band.

The Commission deserves credit for proposing numerous license rules important to maximizing the value of this band. As an initial matter, Ligado agrees with the Commission that creating a spectrum block of the entire five megahertz will best accommodate the fullest range of mobile wireless services, and, more generally, would maximize efficient use of the band.³⁶ Ligado also agrees with the Commission that a 15-year license term is appropriate for this five megahertz band. The Commission correctly recognizes that the investments the Commission seeks for this band—investments meant to deploy the next wave of broadband technology—will necessarily be long-term. Ligado agrees that 15 years should provide a licensee adequate time to operationalize these investments to yield meaningful results.

In addition, Ligado supports the Commission’s proposed performance requirements.³⁷ As the Commission has recognized, population-based metrics are “potentially less suited” to Internet of Things (“IoT”) networks.³⁸ That is because deploying an IoT network is different

³⁶ See *id.* at ¶ 24.

³⁷ See *id.* at ¶¶ 32–39.

³⁸ See, e.g., *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Order and Notice of Proposed Rulemaking, FCC 18-91, GN Docket No. 18-222, ¶ 154 (July 12, 2018).

than deploying a traditional wireless network. For example, building and maintaining an IoT network requires more lead time because it involves a purchase cycle that takes longer to complete. More fundamentally, “things” are not always located where people are—which means that a population metric can miss beneficial deployments. Thus, relative to a consumer wireless network, deploying an IoT network takes more time and can require building out over areas with smaller populations.

Population-based metrics *can* be compatible with IoT networks, however, under certain circumstances. Specifically, if licensees are given sufficient time to meet the applicable performance requirements (both interim and final), then the longer lead times associated with deploying an IoT network become less of an impediment. That is exactly what the Commission has done. By proposing to provide licensees with six years to meet the interim requirement and 12 years to meet the final requirement, the Commission would grant licensees enough time to build and deploy an IoT network that satisfies even a population-based performance requirement. As such, Ligado encourages the Commission to adopt the license size, license term, and performance requirements proposed in the NPRM.

B. To Maximize the Value of the 1675-1680 MHz Band, the Commission Should Adopt a Nationwide License Area and Permit Uplink or Downlink Use of the Band.

Given the close proximity of the 1675-1680 MHz band and the 1670-1675 MHz band, and the lack of a guard band between these two relatively small blocks of spectrum, spectrum coordination will be vital in order to maximize the value of the spectrum to be auctioned. Failing to synchronize the applicable band plans would impose substantial transaction costs, diminishing the utility of the 1675-1680 MHz band. As the Brattle Group has explained, “the value of the 10 MHz from 1670-1680 MHz is greater than the sum of the value of the two five megahertz

bands.”³⁹ Ligado therefore supports the general approach adopted in the NPRM of aligning the band plan for the 1675-1680 MHz band with that of the 1670-1675 MHz band.

Ligado cautions, however, the proposed rules deviate from this general approach in two important respects. First, the NPRM proposes licensing the 1675-1680 MHz band on a PEA basis rather than offering a national license.⁴⁰ Second, the NPRM proposes limiting the band to downlink use only.⁴¹ These proposals would prevent licensees from using the 1675-1680 MHz spectrum to its maximum potential and would impose substantial additional costs on the licensee. The Commission should therefore revise these provisions to ensure that the 1675-1680 MHz band mirrors the 1670-1675 MHz band with respect to these important parameters.

The NPRM’s proposed PEA-based license size is particularly challenging because the 1675-1680 MHz band is small and isolated. As a result, the band’s commercial viability will be impaired if it is geographically fragmented.⁴² Generally, fragmented uses of small bands are viable only when the use of the entire band is coordinated—which would not be the case if ownership of the 1675-1680 MHz is fragmented. Furthermore, as the Brattle group has noted, “the smaller the licenses, the more complicated the potential aggregation problem faced by bidders, risking inefficient auction outcomes.”⁴³ By contrast, as the Commission has recognized, nationwide license areas “provide economies of scale” and “provide for flexibility in the design

³⁹ Attachment A, Coleman Bazelon, The Brattle Group, *Choosing an Appropriate Geographic License Size: Comment on “Allocation and Service Rules for the 1675-1680 MHz Band”* (June 21, 2019), at 15 (hereinafter *Brattle Report*).

⁴⁰ See *NPRM* at ¶ 25–26. The 1670-1675 MHz band is licensed on a nationwide basis.

⁴¹ See *id.* at ¶ 22. The 1670-1675 MHz band can be used for uplink, downlink, or TDD.

⁴² See generally *Brattle Report*.

⁴³ *Id.* at 15.

and implementation” of new services.⁴⁴ Nationwide license areas also “alleviate some of the problems” that licensees have experienced when attempting “to aggregate smaller licensed service areas.”⁴⁵ Moreover, this mid-band spectrum is well suited for “deployments that support IoT and 5G,” as the NPRM itself recognizes.⁴⁶ But industrial IoT services—which will comprise a great portion of overall IoT services—are designed for national enterprises, such as transportation or logistics providers, that require a nationwide network.⁴⁷ It is therefore no surprise that most nations trying to win the race to 5G have decided to license mid-band spectrum on a nationwide basis.⁴⁸

Smaller license sizes also would increase transaction costs. Given the lack of a guard band, licensees in the 1675-1680 MHz band will have to negotiate their use of this spectrum with Ligado (which has leased the rights to five megahertz in the 1670-1675 MHz band held by Crown Castle International Corporation). The Commission’s adoption of a smaller license size, such as PEAs, would result in a potentially much greater number of licensees having to separately negotiate with Ligado, thereby increasing transaction costs.⁴⁹ On the other hand, a

⁴⁴ See *Amendment of the Commission’s Rules to Establish New Narrowband Pers. Commc’ns Servs.*, 8 FCC Rcd. 7162 ¶ 26 (1993).

⁴⁵ *Id.* Nor would a nationwide license size area be unique in this context. For example, the 2385-2390 MHz band also is a 5 MHz block of unpaired spectrum that is licensed on a nationwide basis. *Amendments to Parts 1,2,27 & 90 of Commission’s Rules to License Servs. in 216-220 MHz, 1390-1395 MHz, 1427-1429 MHz, 1429-1432 MHz, 1432-4135 MHz, 1670-1675 MHz & 2385-2390 MHz Gov’t Transfer Bands*, 17 FCC Rcd. 9980, 9983 ¶ 3 (2002).

⁴⁶ See *NPRM* at ¶ 46.

⁴⁷ See Mehmet Yavuz, Qualcomm, *Private LTE networks create new opportunities for industrial IoT* (May 31, 2017), available at <https://www.qualcomm.com/media/documents/files/private-lte-network-presentation.pdf>.

⁴⁸ Letter from Scott K. Bergmann, CTIA, to Marlene H. Dortch, Secretary, Federal Communications Commission, *Ex Parte Presentation*, GN Docket Nos. 17-183, 17-258, 18-122 (July 9, 2018).

⁴⁹ See *Brattle Report* at 16.

nationwide license would reduce transaction costs and promote the efficient use of this spectrum by drastically reducing the number of parties that have to engage in spectrum coordination negotiations.

