

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of

Amendment of the Commission's Rules with
Regard to Commercial Operations in the
3550-3650 MHz Band

GN Docket No. 12-354

**COMMENTS OF GOOGLE INC. ON
THE PROPOSED REVISED FRAMEWORK**

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I. INTRODUCTION AND SUMMARY.

Across the country and around the world, rapidly growing demand for wireless broadband is being met by a diverse set of service arrangements, including not only licensed macrocell services, but also home Internet access connections; cable operator hot spots; community access in schools and libraries; access points in hotels, coffee shops, and retail stores; and dense network deployments at sports, entertainment, and transportation venues. Wireless technologies are equally diverse, ranging from 3G and 4G mobile offerings to unlicensed standards such as Wi-Fi, Bluetooth, and RFID.

For the foreseeable future, a variety of service models and technologies will be required to meet the exponentially increasing demand for bandwidth. In the long run, moreover, facilitating such diversity will allow the most efficient and useful technologies to prevail in the marketplace. These practical considerations are particularly salient in the 3.5 GHz band,¹ where the need to operate on a shared basis with incumbents forecloses simple extension of approaches that have worked elsewhere: Innovation is mandatory in order to “vastly increase the usability of the 3.5 GHz band for wireless broadband.”²

In important respects, including its adoption of the managed, three-tier access framework recommended in the PCAST Spectrum Report,³ the Commission’s Revised Framework provides

¹ In this filing, references to the 3.5 GHz band include the 150 MHz of spectrum between 3.55 and 3.7 GHz.

² *Commission Seeks Comment on Licensing Models and Technical Requirements in the 3550-3650 MHz Band*, Public Notice, GN Docket No. 12-354 at ¶ 4 (rel. Nov. 1, 2013) (“Public Notice”).

³ See Executive Office of the President, President’s Council of Advisors on Science and Technology, *Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, Report to the President at App. C (July 2012) (“PCAST Spectrum Report”).

a promising foundation for diverse service opportunities in the 3.5 GHz band. Some features of the Revised Framework, however, should be refined to better support a diverse and healthy wireless ecosystem and establish this band as a model for further spectrum sharing.

First, the Commission should quickly set foundational rules for commercial use of the 3.5 GHz band. It should not delay such action while comprehensive solutions to all pending questions are being finalized. Establishing the basic framework for commercial operations will allow industry to move forward with development of various hardware and software approaches that may be successful in the band. While innovators are refining the tools they intend to use in the 3.5 GHz band, the Commission can address the remaining technical questions in this proceeding. This bifurcated approach maximizes opportunities for service innovation, and will best promote deployment of promising technologies in the future.

Second, the Commission should implement a licensing model for the 3.5 GHz band that takes full advantage of the capabilities of Spectrum Access Systems (“SAS”). Although the Revised Framework relies on some SAS functions, spectrum reservations that take advantage of all SAS spectrum management capabilities will enable more flexible commercial operations that maximize utilization of the band. The Commission’s proposed reliance on census-tract licensing, by contrast, would lead to functionally random geographic assignments that are too big to fit many potential small-cell network deployments, and too inflexible to maximize spectral efficiency overall.

Third, the Commission should resolve technical issues in a manner that maximizes opportunities for innovation, minimizes the costs of licensing and deployment, and protects incumbent operations. For example, licensing rules should discourage mutually exclusive license applications, and thus the need for auctions, by providing preferences for networks that

have been deployed and that operate efficiently. And rather than mandating specific technical parameters for all SASs, the Commission should permit ongoing, competitive development of SAS capabilities, subject to minimum interference-protection criteria.

II. THE COMMISSION SHOULD CONTINUE TO MOVE QUICKLY TO ENABLE INVESTMENT IN THE 3.5 GHZ BAND.

By rapidly adopting foundational rules for the 3.5 GHz band, the Commission will advance the national objective of “[e]xpanding the availability of spectrum for innovative and flexible commercial uses . . . as promptly as possible for the benefit of consumers and businesses.”⁴ The Cisco Visual Networking Index predicts that global IP traffic will triple over the next five years, and traffic from wireless devices will constitute the majority of all IP traffic by 2016.⁵ Small cell networks are playing an increasingly important role in meeting this rapid growth in demand for wireless data.⁶ Indeed, as the Commission has recognized, “the widespread adoption of Wi-Fi illustrates many of the potential benefits of small cells.”⁷ For example, Cisco determined that 33% of traffic that would otherwise be carried over mobile networks was offloaded to Wi-Fi or femtocells last year.⁸ For smartphones and tablets in

⁴ Presidential Memorandum—Expanding America’s Leadership in Wireless Innovation, *available at* <http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio>.

⁵ See Cisco Visual Networking Index: Forecast and Methodology, 2012–2017 at 1-2 (May 29, 2013), *available at* http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360.pdf.

⁶ For example, the number small cell networks using licensed spectrum recently surpassed the total number of macrocell deployments. See Informa Telecoms and Media, Small Cell Market Status at 3 (Feb. 2003), *available at* <http://www.smallcellforum.org/resources-reports>.

