

**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

REPLY COMMENTS OF GOOGLE INC.

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TABLE OF CONTENTS

I.	INTRODUCTION AND SUMMARY	1
II.	THE COMMISSION SHOULD ADOPT RULES FOR THE 3.5 GHZ BAND THAT PROTECT INCUMBENTS, PERMIT A DIVERSITY OF BUSINESS MODELS, AND PROMOTE EFFICIENT SPECTRUM USE	3
A.	Smaller, Dynamic Exclusion Zones Will Protect Incumbents and Maximize Efficient Spectrum Use	3
B.	The Commission Should Grant Both Secondary Exclusive and GAA Users Access to the 3.5 GHz Band.	6
C.	The SAS Should Assign Rights in the Secondary Exclusive Tier so as to Privilege Efficient Use	9
III.	THE COMMISSION SHOULD ADOPT RULES EXPEDITIOUSLY	12
IV.	CONCLUSION.....	15

I. INTRODUCTION AND SUMMARY.

The rules the Commission establishes in this proceeding will determine whether investment in the 3550-3700 MHz band (“3.5 GHz band”) is commercially viable. The ideas expressed at the recent “3.5 GHz Workshop” and in written comments largely recognize that, for there to be robust commercial and public use of the band, the Commission must permit a variety of business models, ensure access for entities that build facilities, and avoid unnecessary restrictions or regulatory complexity. Adopting these policies is the key to ensuring substantial use of this technically challenging band.

Accordingly, at a high level, the Commission should adopt rules that: (1) create a three-tier access system with an incumbent tier, a “secondary exclusive”¹ tier, and a General

¹ Google recommends that the Commission use the term “secondary exclusive access” to describe Tier 2 operations, as this term more accurately describes the type of use that will meet the FCC’s goals for this tier. Indeed, commenters broadly agree that the Commission should not restrict Tier 2 operations based on attempts to determine which types of users are sufficiently important to warrant “priority access.” *See, e.g.*, Comments of Alcatel-Lucent at 5 (“[A]ny class of user that demands wireless services with quality of service guarantees ... should be eligible to obtain such access.”) (“Alcatel-Lucent Comments”); Comments of the Information Technology Industry Council at 3 (stating same) (“ITI Comments”); Comments of Nokia Siemens Networks US LLC at 20-21 (stating same) (“Nokia Siemens Comments”); Comments of the Consumer Electronics Association at 3-5 (proposing that Priority Access should be widely available) (“CEA Comments”); Comments of AT&T at i, 7-9 (proposing that eligibility for the Priority Access Tier should include commercial wireless operators) (“AT&T Comments”); Comments of Ericsson at 5-6 (stating same) (“Ericsson Comments”); Comments of CTIA – The Wireless Association[®] at 13-15 (stating that a licensing approach based on determining “priority” eligibility would present implementation challenges) (“CTIA Comments”); Comments of Mobile Future at 6-7 (same). *But see, e.g.*, Comments of Motorola Solutions, Inc. at 2-3 (proposing that certain public safety, infrastructure, and government operations should be entitled to higher priority access than commercial operations) (“Motorola Solutions Comments”); Comments of Open Technology Institute at the New America Foundation, Consumer Federation of America, Public Knowledge, and Free Press at 5, 19, 22-24 (arguing that Priority Access should be limited to infrastructure and community anchor institutions) (“PISC Comments”). Unless otherwise noted, all comment citations herein are to comments filed in GN Docket No. 12-354 (filed Feb. 20, 2013).

Authorized Access (“GAA”) tier; (2) allow both indoor and outdoor operation in the secondary exclusive tier by entities that require quality of service guarantees; and (3) rely on a robust Spectrum Access System (“SAS”) to protect incumbents and allow mutual protection among secondary exclusive users.

Further, in implementing the three-tier framework, the Commission should: (1) establish reasonable exclusion zones designed solely to protect incumbent operations rather than new commercial users; (2) permit a market-driven mix of secondary exclusive and GAA uses; and (3) assign rights in the secondary exclusive tier through the SAS by privileging efficient use. Together, these actions will maximize use of the band.