The NPRM's proposal to designate this spectrum for downlink use only would also significantly diminish the 1675-1680 MHz band's value and utility. The band plan for the 1670-1675 MHz band permits that spectrum to be used for uplink, downlink, or TDD. As discussed above, it is critical that users in these two bands coordinate, and allowing licensees to have complementary services would facilitate that goal. Conversely, limiting the 1675-1680 MHz band to downlink only would create inconsistencies between the bands that will require more negotiations to resolve, again increasing transaction costs and depressing the value of this important mid-band spectrum.

Any potential bidder for the 1675-1680 MHz band also will need to know, beyond the proposed power limits and out-of-band emissions limits in the NPRM,⁵⁰ whether the license holder of the 1675-1680 MHz band will be required to coordinate with, and not cause harmful interference to, operations in the adjacent 1670-1675 MHz band. The NPRM is noticeably silent on this point. As a result, the Commission needs to address the issue of coordination with the 1670-1675 MHz operations in any final rules since potential bidders need that information. The coordination issue is especially relevant because the 1670-1675 MHz band can be used for uplink, downlink, or TDD—further complicating the coordination picture, especially if licenses are purchased on a PEA basis. So while the NPRM does not focus on what coordination obligations would be imposed on the 1675-1680 MHz band, the Commission's final rules should do so to fully inform potential bidders.

⁵⁰ See *NPRM* at ¶¶ 44–53.

In sum, given the need for close coordination and the commercial realities of deploying a small and isolated band, failure to align the license area size and permitted uses of the 1675-1680 MHz band would lead to the inefficient allocation of this prime, lower mid-band spectrum—something the U.S. can ill afford as it attempts to win the race to 5G. Ligado therefore urges the Commission to license the 1675-1680 MHz band on a nationwide basis and to grant licensees the flexibility to use that spectrum for uplink, downlink, or TDD.⁵¹

C. The Proposed Licensee Eligibility Requirements and Competitive Bidding Rules Are Appropriate, But The Commission Can Obtain a Higher Reserve Price For This Band By Approving Ligado’s License Modification Applications.

Ligado further agrees that the Commission should adopt an open eligibility standard for the license(s) in this band to encourage efforts to adopt new technologies, products, and services while helping to ensure efficient use of this spectrum.⁵² Ligado looks forward to working with the Commission to examine more closely the applicability of those rules to this band in due course.

For now, however, Ligado notes that Part I of the Commission’s rules contains information on the competitive bidding process, including the establishment of a reserve price. Specifically, under section 1.2104(c), the Commission may establish a reserve price, either disclosed or undisclosed, below which a license subject to auction will not be awarded.⁵³ The

⁵¹ At a minimum, if the Commission were to adopt a PEA-based license size, then it should permit the use of package bidding when auctioning this spectrum. Package bidding is an imperfect solution because it increases complexity and does not necessarily result in perfect aggregation. But it would at least mitigate some of the harms that are otherwise likely to result from PEAs.

⁵² See *NPRM* at ¶ 29.

⁵³ 47 C.F.R. § 1.2104(c); see also 47 U.S.C. § 309(j)(4)(F) (requiring the Commission to “prescribe methods by which a reasonable reserve price will be required, or a minimum bid will be established . . . unless the Commission determines that such a reserve price or minimum bid is not in the public interest”).

Commission has an opportunity to obtain a reasonable reserve price for this 5 megahertz band—but Ligado cautions that the Commission’s ability to obtain such a price is contingent on its decisions in other proceedings.

Ligado has explained that if the Commission approves the company’s pending License Modification Applications to enable it to use 35 megahertz of vital lower mid-band spectrum for 5G, then the company would plan to participate actively in the auction for the 1675-1680 MHz band and would expect to meet a reasonable reserve price to ensure the auction was successful.⁵⁴ Conversely, however, any decision by the Commission not to take action in approving Ligado’s license modification applications would impair Ligado’s ability to participate robustly in the auction. As the company has explained to the Commission, because Ligado does not know whether it will be able to use its 35 megahertz of spectrum for terrestrial operations, the company cannot determine whether it will be able to create the highest and best use of the spectrum that is the subject of the auction, which, when combined with the 1670-1675 MHz band, would create a ten megahertz contiguous block that could be deployed as part of Ligado’s 40 megahertz plan.⁵⁵ Ligado’s ability to definitively commit to bidding in the auction depends on whether the 35 megahertz covered by the License Modification Applications is useful to the company. Therefore, unless the Commission approves the License Modification Applications, Ligado may not be able to participate in an auction for the 1675-1680 MHz block.

⁵⁴ *See June 14, 2019 Ex Parte.*

⁵⁵ By dint of an agreement with Crown Castle Inc., the license holder of 1670-1675 MHz band, Ligado has the ability to access and use the 1670-1675 MHz band consistent with the Commission’s rules. *See Master Agreement by and among Crown Castle MM Holding LLC, OP LLC, and TVCC One Six Holdings LLC Dated July 16, 2007*, ULS File No. 0003108073 (filed July 17, 2007) (Lease ID L000002305, now L000007295).

A consequence of this uncertainty is that the Commission may have difficulty achieving the outcome specified in the President’s budget and likely may resort to auctioning the 1675-1680 MHz block for a significantly lower price than the block otherwise could extract—and to a party that has assigned a low value to the block. Expert economists have advised that if the block is sold under these circumstances, the spectrum would be much less likely to be put into use quickly and would be less likely to go to its highest value use.⁵⁶ As a result, the Commission’s ultimate goal—5G leadership—will be delayed. Accordingly, Ligado urges the Commission to proceed in setting the 1675-1680 MHz band for auction mindful of its broader 5G objectives.

V. CONCLUSION

The Commission has created an opportunity to leverage a relatively small band of prime, lower-mid-band spectrum to produce an impact that far exceeds its size. This band can play a critical role in a larger 40 megahertz plan that will help propel the United States across the finish line of the 5G race. For the reasons set forth herein, the Commission should move swiftly to

⁵⁶ See *June 14, 2019 Ex Parte* at 1.

approve rules to reallocate the 1675-1680 MHz band for shared commercial use—and finally enable this spectrum to meet the American people’s growing demand for advanced wireless broadband service.