⁷ *Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Notice of Proposed Rulemaking, 27 FCC Rcd. 15,594, 15,606 ¶ 33 (2012)(“NPRM”).

⁸ See Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012–2017 at 11, 20 (Feb. 6, 2013), *available at*

particular, Cisco found that “daily data consumption over Wi-Fi is four times that of cellular.”⁹

Cisco also predicts that “Wi-Fi off-load traffic will only continue to grow.”¹⁰

Further, as the Commission has observed, the last ITU World Radiocommunication Conference identified much of the 3.5 GHz band as suitable for broadband use in many parts of the world.¹¹ Other jurisdictions are moving to provide commercial access to spectrum in the band.¹² For example, the United Kingdom intends to make additional spectrum available in this band as early as April 2015.¹³ Quick action by the Commission will contribute to preserving the United States’ global leadership in wireless services and technology.

Industry is ready to move forward. Google, for instance, is operating a pilot program that includes SAS functionality.¹⁴ Prompt resolution of core licensing and authorization questions in the 3.5 GHz band will enable Google and other companies working on spectrum-sharing innovations to justify the substantial investments that will be needed to bring SASs and devices to the marketplace. The Commission therefore should issue an order as quickly as possible on

http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf.

⁹ *Id.* at 20.

¹⁰ *Id.*

¹¹ *See* NPRM ¶ 29.

¹² *See generally* Official Journal of the European Union, Commission Decision of 21 May 2008 on the harmonisation of the 3400-3800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community, *available at* <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:144:0077:0081:EN:PDF>; *see also* Crown Recognised Spectrum Access in 3400 to 3600 MHz, OFCOM, <http://stakeholders.ofcom.org.uk/consultations/crown-rsa/summary> (last visited Nov. 21, 2013).

¹³ *See* Ofcom, 2.3 and 3.4 GHz spectrum award: Consultation on a 3.4 GHz band plan, varying UK Broadband Limited’s licence and a call for inputs on other aspects of the award at 2 ¶ 1.6 (Oct. 16, 2013), <http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz/summary/2.3-3.4-ghz.pdf>.

¹⁴ *See* Reply Comments of Google Inc. at 12, GN Docket No. 12-354 (filed Apr. 5, 2013).

the issues discussed in Section III, below, and then resolve technical issues such as auction administration and details of interference protection.

III. THE COMMISSION SHOULD TAKE ADVANTAGE OF ADDITIONAL SAS CAPABILITIES TO ENABLE MORE EFFICIENT USE OF THE BAND.

Google supports the Revised Framework’s proposal to expand Priority Access eligibility while reserving some spectrum for General Authorized Access (“GAA”) users.¹⁵ Opening the Priority Access tier will encourage deployment of systems that require reliable access to spectrum to deliver a higher quality of service.¹⁶ The licensing proposals for the Priority Access tier set forth in the Revised Framework provide a useful starting point for achieving this goal. But the Commission can enable more robust use of the 3.5 GHz band by crafting a licensing regime that harnesses SAS capabilities.

A. Priority Access License Areas Should Reflect Interference Protection Requirements, Not Census Tracts or Other Standard Geographic Units.

Google supports the Commission’s goal of authorizing Priority Access Licenses (“PALs”) in a “highly localized” fashion tailored to small-cell network deployments, while allowing geographic aggregation to license larger networks.¹⁷ Google disagrees, however, that census tracts or similar “standard geographic units” are suited to this goal. Census tracts and other standard geographic areas such as counties and grids were created for purposes unrelated to small-cell operations, and do not match spectrum boundaries in small-cell deployments. Using

¹⁵ Public Notice ¶ 11. A “Priority Access” tier with broad eligibility aligns closely with the “secondary exclusive access” tier described by the PCAST Spectrum Report.

¹⁶ See Comments of Google Inc. at 4, GN Docket No. 12-354 (filed Feb. 20, 2013) (“Google Comments”); Comments of Alcatel-Lucent at 3-6, GN Docket No. 12-354 (filed Feb. 20, 2013); Comments of the Consumer Electronics Association at 5-6, GN Docket No. 12-354 (filed Feb. 20, 2013); Comments of PCIA—The Wireless Infrastructure Association and the DAS Forum, at 5, GN Docket No. 12-354 (filed Feb. 20, 2013).

¹⁷ Public Notice ¶ 15.

such areas will create many areas where licensed wireless signals cross license-unit boundaries, and many others where licensed territory is unserved by the licensee. In short, census tracts (and other standard geographic units) are *necessarily* under-inclusive as well as over-inclusive.

First, census tracts, which the government creates based on “population characteristics, economic status, and living conditions,” often will be too big geographically to correspond with small-cell operations.¹⁸ Small cell networks in the 3.5 GHz band could be limited to footprints as small as a coffee shop or office park. Yet, as the Commission notes, there is an 85,000-square-mile census tract in Alaska.¹⁹ Even in very dense urban areas, census tracts typically overlap many city blocks.²⁰ Thus, if a hotel, hospital, or business headquarters, for example, wanted to use the 3.5 GHz band for an in-building or on-campus network, requiring a reservation throughout the entire census tract would leave substantial spectrum unutilized by any Priority Access user, with access limited to GAA. Licensing based on sizable geographic blocks would effectively preclude participation by a range of potential network operators.