Finally, the Commission should adopt expeditiously rules governing sharing of the 3.5 GHz band. As demonstrated at the 3.5 GHz Workshop, many entities have already made substantial investments in sharing technologies that could be deployed in this band. For example, as described below, Google has started work on a prototype SAS that would protect incumbent operations and advance the state of the art in spectrum sharing. Google and other innovators need final rules to move forward with these technologies and to justify the substantial expense required to convert prototypes into working systems. The FCC should not delay such rules in an effort to craft a single spectrum sharing approach that addresses all challenges in all bands where sharing may be possible in the future. Instead, it should promptly adopt rules specifically for the 3.5 GHz band that are technology-neutral and as simple as possible. The Commission can apply the sharing principles embodied in these rules to other bands as the opportunity arises. In this way, as Dr. Preston Marshall explained at the Workshop, facilitating sharing in the 3.5 GHz band will not only serve as a worthwhile endeavor in its own right, but

also could “lay the groundwork for an even more fundamental opportunity to rapidly adopt the SAS approach in other bands.”²

II. THE COMMISSION SHOULD ADOPT RULES FOR THE 3.5 GHz BAND THAT PROTECT INCUMBENTS, PERMIT A DIVERSITY OF BUSINESS MODELS, AND PROMOTE EFFICIENT SPECTRUM USE.

Strong record evidence establishes the promise of small cell operations using the 3.5 GHz band.³ In order to attract the investment needed for network deployments, the Commission should move quickly to adopt rules that establish exclusion zones that protect incumbents based on small cell operating parameters, allow both secondary exclusive and GAA uses, and require the SAS to assign rights in the secondary exclusive tier so as to privilege efficient use.

A. Smaller, Dynamic Exclusion Zones Will Protect Incumbents and Maximize Efficient Spectrum Use.

The Commission recognized in the NPRM that the “combination of technical and service characteristics for small cell deployments in the 3.5 GHz band has the potential to reduce geographic exclusion zones while still providing necessary protections for incumbents.”⁴

² 3.5 GHz Workshop Presentation of Dr. Preston Marshall, Deputy Director, Information Sciences Institute, University of Southern California, at 5, *available at* <http://wireless.fcc.gov/workshop/Panel%202-2%20%20Preston%20Marshall.pdf> (“Marshall Presentation”).

³ *See, e.g.*, Comments of Qualcomm Incorporated at i (“Qualcomm Comments”); PISC Comments at 7-11; Comments of Wi-Fi Alliance at 4; Comments of PCIA—The Wireless Infrastructure Association and the DAS Forum, a Membership Section of PCIA at 2-5; Nokia Siemens Comments at 5; Comments of Microsoft Corporation at 3 (“Microsoft Comments”); CEA Comments at 8; Comments of Allied Communications, LLC at 2; Alcatel-Lucent Comments at 1-3; Comments of WiMAX at 1; Comments of the National Cable & Telecommunications Association at 2; AT&T Comments at i, 3-4; Comments of WhiteSpace Alliance at 2; Comments of Spectrum Bridge, Inc. at 4 (“Spectrum Bridge Comments”); Comments of SITA at 2.

⁴ *Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Notice of Proposed Rulemaking and Order, 27 FCC Rcd. 15594, ¶ 109 (rel. Dec. 12, 2012) (“NPRM”).

Commenters overwhelmingly agree.⁵ NTIA assumed in the Fast Track report that the 3.5 GHz band would be used for traditional commercial macrocells. It recommended substantial exclusion zones to accommodate those macrocell deployments. But unlike macrocells, small cells have low antenna heights and low transmit power.⁶ As Qualcomm's analysis of hypothetical small cell deployment in San Diego illustrates, NTIA's proposed zones are over-protective in the small cell context, and the FCC can reduce exclusion zones dramatically if it designates the band for use by small cells rather than macrocells.⁷

Moreover, the record confirms that the Commission should design geographic exclusion zones to protect incumbent users rather than new entrants.⁸ In other words, the Commission should calculate protection zones based only on the interference tolerance of incumbent operations, not the tolerance of potential new operations.⁹ Outside of these protection zones, the

⁵ See, e.g., AT&T Comments at 11-13; Motorola Solutions Comments at 7; ITI Comments at 6; Nokia Siemens Comments at 21-23; Comments of the Utilities Telecom Council, the Edison Electric Institute and the National Rural Electric Cooperative Association at 13, 22 ("UTC, EEI, NRECA Comments"); PISC Comments at 5, 17, 26; CEA Comments at 9; Comments of the Wireless Internet Service Providers Association at 8-9 ("WISPA Comments"); Comments of Shared Spectrum Company at 3-5; Qualcomm Comments at 2, 16-17; Comments of the Wireless Innovation Forum on the FCC Notice of Proposed Rulemaking and Order on Enabling Innovative Small Cell Use in the 3.5 GHz Band Adopted December 12, 2012 at 3 ("Wireless Innovation Forum Comments").