Respectfully submitted,

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Attachment

June 21, 2019

Attachment A

Choosing an Appropriate Geographic License Size

COMMENT ON “ALLOCATION AND
SERVICE RULES FOR THE 1675-1680 MHZ
BAND”

PREPARED FOR

Ligado

PREPARED BY

Coleman Bazelon

June 21, 2019

Notice

- This report was prepared for Ligado Networks, in accordance with The Brattle Group's engagement terms, and is intended to be read and used as a whole and not in parts.
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I. Introduction

Ligado’s commitment to deploy its mid-band spectrum for terrestrial mobile use aligns perfectly with the Federal Communications Commissions’ (FCC) goals of providing more spectrum for terrestrial mobile use and building the foundations for a strong 5G future. A report released by the White House in May 2019 advises that that the U.S. should pursue “spectrum flexibility and agility to use multiple bands and new waveforms” and recommended identifying new bands for sharing.¹ Ligado petitioned the FCC in 2016 to allow sharing between terrestrial users and government users in the 1675 to 1680 MHz band (NOAA band).² As a part of its 5G strategy, Ligado wanted the FCC to make 40 megahertz of mid-band spectrum available for terrestrial mobile use.³ This 40 megahertz would be available from a combination of the FCC approving Ligado’s proposal for terrestrial use of the 1526-1536 MHz band, the 1627.5 – 1637.5 MHz band, the 1646.5 – 1656.5 MHz band, the 1670-1675 MHz band, and designating the 1675 – 1680 MHz band for shared use.⁴ As early as 2016, Ligado had presented a plan to the FCC that proposes to utilize their “terrestrial mid-band spectrum as a greenfield opportunity that is aligned with the Commission’s stated goals of providing the foundation of the 5G future.”⁵ They have also stated that by deploying 40 megahertz of “smart capacity on mid-band spectrum”⁶, they can “create a model of at least a partial

¹ White House Office of Science and Technology Policy, “Research and Development Priorities for American Leadership in Wireless Communication”, May 2019, <https://www.whitehouse.gov/wp-content/uploads/2019/05/Research-and-Development-Priorities-for-American-Leadership-in-Wireless-Communications-Report-May-2019.pdf>

² FCC, “Ligado Request Allocation 1675-1680 MHz Band”, Public Notice, DA-16-443, April 22, 2016, <https://www.fcc.gov/document/ligado-request-allocation-1675-1680-mhz-band>

³ Ligado, “Commission Action Can Unlock 40 Megahertz of Mid-Band Spectrum”, Ex Parte Presentation in IB Docket No. 11-109, pp. 3 - 4, June 5, 2017. <https://ecfsapi.fcc.gov/file/1060526183070/Ligado%20Ex%20Parte%20and%20Summation%20Document%20--%20June%205%2C%202017.pdf>

⁴ *Id.*

⁵ Doug Smith, “Looking Forwards to a 5G Future for the U.S. Wireless Industry”, Ligado Networks, May 23, 2016, <https://ligado.com/blog/looking-forward-5g-future-u-s-wireless-industry/>

⁶ *Id.*

5G network – a next-generation, hybrid satellite-terrestrial network – that will enable 5G use cases and mobile applications that require ultra-reliable, highly-secure and pervasive connectivity.”⁷ Commissioner Brendan Carr publicly stated that “combined with adjacent and nearby channels we could have a 40 MHz block that offers high throughput at great distance and those are excellent characteristics for next-gen mobile broadband.”⁸

The architecture of 5G networks will require spectrum in a variety of different bands.⁹ Terrestrial wireless providers need to make use of the particular characteristics of each band – low-, mid- and high-band – in a coordinated manner, for a seamless 5G strategy.¹⁰ Low band spectrum will provide coverage for wide-area and long-range communications; mid-band spectrum (1-6 GHz) will support applications that would benefit from a combination of coverage and capacity support; high band (mmW spectrum at 24 GHz and above) will provide capacity for short-range communications that require fast data rates and low latency.¹¹ This mix of spectrum that 5G networks productively integrate creates a ‘spectrum trifecta.’¹² Within this trifecta, the mid-band spectrum is becoming increasingly valuable and a cornerstone for 5G deployment.¹³

⁷ *Id.*

⁸ Randy Sukow, “1675-1680 MHz Item Turns into Debate on Mid-band Readiness”, May 9, 2019, <https://www.nrtc.coop/rural-connect/1675-1680-mhz-item-turns-into-debate-on-mid-band-readiness>

⁹ FCC, “Promoting Investment in the 3550-3700 MHz Band”, Report and Order, ¶ 8, GN Docket No. 17-258, adopted October 24, 2018, <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>.

¹⁰ Ericsson, “5G Spectrum: Strategies to Maximize all Bands”, <https://www.ericsson.com/en/networks/trending/hot-topics/5g-spectrum-strategies-to-maximize-all-bands>

¹¹ Letter to Marlene H. Dortch, FCC, from Reed Hundt, “Re: Use of Spectrum Bands Above 24 GHz for Mobile Radio Services”, GN Docket No. 14-177; IB Docket Nos. 15-256, 97-95; WT Docket No. 10-112; July 1, 2016, [https://ecfsapi.fcc.gov/file/1070164539932/Hundt%20Letter%20on%205G%20\(7-1-2016\).pdf](https://ecfsapi.fcc.gov/file/1070164539932/Hundt%20Letter%20on%205G%20(7-1-2016).pdf)

[https://ecfsapi.fcc.gov/file/1070164539932/Hundt%20Letter%20on%205G%20\(7-1-2016\).pdf](https://ecfsapi.fcc.gov/file/1070164539932/Hundt%20Letter%20on%205G%20(7-1-2016).pdf). *See also*, Tom Wheeler, “The Future of Wireless: A Vision for U.S. Leadership in a 5G World,” prepared remarks at the National Press Club, Washington, D.C., June 20, 2016, accessed January 16, 2019, http://transition.fcc.gov/Daily_Releases/Daily_Business/2016/db0620/DOC-339920A1.pdf.

¹² Coleman Bazelon and Paroma Sanyal, “Mobile Broadband Spectrum: A Revaluation in a 5G World”, Prepared for the CTIA, May 29, 2019.

¹³ Mike Dano, “Absence of Mid-Band Spectrum Clouds Trump’s 5G Proclamation”, Light Reading, April 12, 2019, <https://www.lightreading.com/mobile/5g/absence-of-mid-band-spectrum-clouds-trumps-5g-proclamations-/d/d-id/750811>

The FCC last year made low-band spectrum available in the TV incentive auction and this year is making significant amounts of mmW spectrum available. The industry's focus is now turning to mid-band spectrum,¹⁴ “the so-called Goldilocks band for its ideal mix of technical properties.”¹⁵ However, the provision of merely 5 megahertz in adjacent spectrum at a future uncertain date does little to implement the FCC's vision. This report focused on the imperative of combining the national scope of the 35 megahertz of spectrum with a national license for the adjacent 5 megahertz.