In addition, the population-orientated boundaries of census tracts are unlikely to correspond with a small cell’s spectrum propagation. To avoid putting residents on a census boundary, streets commonly serve as the boundaries between census tracts in urban areas. For example, D.C. Census Tract 102, which contains the Commission’s headquarters at 445 12th Street S.W., is bounded by the centerline of Independence Avenue on the north, the centerline of 14th Street on the west, and portions of 3rd and 4th Streets on the east. But the middle of a street

¹⁸ See U.S. Census Bureau, Frequently Asked Questions, Definition: Census tract, <https://ask.census.gov/faq.php?id=5000&faqId=6459>.

¹⁹ Public Notice ¶ 15.

²⁰ See, e.g., U.S. Census Bureau, 2010 Census – Census Tract Reference Map: Baltimore City, MD, http://www2.census.gov/geo/maps/dc10map/tract/st24_md/c24510_baltimore_city/DC10CT_C24510_001.pdf.

is a particularly poor boundary for a small-cell license area, because streets are free of the obstructions that create natural signal boundaries. Indeed, if small cell networks are deployed on streetlight poles, or on the corners of buildings, then streets and the sidewalks on both sides are likely to be at the very center of the served area, and even short-range signals might span two or more census tracts.

As the Commission recognizes, the standardized geographic areas it typically uses for licensing, which are “an aggregation of county-equivalent entities,” are far larger than the “highly localized” licenses that are appropriate in this proceeding.²¹ Boundary issues become far more acute as license areas get smaller. This is because, as geographic areas increase, their boundaries grow linearly while the overall area increases far more quickly (for example, as the square of the radius of a circular area). Conversely, reducing the size of a geographic area results in a very significant decrease in overall area, with only a linear decrease in the corresponding boundary length. Put another way, the proportion of a license’s boundary to its overall area gets bigger as the size of the license area decreases. This makes boundary issues more salient as license areas shrink to reflect small cell use as opposed to macrocell use.

To solve this problem, the Commission should base license areas on spectrum characteristics rather than population characteristics. In other contexts, the Commission already relies on actual use to establish license areas. For example, the Commission assigns broadcast license areas based on predicted service contours, and authorizes fixed microwave operations between specific locations.²² The SAS approach gives the Commission a powerful new tool to

²¹ See Public Notice ¶ 15. See also Federal Communications Commission, Office of Engineering and Technology, FCC Areas, at <http://transition.fcc.gov/oet/info/maps/areas/> (last visited Dec. 5, 2013).

²² See, e.g., 47 C.F.R. §§ 73.684 (television broadcast), 101.21 (fixed microwave).

extend the same principle to wireless broadband, by adopting license boundaries for 3.5 GHz band operations that conform to spectral use. Instead of relying on geographically standard units, the 3.5 GHz licensing rules should employ the reservation capabilities of SASs to assign a license based on the applicant’s proposed network equipment and location, as well as the physical characteristics of the area where that network will operate. Doing so will enable more intensive, more flexible, and lower-cost use of the band as compared to the use permitted under a standard geographic licensing framework.

B. To Encourage Efficiency, the Commission Should Tie Priority Access License Renewals to Actual Use.

The Revised Framework proposes PALs that would terminate automatically after one year with no right of renewal, but could be aggregated consecutively to produce longer-term rights.²³ The Public Notice explains that this proposal represents an effort to provide the flexibility of short-term licenses with the predictability of longer-term licenses, while minimizing “administratively-intensive” requirements such as renewal and performance obligations.²⁴

Google believes the Commission can better achieve each of these goals by issuing licenses with a renewal expectancy limited to those portions of the spectrum that the licensee actually uses, as recorded in an SAS. Because all networks and devices would register with an SAS to obtain access to 3.5 GHz spectrum, SASs would collect information on when and where spectrum is being used, all in the normal course of operations and without additional administrative burden. This operational information could form the basis for determining whether a licensee actually is using spectrum. This approach will promote network deployments

²³ Public Notice ¶¶ 13, 24.

²⁴ *Id.* ¶ 13.

in reserved spectrum, while taking advantage of SAS features to minimize administrative burdens.

Permitting aggregation of consecutive future PALs, as the Commission proposes, would enable licensees to reserve and retain spectrum for a number of years without ever actually using it. Assuming renewal fees are paid, such reservations would exclude other Priority Access users, with no guarantee that the licensee would use its reserved spectrum. Indeed, the proposed aggregation feature entirely undermines the Commission's belief that "short term licenses with no renewal expectancy would ... significantly reduce the risk of spectrum warehousing."²⁵

Basing renewal rights on actual use, in contrast, will provide licensees with sufficient certainty to make longer-term network investments, while ensuring that other users can compete for the spectrum if the licensee fails to deploy a network. Specifically, Google recommends that the Commission establish a two-year term for a licensee's initial PAL in a given protection area in order to allow a reasonable period of time for build-out, with a one-year term thereafter. The PAL holder would have a renewal expectancy in perpetuity, subject to the payment of an annual license fee, *but only for the portion of the currently licensed spectrum actually used*. Spectrum that is not used at the time of annual renewal would be available for reservation by another Priority Access user.