In this valuable mid-band space, Ligado currently holds 20 megahertz of terrestrial downlink spectrum in the 1525 – 1559 MHz band, 20 megahertz of terrestrial uplink spectrum in the 1626.5 – 1660.5 MHz band,¹⁶ and has leased the rights to 5 megahertz of downlink in the 1670 – 1675 MHz band held by Crown Castle International Corporation (“Crown Castle”).¹⁷ Of this, Ligado has committed to surrender terrestrial rights to 10 megahertz of downlink spectrum (1545 – 1555 MHz) to protect Global Navigation Satellite Systems (GNSS) such as GPS.¹⁸ To further protect GNSS, it has committed to reducing the power levels of transmissions in its remaining terrestrial spectrum. The 35 megahertz of Ligado's greenfield spectrum in the mid-band could be boosted

¹⁴ Monica Allevan, “Lawmakers Call on FCC to Speed Efforts to Release Midband Spectrum for 5G”, Fierce Wireless, May 13, 2019, accessed June 6, 2019, <https://www.fiercewireless.com/wireless/lawmakers-call-fcc-to-speed-efforts-to-release-midband-spectrum-for-5g>

¹⁵ Roslyn Layton, “Mid Band Spectrum Is the Next Critical Piece to Timely 5G Deployment”, Forbes, May 1, 2019, accessed June 5, 2019, <https://www.forbes.com/sites/roslynlayton/2019/05/01/mid-band-spectrum-is-the-next-critical-piece-to-timely-5g-deployment/#7faf81de1922>

¹⁶ To protect GPS operators Ligado has offered to give up its terrestrial use authority in the 1545-1555 MHz band, thus creating a 23 megahertz guardband for GPS. Additionally, it has applied for “reduced power levels nationwide for base stations that would operate in the 1526-1536 MHz band (under Ligado's proposal, the “lower downlink” band) and for user equipment in the 1627.5-1637.5 MHz and 1646.5-1656.5 MHz portions of the band (the “lower uplink” and “upper uplink” bands, respectively). See Ligado, “Commission Action Can Unlock 40 Megahertz of Mid-Band Spectrum”, Ex Parte presentation in IB Docket No. 11-109, pp. 3 - 4, June 5, 2017, <https://ecfsapi.fcc.gov/file/1060526183070/Ligado%20Ex%20Parte%20and%20Summation%20Document%20--%20June%205%2C%202017.pdf>

¹⁷ Coleman Bazelon, “Putting Mid-Band Spectrum to Work: Sharing between Ligado and its GPS Neighbors”, pp. 6. Comments of Ligado Network Inc., IB Docket No. 11-109 May 23, 2016. http://licensing.fcc.gov/myibfs/download.do?attachment_key=1136780

¹⁸ Ligado, “Ligado Network's Mobile Terrestrial Services Plan & the Protection of GNSS Service”, pp. 8-9, November 2017, accessed June 6, 2019, <https://www.gps.gov/governance/advisory/meetings/2017-11/green.pdf>

with a valuable complementary asset if the firm can plan to couple the 5 megahertz in the NOAA band with its existing 35 megahertz. Ligado then would be able to support its own 5G deployment on a national basis.

II. FCC Notice of Proposed Rulemaking (NPRM)

On May 9, 2019, the FCC adopted a Notice of Proposed Rulemaking (NPRM) and Order¹⁹ that proposes sharing in the 1675 – 1680 MHz spectrum band between incumbent federal use and terrestrial mobile and fixed wireless services. Currently, the band is allocated to Meteorological Aids (MetAids) and the Meteorological Satellite (MetSat) services for both federal and non-federal use. The National Oceanic and Atmospheric Administration (NOAA) uses this band for its weather tracking and monitoring. In the International Telecommunication Union (ITU), this band is already shared between MetAids, MetSat and flexible terrestrial use. The NPRM proposes that the band be auctioned for the use of fixed and mobile terrestrial services.²⁰ However, the NPRM does not propose any change to the federal allocations in the band. Any new fixed or mobile service will be licensed on a co-primary basis and will have to protect federal incumbents from interference.²¹ While federal MetSat Service (space-to-earth) operations²² “will remain primary in the band”, the FCC proposes that the unused non-federal MetAids Service allocation should be removed from the band. Non-federal users of the MetSat service are not protected, but Ligado has

¹⁹ FCC, “Allocation and Service Rules for the 1675-1680 MHz Band”, Notice of Proposed Rulemaking and Order, WT Docket No. 19-116, Adopted May 9, 2019, <https://docs.fcc.gov/public/attachments/DOC-357088A1.pdf>

²⁰ *Id.* ¶ 13, 42.

²¹ *Id.* ¶ 14.

²² These services provide weather data to NOAA and others, which is used for forecasting weather, and managing hydrological resources across the country, and therefore need to be protected. MetSat services will continue to occupy the band until at least 2036. See FCC, “Allocation and Service Rules for the 1675-1680 MHz Band”, Notice of Proposed Rulemaking and Order, ¶ 16, WT Docket No. 19-116, Adopted May 9, 2019, <https://docs.fcc.gov/public/attachments/DOC-357088A1.pdf>

submitted a plan ensuring these users continue to have access to the meteorological information they now receive through the MetSat Service.²³

In this NPRM, the FCC is proposing to license this band as a single five-megahertz block²⁴, since it suggests the full five megahertz may be needed for the efficient deployment of mobile services.²⁵ It proposes a 15-year license term for this band as it provides sufficient incentive to the providers for making long-term investments.²⁶ This NPRM also proposes to license this band on a geographic area basis, specifically on a partial economic area (PEA) basis.²⁷ It states that such a license size will “enable a wide range of bidders to participate in the auction and select the focused geographic areas that are most suited to their planned operations using the 1675 – 1680 MHz spectrum”.²⁸ The NPRM also asks whether other license sizes would be more appropriate for the band.

III. Discussion on Optimal Geographic License Size

A. A Brief History of License Size at the FCC

One of the primary goals of any spectrum auction is to put the spectrum being licensed to its highest value use.²⁹ In a market system, bidders who can create the most value from a resource are willing to pay the most for it. Bidders with the highest value for spectrum will likely bid more for

²³ Ligado, “Ligado Network’s Mobile Terrestrial Services Plan & the Protection of GNSS Service”, November 16, 2017, <https://www.gps.gov/governance/advisory/meetings/2017-11/green.pdf>

²⁴ FCC, “Allocation and Service Rules for the 1675-1680 MHz Band”, Notice of Proposed Rulemaking and Order, ¶ 24, WT Docket No. 19-116, Adopted May 9, 2019. <https://docs.fcc.gov/public/attachments/DOC-357088A1.pdf>

²⁵ *Id.* ¶ 26.

²⁶ *Id.* ¶ 32.

²⁷ *Id.* ¶ 26.

²⁸ *Id.*

²⁹ Peter Cramton, "Lessons Learned from the UK 3G Spectrum Auction", Report on the UK 3G Spectrum Auction for UK National Audit Office, Appendix 3, May, 2001, <http://works.bepress.com/cramton/136/>

the spectrum compared to others with lower values.³⁰ This competition amongst bidders is one of the factors that ensures an efficient outcome. The geographic license size, i.e. the size of the licensed geographic area in a spectrum auction, can be an important determinant of the strength of such competition. It may determine which providers will have an incentive to bid in the auction, and how the ultimate market structure may evolve. Depending on business plans, some bidders may have desires for national coverage and others may have differential demand in various areas of the country. Furthermore, the need for spectrum to carry out any business plan may vary by geographic area. For example, the demand for spectrum in the urban and sub-urban New York area may be higher than the demand for spectrum in rural Vermont. Additionally, even within the urban areas in New York, the demand for spectrum may vary depending on population, the bidder's existing spectrum position, and deployed technology, among other factors. Taking these various and sometime competing desires into account, the FCC has used different geographic areas for different types of spectrum. Below we discuss this in brief.

The first FCC auction was a nationwide narrowband Personal Communications Services (PCS) (900 MHz)³¹ auction in July 1994.³² It used a simultaneous multiple round auction with ascending bids³³ to allocate 11 nationwide licenses.³⁴ The auction for the 1670 – 1675 MHz Band in 2003 was also

³⁰ There are important caveats to this. Bidders with market power may value licenses more, and be willing to pay more for them, but that higher value may reflect anticompetitive benefits, rather than greater efficiencies. Also, within an auction, if bidders can collude, even tacitly, the bidder with the highest bid may not be the bidder who can use the spectrum resource most efficiently. Should either of those concerns arise, there are tools to address them, but they are beyond the scope of the current analysis of geographic license size.

³¹ The Narrowband PCS frequencies were used for voice messaging, two-way paging, and other low bandwidth one- and two-way services. See FCC, "Narrowband Personal Communications Services", Updated March 20, 2017, <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/narrowband-personal-communications-service-pcs>

³² FCC, "Auction 1: Nationwide Narrowband PCS", Fact Sheet, July 1994, <https://www.fcc.gov/auction/1/factsheet>

³³ Peter Cramton, "Money out of Thin Air: The Nationwide Narrowband PCS Auction", *Journal of Economics & Management Strategy*, pp. 267 – 343, Vol. 4(2), February 1995. <http://www.cramton.umd.edu/papers1995-1999/95jems-money-out-of-thin-air.pdf>. See also FCC, "FCC Auction Highlights, Personal Communication Service Licenses, Auction of 10 Nationwide Narrowband PCS Licenses", Bidders Information Package, July 1994, <http://wireless.fcc.gov/auctions/01/releases/bip1.pdf>

³⁴ FCC, "Auction 1: Nationwide Narrowband PCS", Fact Sheet, July 1994, <https://www.fcc.gov/auction/1/factsheet>

for a single nationwide license.³⁵ In 1994, the FCC also auctioned another 30 licenses in five Regional Narrowband PCS Service areas.³⁶ The first broadband auction, Auction 4 with bidding ending in early 1995, offered two 30 megahertz blocks of spectrum (99 licenses) for PCS in the 2 GHz band ("broadband PCS")³⁷ and Auction 7 offered a 900 MHz Specialized Mobile Radio Service (SMR)³⁸ spectrum, both over geographic areas that divided the country into 51 major trading areas ("MTAs"). The Wireless Communication Service (WCS) (2.3 GHz band) auction (Auction 14) in April 1997 divided the country into 52 Major Economic Areas (MEAs) and 12 Regional Economic Areas (REAGs).³⁹ The 800 MHz SMR auction (Auction 16),⁴⁰ and the 39 GHz auction (Auction 30),⁴¹ divided the U.S. into 175 Economic Areas (EAs). However, the broadband PCS D, E and F blocks used the 493 Basic Trading Areas (BTAs) as the geographic license area.⁴² Auction 44 and 49 used a combination of 734 MSA/RSAs (the geography used for the pre-auction cellular licenses) and 6 Economic Area Groupings (EAGs) to auction the lower 700 MHz band.⁴³ The 700 MHz auction (Auction 73)⁴⁴ and the mid-band auctions, AWS-1 and AWS-3,⁴⁵ used a combination on 734 Cellular Marketing Areas (CMAs), EAs and REAGs. The TV Incentive Auction first

³⁵ FCC, "Auction 46: 1670-1675 MHz Band Nationwide License", Fact Sheet, April, 2003, <https://www.fcc.gov/auction/46/factsheet>

³⁶ FCC, "Auction 3: Regional Narrowband PCS", Fact Sheet, October 1994, <https://www.fcc.gov/auction/3/factsheet>

³⁷ FCC, "Auction 4: Broadband PCS A and B Block, Fact Sheet, March 1995, <https://www.fcc.gov/auction/4/factsheet>

³⁸ FCC, "Auction 7: 900 MHz Specialized Mobile Radio Service", Fact Sheet, April 1996, <https://www.fcc.gov/auction/7/factsheet>

³⁹ FCC, "Auction 14: Wireless Communication Services (WCS)", Fact Sheet, April 1997, <https://www.fcc.gov/auction/14/factsheet>

⁴⁰ FCC, "Auction 16: 800 MHz Specialized Mobile Radio Service (SMR)", Fact Sheet, December 1997, <https://www.fcc.gov/auction/16/factsheet>

⁴¹ FCC, "Auction 30: 39 GHz", Fact Sheet, July 1994, <https://www.fcc.gov/auction/30/factsheet>

⁴² FCC, "Auction 11: Broadband PCS D, E, & F Block, Fact Sheet, January 1997, <https://www.fcc.gov/auction/11/factsheet>

⁴³ FCC, "Auction 44: Lower 700 MHz Band", Fact Sheet, September 2002, <https://www.fcc.gov/auction/44/factsheet>; "Auction 49: Lower 700 MHz Band", Fact Sheet, June 2003. <https://www.fcc.gov/auction/49/factsheet>

⁴⁴ FCC, "Auction 73: 700 MHz Band", Fact Sheet, March 2008, <https://www.fcc.gov/auction/73/factsheet>

⁴⁵ FCC, "Auction 66: Advanced Wireless Services (AWS-1)", Fact Sheet, September 2006, <https://www.fcc.gov/auction/66/factsheet>; "Auction 97: Advanced Wireless Services (AWS-3), Fact Sheet, January, 2015, <https://www.fcc.gov/auction/49/factsheet>.

established Partial Economic Areas (PEAs), which are subdivisions of EAs and divide the U.S. into 416 geographic areas.⁴⁶ The recent millimeter wave auctions, the 28 GHz band (Auction 101) has been licensed on a county basis,⁴⁷ while the 24 GHz band (Auction 102) is licensed on a PEA basis (416 PEAs).⁴⁸ The Connect America Fund II (CAF II) auctions⁴⁹ for allocating funds for fixed broadband and voice services deployment, on the other hand, used census blocks as the geographic area.⁵⁰ Thus, as the above discussion illustrates, the FCC has used a variety of geographic license sizes and support areas, from a single nationwide license area to using millions of census blocks, for various spectrum band licensing and service deployments.