SASs would enable low-cost administration of this approach. To discourage warehousing of spectrum, each network operator should be required to certify that its network registrations filed with the SAS are correct and for actual devices operating under the license.²⁶

²⁵ Public Notice ¶ 33.

²⁶ See, e.g., *U. S. v. Matanky*, 482 F.2d 1319 (9th Cir. 1973) (Medicare reimbursement claims filed with private insurance carriers subject to 18 U.S.C. § 1001, which prohibits willful false

Renewals would be automatic, based upon receipt of a renewal fee calculated in accordance with the certified use described in an SAS. Priority Access rights for any remaining, unused spectrum would then become available for other license applicants or, failing licensed use, for GAA devices to use on a non-exclusive basis. For administrative ease, the Commission could issue all renewed and new licenses as of a single date each year, after the close of the renewal window and a subsequent period for new reservations. Illustratively, the annual licensing process might be done on a schedule such as this:

May 15 to May 31—use certifications due, based on SAS reservations at the time
June 1—renewal payments due, based on certified SAS reservations
June 15 to June 20—new spectrum reservations accepted
July 1—one-year PAL renewals and two-year new PALs are issued

By this approach, parties who wish to become licensees will be able to reserve any Priority Access spectrum that is unused, and they can obtain a PAL for precisely the portion of the unused spectrum that their network plans require.

C. Commission Rules Should Enable Dynamic Frequency Assignment of Unpaired 10 MHz Channels.

The Revised Framework contemplates assigning PALs in unpaired 10 MHz blocks.²⁷ 10 MHz is an appropriate frequency block size. Moreover, the Commission soundly proposes that users—either Priority Access or GAA—should not be entitled to a specific 10 MHz block, but rather could be moved by an SAS within the band.²⁸ Although traditional spectrum assignments must use fixed spectrum blocks because there is no feasible way to accommodate dynamic assignment, an SAS can take into account the actual size and shape of the adjoining emitter and

statements “in any matter within the jurisdiction of the executive, legislative, or judicial branch of the Government of the United States”).

²⁷ Public Notice ¶ 17.

²⁸ *Id.* ¶ 30.

receiver masks for devices at a given area and assign blocks to maximize efficient use. For example, as Google has explained, an SAS would have access to specific device performance characteristics based on information provided during the device’s equipment certification process, and could provide devices that have lesser out-of-band emissions with greater opportunities to receive spectrum assignments based on the decreased interference risk.²⁹ Ensuring that users have access to the best available channel will benefit PAL and GAA operations alike. Accordingly, FCC rules should give SASs the flexibility to dynamically assign spectrum blocks at any time—even during a Priority Access license period.

To facilitate such dynamic frequency assignment, all devices should be capable of operations across the entire 150 MHz band, as the Commission proposes.³⁰ This capability is also critical to avoid devices becoming “stranded” and unusable when federal incumbents preempt commercial use of portions of the band, or Priority Access authorizations are not renewed. Without this flexibility, investments in deployed infrastructure and devices would be at greater risk.

The Public Notice specifically seeks comment on the technical feasibility of managing dynamic spectrum access on a near-real-time basis through a database.³¹ Such management is feasible and will advance the Commission’s goals of allowing intensive and efficient use of the band. Google has managed spectrum access through databases, both as a TV White Space database administrator and through an SAS pilot program on its Mountain View campus.

²⁹ See Letter from Aparna Sridhar, Telecom Policy Counsel, Google Inc. to Marlene H. Dortch, Secretary, FCC at 7, GN Docket No. 12-354 (filed Sept. 3, 2013) (“Sept. 3 Google Ex Parte Letter”).

³⁰ See *id.*

³¹ *Id.* ¶ 32.

Although the FCC correctly notes that the SAS functions proposed for the 3.5 GHz band would “go well beyond the parameters of the current TV White Spaces databases,”³² none of the SAS features are technically novel or speculative.

For example, Google has developed a prototype SAS following the principles in the PCAST report and the NPRM in this proceeding, and demonstrated its functionality at the Innovative Spectrum Sharing Technology Day held by the National Telecommunications Information Administration (NTIA) on November 5, 2013. The Google prototype includes the following capabilities:

1. Managing a mix of Priority Access and GAA devices, ensuring non-interference to Priority Access devices while incorporating minimum guarantees of bandwidth availability for GAA use.
2. Dynamic protection of C-band³³ satellite users from both in-band and out-of-band emissions based on the actual antenna elevation and elevation angles of the C-band dish and the distance between the dish and secondary users. Google’s approach takes account of all of these inputs to ensure incumbent protection while freeing up as much spectrum as possible for use by end-user devices.
3. Reflecting a wide range of device characteristics—including but not limited to power, out-of-band emissions, bandwidth, and directionality—to provide technological neutrality in spectrum assignments and encourage improved coexistence capabilities.

The algorithms and methods used to manage spectrum through the model SAS are the same ones used to determine interference in today’s ad hoc processes.

Importantly, the 3.5 GHz rules should dictate protection levels all SASs must provide, rather than requiring specific operating parameters for the databases. The specific means by which an SAS meets those requirements should be an area for competition among database providers. This competition will drive new efficiencies over time, because network operators

³² *Id.*

³³ “C-band” refers to the spectrum between 3.7 GHz and 4.2 GHz, which earth stations use to receive satellite television and radio transmissions.

will favor databases that innovatively make additional spectrum available for use, while meeting all protection criteria. For example, SAS databases could take into account parameters such as client device RF-profiles and C-band dish angles when establishing protection for incumbents, in order to make additional spectrum available for commercial use.³⁴ Mandating technically specific rules that lock in one approach, on the other hand, will undermine both innovation and competition.

D. The 3.5 GHz Band Plan Should Include the Entire 150 MHz Band and Provide a Specific Minimum Allotment for GAA Use.

The Public Notice asks whether the Commission should extend its Revised Framework proposals to the 3650-3700 MHz band.³⁵ Google supports including this additional 50 MHz of spectrum in the Commission's rules for 3.5 GHz commercial operations. As the Commission previously has recognized, the benefits of access to an additional 50 MHz are significant.³⁶ More contiguous spectrum can support more uses, attract more services, and encourage expansion of the equipment market—all of which will increase the intensity and diversity of 3.5 GHz operations.³⁷

³⁴ Google's SAS prototype accounts for aggregated interference to incumbents caused by Priority Access and GAA users. It also accounts for a device's actual out-of-band emissions characteristics. As a result, Google's SAS can dynamically maximize spectrum utilization by allowing additional secondary users until aggregated interference could harm incumbent systems, and by allowing devices with more efficient masks to operate closer to incumbent operations.

³⁵ See Public Notice ¶¶ 28-32, 51.

³⁶ NRPM ¶ 80.

³⁷ See Google Comments at 11, 13.

Most commenters agree that the Commission should include the 3650-3700 MHz band in its 3.5 GHz small cell regulatory framework.³⁸ Some C-band satellite users, however, have urged the Commission not to do so based on concerns about potential harmful interference to their operations.³⁹ Like these dissenters, Google itself relies on C-band satellites, having deployed dishes to support its Internet Protocol Television Service offerings.⁴⁰ But as Google has explained elsewhere in this proceeding, straightforward interference mitigation techniques will enable the co-existence of small cell terrestrial uses and legitimate C-band satellite operations.⁴¹ Protection of satellite operations will require some limitations on the use of the 3650-3700 MHz band, but the affected geographic area represents a small portion of the United States. There is no reason to substantially limit 3.5 GHz operations throughout the United States,

³⁸ *See, e.g.*, Comments of the Information Technology Industry Council Comments at 5, GN Docket No. 12-354 (filed Feb. 20, 2013) (“The Commission should include the 3650-3700 MHz band in its proposed regulatory regime”); Comments of Motorola Solutions, Inc. at 4, GN Docket No. 12-354 (filed Feb. 20, 2013) (“MSI is generally supportive of expanding the SAS concepts above to the 3650-3700 MHz band . . . ”); Comments of Qualcomm Incorporated at 19, GN Docket No. 12-354 (filed Feb. 20, 2013) (“The FCC Should Add The 3650 to 3700 MHz Band For Small Cell Use”); Comments of the Wireless Internet Service Providers Association at 19, GN Docket No. 12-354 (filed Feb. 20, 2013) (“WISPA urges the Commission to include the 3650-3700 MHz band in the rules it adopts for the Citizens Broadband Service, and to adopt common technical rules.”); Reply Comments of Verizon and Verizon Wireless at 3, GN Docket No. 12-354 (filed Apr. 5, 2013) (“The Commission should combine the 3.5 GHz band with the 50 MHz of spectrum between 3650 and 3700 MHz, and thus make a total of 150 MHz of spectrum available for commercial use, subject to interference protections for incumbent government users.”); Comments of WiMax Forum at 7-8, GN Docket No. 12-354 (filed Feb. 20, 2013) (“The WiMAX Forum generally supports the supplemental proposal to incorporate the 3650-3700 MHz band into the proposed regulatory regime”); *see also* Comments of Cambium Networks LLC at 3, GN Docket No. 12-354 (filed Feb. 20, 2013) (noting similarities between existing operations in 3650-3700 MHz band and proposed operations in 3550-3650 MHz band).

³⁹ *See, e.g.*, Comments of the National Association of Broadcasters at 3-4, GN Docket No. 12-354 (filed Feb. 20, 2013); Comments of the Satellite Industry Association at 18, GN Docket No. 12-354 (filed Feb. 20, 2013).

⁴⁰ *See* Sept. 3 Google Ex Parte Letter at 3.

⁴¹ *See generally id.*

when SASs can readily identify and protect these incumbents.⁴² The Commission therefore should make clear that the 3.5 GHz band plan will include the entire 150 MHz from 3550-3700 MHz, and adopt appropriate interference mitigation requirements in a subsequent order.