⁴⁶ FCC, “Wireless Telecommunications Bureau Provides Details About Partial Economic Areas”, GN Docket No. 12-268, Public Notice, DA 14-759, June 2, 2014. This “Incentive Auction Report and Order”, divided EAs into 416 service areas. See “Details About Partial Economic Areas”, <https://www.fcc.gov/document/wtb-provides-details-about-partial-economic-areas>

⁴⁷ FCC, “Auction 101: Spectrum Frontiers - 28 GHz”, Fact Sheet, November 2018, <https://www.fcc.gov/auction/101/factsheet>

⁴⁸ FCC, “Auction 102: Spectrum Frontiers - 24 GHz”, Fact Sheet, March 2019, <https://www.fcc.gov/auction/102/factsheet>

⁴⁹ FCC, “Connect America Fund Phase II Auction (Auction 903)”, Overview, <https://www.fcc.gov/auction/903>

⁵⁰ FCC, “WCB Announces Revised List of Census Blocks for CAF Phase II Auction”, Public Notice, DA-18-111, released on February 6, 2018, <https://www.fcc.gov/document/wcb-announces-revised-list-census-blocks-caf-phase-ii-auction>

Table 1: FCC License Geographies

Geographic License Type [a]	Number of Geographic Units [b]	Illustrative Service / Auctions [c]
[1] Nationwide Area	1	Personal Communications Services (PCS) (900 MHz), Auction 1, 1994; 1670 - 1675 MHz Band, Auction 46, 2003
[2] Economic Area Groupings (EAG)	6	1.4 GHz Band, Auction 69, 2007
[3] Regional Economic Area Groupings (REAG)	12	WCS Auction, Auction 14, 1997
[4] Major Trading Areas (MTA)	51	900 MHz SMR, Auction 7, 1995
[5] Major Economic Areas (MEA)	52	WCS Auction, Auction 14, 1997; Upper 700 MHz Guard Bands, Auction 33, 2000
[6] Economic Areas (BEA)	176	800 MHz SMR, Auction 16, 1997
[7] Partial Economic Areas (PEA)	416	Incentive Auction, Auction 1001, 1002, 2017; 24 GHz, Auction 102, 2019
[8] Basic Trading Areas (BTAs)	493	Broadband PCS, Auction 11, 1997
[9] Cellular Market Areas (CMA)	734	700 MHz, Auction 73, 2008; AWS-1, Auction 66, 2006; ASW-3, Auction 97, 2015
[10] Metropolitan Statistical Areas (MSA)	306	Interactive Video And Data Services, Auction 2, 1994.
[11] Rural Service Areas (RSA)	428	Cellular Unserved, Auction 12, 1997.
[12] County & Equivalent	3,143	Proposed Licensing in the 3.5 GHz Band, 2018
[13] Census Tracts	73,057	Original Licensing in the 3.5 GHz Band, 2015
[14] Census Block Groups (CBG)	217,740	CAF II, Auction 903, 2018
[15] Census Blocks (CB)	11,078,297	CAF II, Auction 903, 2018

Sources: The following areas - Nationwide Area, EAG, REAG, MTA, MEA, BEA, BTA, MSA, RSA, are 1990 FCC geographies and PEA is a 2010 FCC geography. See the specific link for a particular geography in the two following links. (i) "FCC Areas", <https://www.fcc.gov/oet/maps/areas> ; and (ii) "Auction Maps: Geographic Licensing Schemes", <https://www.fcc.gov/economics-analytics/auctions-division/auctions/auction-maps>; The following areas - County & Equivalent, Census Tracts, Census Blocks and Census Block Groups are 2010 geographies and are from (iii) "2010 Census Tallies ", https://www.census.gov/geographies/reference-files/time-series/geo/tallies.html#par_textimage

Notes:

All the citations below are applicable to both column [a] and column [c].

[1]: FCC, "Auction 1: Nationwide Narrowband PCS", Fact Sheet, July 1994, <https://www.fcc.gov/auction/1/factsheet>; "Auction 46: 1670-1675 MHz Band Nationwide License", Fact Sheet, April 2003, <https://www.fcc.gov/auction/46/factsheet>

[2]: FCC, Auction 69, 1.4 GHz Bands, Fact Sheet, March 2007, <https://www.fcc.gov/auction/69/factsheet>

[3]: FCC, "Auction 14: Wireless Communication Services (WCS)", Fact Sheet, April 1997, <https://www.fcc.gov/auction/14/factsheet>

[4]: FCC, "Auction 7: 900 MHz Specialized Mobile Radio Service", Fact Sheet, April 1996, <https://www.fcc.gov/auction/7/factsheet>

- [5]: FCC, "Auction 14: Wireless Communication Services (WCS)", Fact Sheet, April 1997, <https://www.fcc.gov/auction/14/factsheet>; "Auction 33: Upper 700 MHz Guard Bands", Fact Sheet, September 2000, <https://www.fcc.gov/auction/33/factsheet>
- [6]: FCC, "Auction 16: 800 MHz Specialized Mobile Radio Service (SMR)", Fact Sheet, December 1997, <https://www.fcc.gov/auction/16/factsheet>
- [7]: FCC, "Auction 1000", <https://www.fcc.gov/auction/1000FCC>; "Auction 102: Spectrum Frontiers - 24 GHz", Fact Sheet, March 2019, <https://www.fcc.gov/auction/102/factsheet>; Incentive Auction Report and Order, divided EAs into 416 service areas; Wireless Telecommunications Bureau Provides Details About Partial Economic Areas, GN Docket No. 12-268, Public Notice, DA 14-759 (rel. June 2, 2014), <https://www.federalregister.gov/documents/2014/09/04/2014-21007/wireless-telecommunications-bureau-provides-details-about-partial-economic-areas>
- [8]: FCC, "Auction 11: Broadband PCS D, E, & F Block, Fact Sheet, January 1997, <https://www.fcc.gov/auction/11/factsheet>
- [9]: FCC, "Auction 73: 700 MHz Band", Fact Sheet, 2008. <https://www.fcc.gov/auction/73/factsheet>; "Auction 66: Advanced Wireless Services (AWS-1)", Fact Sheet, September 2006, <https://www.fcc.gov/auction/66/factsheet>; "Auction 97: Advanced Wireless Services (AWS-3)", Fact Sheet, January, 2015, <https://www.fcc.gov/auction/49/factsheet>
- [10]: FCC, "Auction 2: Interactive Video And Data Services", Fact Sheet, July, 1994, <https://www.fcc.gov/auction/2/factsheet>.
- [11]: FCC, "Auction 12: Cellular Unserved", Fact Sheet, January, 1997, <https://www.fcc.gov/auction/12/factsheet>.
- [12]: FCC, "Promoting Investment in the 3550-3700 MHz Band, Report and Order", GN Docket No. 17-258, Adopted October 24, 2018, <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>; Fierce Wireless, "FCC adopts county-sized license areas, 10-year terms for 3.5 GHz CBRS band", October 23, 2018, <https://www.fiercewireless.com/wireless/fcc-adopts-county-sized-license-areas-10-year-terms-for-3-5-ghz-cbrs-band>
- [13]: FCC, "Promoting Investment in the 3550-3700 MHz Band", Report and Order, ¶ 9, GN Docket No. 17-258, adopted October 24, 2018. <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>
- [14]: FCC, "Connect America Phase II Auction: Final Eligible Areas", <https://www.fcc.gov/reports-research/maps/caf2-auction-final-areas/>
- [15]: FCC, "Connect America Phase II Auction: Final Eligible Areas", <https://www.fcc.gov/reports-research/maps/caf2-auction-final-areas/>

In several FCC proceedings, industry participants have argued for a smaller or larger geographic license size depending on the type of spectrum and the needs of the participants. For a recent example, in the 3.5 GHz proceeding, Charter Communications wanted the FCC to limit license size to county-level at the most.⁵¹ In its most recent filing, Charter argued that increasing the size of the license area would prevent companies other than the large wireless providers from gaining access to the CBRS band.⁵² However, CTIA had proposed that the commission use the larger Cellular Market Areas (CMA) rather than census tracts.⁵³ It is issues such as these that the FCC has to balance when determining an appropriate geographic license size for a spectrum band.