The Public Notice also seeks comment on how the 3.5 GHz band plan should accommodate both Priority Access and GAA uses.⁴³ In particular, the Commission asks whether the rules should assign a specific proportion of bandwidth for GAA use at certain locations and times.⁴⁴ Google agrees that the rules should account for the possibility that there may be locations where demand for Priority Access use becomes so high as to preclude GAA operations. The Commission therefore should reserve some spectrum in this band for GAA use. Calculating minimum ratios of spectrum, however, is unnecessarily complicated. The Commission should instead reserve a fixed amount of spectrum for GAA use, and allow the rest to remain open for Priority Access assignments if demand exists. (If it does not, then the unreserved Priority Access spectrum use will be available for GAA use.) Specifically, Google recommends that the band plan include ten 10 MHz channels that would be available for Priority Access operations, and allow GAA use in any of these channels if there are no Priority Access reservations. The remaining 50 MHz would be available in every market for GAA operations.

Finally, the Commission seeks comment on how it could implement a “use-it-or-share-it” concept to enable GAA use in areas where Priority Access licensees have not deployed networks.⁴⁵ In this context, reservations and the accompanying certifications in an SAS—which provide a record of network deployments over a covered area—should serve as the determination

⁴² *See id.* at 6-7.

⁴³ Public Notice ¶ 28.

⁴⁴ *Id.* ¶ 28.

⁴⁵ *Id.* ¶ 29.

of “use.” The Commission should permit partial or intermittent use by PALs over the course of the license term, although, as described above, the licensee would have to document its actual use at the time of the annual renewal window. Also as described above, unserved portions of a license area would become eligible for relicensing in the Priority Access tier during the next PAL license cycle, and for GAA use if no other party obtains a PAL for the some or all of the unserved area.

IV. THE COMMISSION NEED NOT RESOLVE TECHNICAL IMPLEMENTATION DETAILS IN ORDER TO MOVE FORWARD ON CORE RULES FOR THE BAND.

The Commission also requests comment on rules related to: (1) auctions; (2) base station transmit power; (3) acceptable interference environments; and (4) technical flexibility for devices. While Google agrees that rules for these issues should provide sufficient guidance to enable an SAS to determine appropriate protection for 3.5 GHz operations, the Commission should, wherever possible, avoid mandating specific operating requirements. As the Commission correctly observes, the 3.5 GHz band has the potential to accommodate a “variety of possible network deployments and the wide range of potential network parameters and RF configurations.”⁴⁶ To realize this goal, the rules must allow SASs sufficient flexibility to “coordinate much of the interaction between disparate users in the 3.5 GHz band.”⁴⁷

Most important for now, the Commission should not delay issuing an order on core 3.5 GHz band issues while it completes consideration of every technical concern. If the Commission cannot immediately finalize rules on a technical topic, then it should issue a Further Notice of Proposed Rulemaking seeking additional comment on that issue in conjunction with an order

⁴⁶ *Id.* ¶ 43.

⁴⁷ *Id.* ¶ 41.

opening the 3.5 GHz band for wireless broadband. It should then resolve the technical issues transparently and rapidly to enable the commencement of commercial operations.

A. Avoiding and Resolving Mutually Exclusive Applications.

The Public Notice seeks comment on auctions and other mechanisms for authorizing commercial operations in the 3.5 GHz band, including proposals that will “incentivize targeted use of the Priority Access tier by a diverse group of users.”⁴⁸ While the Commission may need to use an auction mechanism to assign Priority Access rights⁴⁹ in some circumstances, it should turn to auctions only where mutual exclusivity cannot be avoided in a manner more consistent with low-cost entry into the band.⁵⁰

If the Commission adopts the three-tiered band plan recommended in the PCAST report and described in Section III, above, and takes advantage of SAS capabilities to avoid ill-fitting geographic licensing, then mutual exclusivity should be the exception rather than the rule. Most obviously, there will be many instances where there are more 10 MHz Priority Access channels at a particular location than PAL applicants request. Even when demand for 10 MHz channels exceeds supply, an SAS’s ability to resolve disputes on a technical basis could avoid mutual exclusivity in many other situations. For example, an SAS could use terrain and physics-based propagation modeling to determine that two competing users do not actually require overlapping spectrum, so no conflict exists at a given location.⁵¹ An SAS could also provide a timing reference to synchronize the transmissions of multiple separate entities in the same vicinity,

⁴⁸ *Id.* ¶¶ 22-27.

⁴⁹ In the case of GAA users, Google agrees with the Commission’s proposal not to license GAA users separately, but instead to license these uses by rule under Part 95. *See id.* ¶ 22.

⁵⁰ *See* 47 U.S.C. § 309(j).

⁵¹ *See* Google Comments at 4 n.8.

thereby reducing interference for those networks that operate on a synchronized basis. (To maximize efficiency, such operations should be favored over non-synchronized networks in the event of conflicting applications.⁵²) Priority Access applicants can further avoid mutual exclusivity by employing interference-avoidance technologies such as fast power control, channel coding/forward error correction, adaptive modulation, and MIMO techniques.

If such mechanisms are in place—working through SASs that dynamically assign channels and geographic coverage based on need—the Commission will allow far more users to share spectrum much more effectively than was possible in the past. The Commission should further capitalize on this opportunity by giving Priority Access applicants who seek to build systems that rely on contention-avoidance technologies a licensing preference over applicants who do not.⁵³ This also will reduce mutual exclusivity. Mutual exclusivity would exist only when (1) the SAS cannot accommodate all license applicants by fine-tuning spectrum assignments within the 3.5 GHz band, and (2) a contention-avoidance-technology preference does not resolve the conflict.

As proposed in Subsection III.B., above, Priority Access licenses would enjoy a renewal expectancy for the portions of their licensed service area that they are using at the time of renewal. If the Priority Access licensee pays its annual license fee, this spectrum would be relicensed to the incumbent without any possibility of auction. This indefinite renewal

⁵² Google Comments at 8; Google Reply Comments at 10.

⁵³ *See* Google Comments at 11. As the Communications Act makes clear, the Commission’s obligation under Section 309(j) to resolve mutually exclusive applications via competitive bidding shall not “be construed to relieve the Commission of the obligation in the public interest to continue to use engineering solutions, negotiation, threshold qualifications, service regulations, and other means in order to avoid mutual exclusivity in application and licensing proceedings.” 47 U.S.C. § 309(j)(6)(E).

expectancy will further encourage entry into the band, particularly as compared to the Commission's proposal of a time-limited renewal expectancy.

The Commission states that it may “provide quality-assured spectrum for critical access users” such as hospitals, thus exempting them from the conflict-resolution rules that apply to other Priority Access users.⁵⁴ Should the Commission adopt this preference, it should be limited to available spectrum. Thus, for example, if a hospital wishes to deploy a 3.5 GHz network on its own campus during the initial licensing round, it could obtain the right to do so for two years, and thereafter could renew its license indefinitely for the areas in which it actually deployed. But if other users have filled the local Priority Access spectrum, then the hospital would not have a right to evict them. Limiting the preference to the available spectrum is appropriate so that other users can plan and build their networks without fear of being displaced unexpectedly after investments have been made. At a minimum, if the Commission gives a broader preference to critical access users, the preference should sunset after a fixed period, such as five years, unless it is extended after public interest analysis.

Google agrees with the Commission that, where auctions are required, the 3.5 GHz band presents opportunities for “more flexible and dynamic auction mechanisms.”⁵⁵ As Google previously has observed, ad placement auctions used by companies such as Google, Microsoft, and Yahoo determine prices and placement for billions of ads per day on a second-by-second basis, and some concepts developed in contexts like that may be transferable to spectrum assignments for small cell use.⁵⁶ The Commission can establish auction mechanism specifics for

⁵⁴ Public Notice ¶ 39.

⁵⁵ *Id.* ¶ 25.

⁵⁶ Google Reply Comments at 12.

the 3.5 GHz band after issuing a Further Notice, and move forward now with core rules for the band.

B. Governing Base Station Transmit Power.

The Public Notice further seeks comment on limiting base station transmit power to 24 dBm with a maximum antenna gain of 6 dBi (yielding a maximum EIRP of 30 dBm), and enabling an SAS to “regulate” device power levels.⁵⁷ As Google has suggested, the Commission should authorize a 36 dBm EIRP outdoor power limit for fixed Priority Access and GAA operations—in line with the rules for Wi-Fi equipment—in areas where they will not interfere with incumbent operations. This will enable both robust wireless network coverage and high spectral reuse of 3.5 GHz spectrum.⁵⁸ With respect to transmit power below this level, an SAS should not control base station transmit power for deployed systems, but rather could “offer” a network operator the opportunity to transmit at reduced power where new operations using the full transmit power would result in harmful interference, but operations using lower power levels would not.

To the extent that the Commission considers enabling transmit power above 36 dBm for certain use cases—such as rural coverage—it should retain a limit on conducted power into the antenna but permit higher EIRP. By doing so, the Commission can ensure that it retains meaningful limits on the ability of Priority Access licenses to exclude other Priority Access and GAA users (or to interfere with an incumbent) based on signal coverage from a single access point over a large area. Enabling higher EIRPs necessarily means that the higher power signal would be directional. Accordingly, a Priority Access licensee taking advantage of higher EIRP

⁵⁷ Public Notice ¶¶ 45-46.

⁵⁸ Google Comments at 10-11.

would have a limited area over which its operations potentially would exclude others, or—if it wished to enable wider coverage using a greater EIRP—the licensee would have to sectorize its network rather than relying on a single access point. The resulting protected areas would follow the shape of the antenna directionality; spectrum could be used more intensively because a smaller geographic area would be protected. However, the Commission’s rules should require a licensee who registers multiple directional antennas that take advantage of higher EIRPs, all at a single location, to provide total network capacity that is similar to the capacity that would be provided if each antenna were associated with its own independent base station. Otherwise, a licensee could create a coverage area at a single location that is much larger than a typical small cell deployment, without a corresponding increase in bandwidth provided to end users.