The FCC has stated that it considers several factors, when determining an appropriate geographic size of a license including: “(1) facilitating access to spectrum by both small and large providers; (2) providing for the efficient use of spectrum; (3) encouraging deployment of wireless broadband services to consumers, especially those in rural areas and tribal lands; and (4) promoting investment in and rapid deployment of new technologies and services.”⁵⁴ Below we briefly discuss the general economic framework for the choice of geographic license sizes, and the benefits and costs of choosing larger and smaller geographic areas.

B. General Economic Framework

The central economic issue for appropriate license size has to do with meeting the needs of different types of bidders. Large incumbents with ubiquitous coverage tend to favor larger license geographies to complement their existing holdings; smaller regional players tend to prefer smaller licenses to complement their existing holdings; and the desires of entrants depends on the specifics of their business plans and their existing holdings.⁵⁵ On the one hand, if the FCC knew ahead of

⁵¹ Bevin Fletcher, “Charter Urges FCC to Limit Geographic Licensing of 3.3 GHz to county-sized areas”, GCN, January 4, 2018, <https://www.ecnmag.com/news/2018/01/charter-urges-fcc-limit-geographic-licensing-35-ghz-county-sized-areas>

⁵² *Id.*

⁵³ FCC, “Promoting Investment in the 3550-3700 MHz Band”, Report and Order, ¶ 15, GN Docket No. 17-258, adopted October 24, 2018, <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>.

⁵⁴ FCC, “Allocation and Service Rules for the 1675-1680 MHz Band”, Notice of Proposed Rulemaking and Order, ¶ 26, WT Docket No. 19-116, Adopted May 9, 2019, <https://docs.fcc.gov/public/attachments/DOC-357088A1.pdf>

⁵⁵ As an example, when a consortium of cable companies bid in the AWS 1 auction, they were interested in spectrum that coincided with their cable franchise areas.

time which bidder should be licensed the spectrum, there would be no need for an auction in the first place – they would simply license the spectrum to the most efficient provider. On the other hand, when there is uncertainty about which potential licensee(s) can put the spectrum to the highest valued use, a well-designed, competitive auction can reveal the most efficient or highest value creating licensees. In general, the geographic licensing regime should be tailored towards the particular characteristics of the spectrum being auctioned and the discussion below on the pros and cons of larger versus smaller geographic licenses will help illustrate why a larger geographic license size is more appropriate for licensing the 1675 – 1680 MHz band.

Emerging demand for newer mobile services from 5G and the Internet of Things (IoT) technologies is pushing wireless providers to create a seamless nationwide network with ubiquitous connectivity. Providers with nationwide mobile wireless footprints can efficiently provide such a service to the entire nation without relying on extensive roaming and other arrangements. If the aim is to roll out the next generation of wireless technology, as was accomplished in the 700 MHz auctions with 4G LTE technology, then nationwide licenses will facilitate the rapid deployment of that new technology. One ongoing spectrum policy debate centers on how to foster greater innovation through the ownership of spectrum that is sufficient for a viable market expansion. The FCC has long recognized this issue and opined in the 700 MHz auction proceeding that the use of large geographic licenses such as REAGs⁵⁶ “may meet the needs of carriers interested in creating a large regional or nationwide service area, which may be especially important for new entrants.”⁵⁷ That auction also allowed for combinatorial bidding to facilitate aggregating those regional licenses into a national footprint.⁵⁸ In the 3.5 GHz Report and Order, the Commission has recognized that smaller license sizes, such as a census tract, may “cause significant difficulties in deployment of large-scale networks for mobile 5G use”.⁵⁹

⁵⁶ There are 12 REAGs, but only 6 needed to cover the continental U.S., See FCC, “Auction Maps: Geographic Licensing Schemes”, <https://transition.fcc.gov/bureaus/oet/info/maps/areas/names/reanames.txt>

⁵⁷ FCC, “Second Report and Order.” WT Docket No. 06-150, ¶ 81. Adopted August 10, 2007. <https://ecfsapi.fcc.gov/file/6519612374.pdf>

⁵⁸ FCC, “Auction of 700 MHz Band Licenses Scheduled for January 24, 2008; Notice and Filing Requirements, Minimum Opening Bids, Reserve Prices, Upfront Payments, and Other Procedures for Auctions 73 and 76”, released on December 3, 2007, <https://www.fcc.gov/document/auction-700-mhz-band-licenses-scheduled-january-24-2008-notice-and>

⁵⁹ FCC, “Promoting Investment in the 3550-3700 MHz Band”, Report and Order, ¶ 21, GN Docket No. 17-258, adopted October 24, 2018, <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>.

Industry trends show that providers have tended to favor spectrum that covers larger areas.⁶⁰ For creating a national footprint that can effectively be the basis to offer services to large enterprise customers seeking to utilize IoT technologies made possible by 5G, larger licenses are more efficient and reduce transaction cost. For example for commercial transportation such as trucking and the rail industry, a nationwide network is essential for “asset tracking, enhanced safety and efficiency”⁶¹ and for “enhanced Positive Train Control”⁶² capabilities. Larger licenses reduce aggregation/exposure risk, implying that providers are not at risk of getting only a part of what they would require to profitably deploy a viable network.

The most important theoretical benefit of smaller licenses is that it gives smaller providers access to spectrum and encourages competition. However, a drawback of smaller licenses is the potential for significant aggregation risk and increased transactions cost.⁶³ If licenses sizes are too small, then a provider who wishes to have a large contiguous geographic footprint may be unable to win all the areas and may be left with a hole in the network coverage footprint – the aggregation risk. While secondary market transactions can be used to create a national footprint, smaller licenses increase the transaction cost of a provider negotiating with multiple small license holders.⁶⁴ A related transaction cost triggered by small licenses, one that is beyond the scope of this paper to quantify but nonetheless is important, is that some spectrum bands may require intensive coordination from an engineering perspective. Bidders on smaller licenses in a challenging spectrum environment would need to account for those transaction costs and the possible impairment of the spectrum if that coordination is suboptimal, in assessing the value of the spectrum.

⁶⁰ FCC, “Promoting Investment in the 3550-3700 MHz Band”, Report and Order, ¶ 23, 25. GN Docket No. 17-258, adopted October 24, 2018, <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>.