C. Establishing an Acceptable Interference Environment.

The Public Notice seeks comment on parameters that could be used to establish an “acceptable” interference environment for 3.5 GHz operations.⁵⁹ In particular, the Commission asks for information regarding noise figures; appropriate values for aggregate, intra-system, and inter-system interference rise over thermal noise (“IoT”); information about receiver desensitization; and whether it should determine acceptable interference based on field strength measurements or power flux density.⁶⁰ In addition, the Commission asks whether it should implement minimum receiver standards in the band.⁶¹ The Commission requests that

⁵⁹ Public Notice ¶ 47.

⁶⁰ *Id.*

⁶¹ *Id.*

commenters take into account interference not only between similar adjacent systems (e.g. LTE-to-LTE), but also systems that use different technologies (e.g. LTE and Wi-Fi).⁶²

The primary answer to these queries is that the Commission should not seek to ensure an acceptable operating environment by including a list of technically specific operating parameters for either Priority Access or GAA networks. Rather, the 3.5 GHz rules should enable SASs to determine compatibility dynamically. In geographic areas with incumbent operations, SASs should define protection criteria based on the environment that commercial systems must maintain in order to protect the incumbent operations. The SASs can then manage commercial operations to ensure that incumbents receive at least that level of protection.

With respect to co-existence of PALs, incompatible uses would trigger a potentially costly auction with an uncertain outcome. Therefore, as discussed in Subsection IV.A., maximizing co-existence will be in the interest of all parties. In addition to adjusting their own service area, operators might, for instance, seek to avoid mutual exclusivity by providing interference criteria tailored to the adjacent user's technology. Similarly, operators would have an incentive to deploy devices with receiver performance characteristics that decrease the risk of harmful interference, in order to avoid reservation conflicts. SASs will facilitate these efforts by providing publicly available information about reservations in the database. This approach is consistent with the Commission's efforts to encourage service providers in other bands to cooperate to avoid mutually exclusive applications.⁶³

⁶² *Id.*

⁶³ See, e.g., *Creation of a Low Power Radio Service and Amendment of Service and Eligibility Rules for FM Broadcast Translator Stations*, Sixth Order on Reconsideration, MB Docket No. 07-172, MM Docket No. 99-25, at 4 ¶ 13 and n. 36 (Oct. 17, 2013) (noting that the Commission will continue to accept "technical settlements" among parties for otherwise mutually exclusive Low Power FM license applications). As the Commission has explained, "through a technical

Although the Commission’s rules should not set detailed technical limits, Google agrees that the Commission should issue guidance to standardize certain inputs for SASs. For example, as the Commission’s questions suggest, receiver performance is the most important variable in determining whether network co-existence will be possible. Rather than having the Commission mandate explicit receiver standards and/or set specific dB values based on assumptions about appropriate receiver performance characteristics, an applicant could provide a “harm claim threshold” for its proposed operations along the lines of recommendations made earlier this year by the FCC Technological Advisory Council.⁶⁴ Indeed, such an approach would be useful not only for assessing co-existence for new Priority Access operations, but also for determining protection for existing 3.5 GHz incumbents.

D. Technical Flexibility.

The Public Notice seeks comment on how the 3.5 GHz rules and SAS systems could accommodate different types of networks and uses.⁶⁵ Consistent with the Commission’s goal of enabling a range of innovative mobile and fixed uses in the 3.5 GHz band,⁶⁶ the Commission’s rules should not prescriptively prohibit any applications—including wireless backhaul—

settlement, the Commission can grant one or more applications immediately, with the remaining applicants in that mutually exclusive group considered separately under the LPFM comparative criteria.” *Id.*

⁶⁴ See generally FCC Technological Advisory Council, Receivers and Spectrum Working Group, Interference Limits Policy, The Use of Harm Claim Thresholds to Improve the Interference Tolerance of Wireless Systems, Ver. 1.0 (Feb. 6, 2013), available at <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf>. The TAC defines a harm claim threshold as the “ceiling[] . . . on in-band and out-of-band interfering signals that must be exceeded before a radio system can claim that it is experiencing harmful interference.” *Id.* See also Comments of Pierre de Vries at 5, GN Docket No. 12-354 (filed Feb. 20, 2013).

⁶⁵ Public Notice ¶ 48.

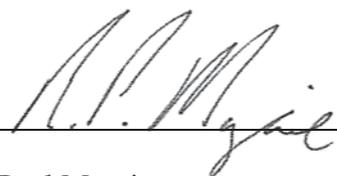
⁶⁶ See NPRM ¶ 1.

provided that devices adhere to a reasonable total EIRP limit. Moreover, the Commission's rules should permit SASs to account for techniques that would minimize interference among disparate networks.

V. CONCLUSION.

For the reasons stated above, the Commission promptly should issue core rules for the 3.5 GHz band that take full advantage of SAS capabilities, and then resolve the remaining technical issues in this proceeding as quickly as possible.

Respectfully submitted,



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