⁶¹ Ligado Networks, “How Ligado's Custom Private Networks Lead the Way”, <https://ligado.com/solutions/>

⁶² *Id.*

⁶³ Peter Cramton, Evan Kwerel, Gregory Rosston and Andrzej Skrzypacz, “Using Spectrum Auctions to Enhance Competition in Wireless Services”, Stanford Institute of Economic Policy research, SIEPR Discussion Paper No. 10-015, February, 2011. <http://www.cramton.umd.edu/papers2010-2014/cramton-kwerel-rosston-skrzypacz-spectrum-auctions-and-competition.pdf>

⁶⁴ FCC Spectrum Policy Task Force, “Report of the Spectrum Rights and responsibilities Working Group”, November 15, 2002, https://www.fcc.gov/sptf/files/SEWGFfinalReport_1.doc

In general, for low and high-band spectrum, the FCC has appeared to favor regional licenses of various sizes as opposed to a nationwide license.⁶⁵ However, despite some of the caveats discussed above, a CTIA report argues that for mid-band spectrum a national licensing scheme is a better vehicle for deploying the spectrum at any sub-national geography.⁶⁶ This report examines the licensing scheme for mid-band spectrum in the U.S. and twelve other countries including UK, Germany, Japan and South Korea, and concludes that a significant majority of the countries have used, or are planning to use, a national licensing scheme to make mid-band spectrum available.⁶⁷ In Spain and South Korea mid-band spectrum will be licensed on a nationwide basis, while Germany and Sweden will use a mix of national and regional geographic licenses, with China, France, Germany and Singapore expected to adopt national licenses as well. To date, Australia and Canada have opted for regional licenses for their mid-band spectrum.⁶⁸ However, as the report argues the regional licenses in these two countries are orders of magnitude larger than the U.S. regional licenses in terms of population.⁶⁹ Given that the U.S. has not yet had an auction to allocate mid-band spectrum in the 5G era, learning from the experience of other countries may lead to a successful deployment of 5G in the U.S. using mid-band spectrum.

The inherent trade-off for the FCC in deciding on appropriate geographic license size is the tension between demands for large versus small geographic areas. Insight into likely efficient outcomes can help. If, for example, the spectrum at issue was likely to be attractive to smaller, rural operators to provide wireless broadband, then larger licenses would forgo this opportunity and smaller licenses that met these bidders' demands would be appropriate. However, to the extent the same spectrum is also attractive to bidders with larger geographic demands the exposure problem becomes more relevant and smaller licenses risk missing out on an efficient allocation. When these tensions exist, package bidding can be a solution.

Package bidding allows bidders to place a bid on a package of licenses so the bidder wins either all of the licenses they desire or none of them. This aggregation of multiple small areas allows bidders

⁶⁵ See pp. 4-6 in this paper.

⁶⁶ David Abecassis, Janette Stewart, Michael Kende and Chris Nickerson, "Mid-Band Spectrum Geographical Licensing Approaches", Analysis Mason, Final Report for CTIA, July 2018, <https://api.ctia.org/wp-content/uploads/2018/07/Analysys-Mason-mid-band-5G-spectrum-paper-7-03-18.pdf>

⁶⁷ *Id.*

⁶⁸ *Id.*

⁶⁹ *Id.*

to optimally express their preferences and avoid the exposure problem by not risking winning some, but not all, of the set of desired licenses. The smaller the licenses, the more complicated the potential aggregation problem faced by bidders, risking inefficient auction outcomes. Additionally, the possibility of gaming increases – auction design and bidder sophistication tends to be an arms race and there is no guarantee that the FCC auction will avoid all opportunities for strategic bidding behavior. This should serve as a caution that more complicated auction designs carry their own risk.

IV. Why a National License Size Makes Sense for the 1675 – 1680 MHz Band

The argument for a nationwide license is strong for the 1675 – 1680 MHz band. In addition to the general argument about nationwide licenses for mid-band spectrum, the 1675 – 1680 MHz band has some unique characteristics that make it different from other mid-band spectrum under consideration. These characteristics warrant a fresh look at the band to analyze whether a nationwide license would be appropriate.

First, this is an isolated band with only five megahertz of bandwidth, so any geographic fragmentation is undesirable. Economies of scale in equipment are already challenging and regional licenses run the risk of creating a patchwork of ownership, where winning bidders may not have sufficient population coverage to profitably deploy 5G on a near-term basis. A five megahertz unpaired regional license may not be sufficient for encouraging economical deployment of nationwide 5G service. This creates inefficiency and risks this valuable spectrum not being put to its highest value use.

Second, the five megahertz of unpaired spectrum is not as valuable, given its limited bandwidth, as it would be if combined with the 1670 – 1675 MHz band, as planned by Ligado, or even with other non-adjacent bands to realize its full value and provide sufficient bandwidth for 5G uses. Ligado's ability to combine the 1675 – 1680 MHz band with the 1670 – 1675 MHz band will have the added benefit of avoiding unused guard bands and/or intense coordination between the two allocations that would be necessary if they were under different ownership. Simply put, the value of the 10 MHz from 1670 – 1680 MHz is greater than the sum of the value of the two five megahertz bands.

Third, having a nationwide license reduces transaction cost and promotes the efficient use of spectrum and fragmented regional licenses may increase the transaction costs. Although Coase teaches that markets will find efficient aggregation of rights, his findings are caveated with transactions costs being sufficiently low. The aggregation of licenses using secondary markets can be imperfect and as “the licenses become more fragmented, bidders face greater difficulties in forming their desired footprints”.⁷⁰ A fragmented band could be aggregated to a more efficient national license, but doing so adds costs.⁷¹

Furthermore, sub-national licenses increase the cost (in both time and diminution of the utility of the spectrum) of inter-band and intra-band coordination, exacerbating the costs created by guard bands.⁷² If licenses are smaller, in addition to the inter-band guard bands discussed above, intra-band, inter-license guard bands may also be necessary, increasing the transaction costs of coordinating between Ligado and the multiple licensees in the adjacent band.

Ligado is in the best position to use this spectrum and having a nationwide license makes it more efficient to deploy in this band, maximizing this band’s potential as a vehicle for deploying 5G services. An argument could be made that if not successful in an auction Ligado could still obtain a nationwide footprint by acquiring the regional licenses in secondary market transactions. However, this leads to wasteful rent-seeking and could delay deployment of 5G services. Smaller providers may have an incentive to bid higher than the intrinsic value of the license in expectation of extracting future rents from Ligado in the secondary market. A nationwide license directly solves this problem; a well-designed package bidding option makes an inefficient outcome less likely. There will be very little incentive to over-bid on the nationwide license as the licensee may not be able to profitably deploy a viable 5G network on the limited bandwidth, and the costs of obtaining the national license without using the spectrum will be high.

⁷⁰ Peter Cramton, “Why Large Licenses are Best for the 700 MHz Spectrum Auction”, April, 2007. <https://works.bepress.com/cramton/105/download/>

⁷¹ FCC, “Promoting Investment in the 3550-3700 MHz Band”, Report and Order, ¶ 32, GN Docket No. 17-258, adopted October 24, 2018, <https://docs.fcc.gov/public/attachments/FCC-18-149A1.pdf>. In this R&O, the Commission has made the case that if providers need larger areas and have to use the secondary market to obtain a larger license area then “the smaller the license area used, the larger the number of transactions that would be required, thus increasing transaction costs.” ¶ 32.

⁷² *Id.* In this R&O, the Commission has supported T-Mobile’s position that “the smaller the license area, the more the interference protection requirements will limit a licensee’s ability to use its assigned spectrum throughout its service area”. ¶23,

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