⁶ Motorola Solutions Comments at 7; Comments of Google Inc. at 14 ("Google Comments").

⁷ Qualcomm Comments at 17-18, Appendix.

⁸ CEA Comments at 9 (citing U.S. Dept. of Commerce, *Identification of 15 Megahertz of Spectrum Between 1675-1710 MHz for Reallocation from Federal Use to Non-Federal Use Pursuant to Section 6401(a) of the Middle Class Tax Relief and Job Creation Act of 2012*, Report to the President, at 1-2 (Feb. 2013), available at http://www.ntia.doc.gov/files/ntia/publications/1675-1710_mhz_report_to_president_02192013.pdf); Comments of Comsearch at 7.

⁹ Google Comments at 14; Motorola Solutions Comments at 7; UTC, EEI, NRECA Comments at 10, 22; PISC Comments at 5, 17-18, 26; Alcatel-Lucent Comments at 5.

FCC should permit secondary exclusive and GAA users to adjust their operations dynamically based on how much interference each new user is willing to tolerate while protecting incumbent users.¹⁰ While incumbents in the 3.5 GHz band have a need for protection from harmful interference, new entrants should be allowed to choose to operate in environments where they may encounter interference. The Commission’s rules should be flexible enough to enable commercial users—whether secondary exclusive or GAA operations—to develop technologies that can tolerate interference. Codifying current assumptions about the levels of interference commercial operations can tolerate would undermine future innovation. If commercial users have an economic incentive to develop and deploy improved technologies that better withstand interference, they will do so.¹¹ Such operations may be productive in some circumstances, such as when Wi-Fi systems in the 2.4 GHz band use an “interference robustness” mode to communicate even in the presence of microwave ovens that also occupy the band, or when personal/portable TV white spaces devices operate on first adjacent television channels even though the interference environment for those channels is less favorable than other vacant TV spectrum.

It is also important to recognize that most users will likely rely on the 3.5 GHz band to supplement service in other bands, not as their only means for connectivity. This is true both for secondary exclusive and GAA networks, which will employ devices that can operate in a suite of bands. Because these devices can turn to alternative bands in the presence of interference from incumbents, new network providers can operate even in areas where they will encounter episodic

¹⁰ Google Comments at 14; PISC Comments at 18, 26.

¹¹ See Comments of Vanu, Inc. at 4 (“Devices that have been certified for operation with higher tolerances to incumbent signals could ... be authorized to operate in zones closer to the incumbent systems.”) (“Vanu Comments”).

3.5 GHz interference from incumbents, and the FCC should not exclude them from using the band when they can do so.

B. The Commission Should Grant Both Secondary Exclusive and GAA Users Access to the 3.5 GHz Band.

The Commission can best promote commercial operations in the 3.5 GHz band by adopting a three-tier access model with: (1) an incumbent tier; (2) a secondary exclusive tier with broad eligibility for users with quality of service needs; and (3) a GAA tier for opportunistic use.¹² The FCC should reject one-sided proposals that would prohibit either secondary exclusive or GAA use. Either of these extremes would compromise innovative and efficient use of the band.

The two-tier, licensed-only regime proposed by a few commenters¹³ assumes that it can be determined *today* that the best and highest use of the 3.5 GHz band for the foreseeable future will be licensed networks requiring quality of service guarantees.¹⁴ This model would not allow any GAA use, even for applications where “best efforts” performance would suffice. It would limit sharing in the 3.5 GHz band exclusively to a small number of commercial providers, likely the major incumbent wireless carriers. The successful history of the 2.4 GHz and 5 GHz bands, however, demonstrates that allowing low-cost, opportunistic access encourages innovation—innovation that would be foreclosed in the 3.5 GHz band if FCC rules limit access solely to exclusively licensed users. Consumers would miss out on the potential development of

¹² Google Comments at 3; AT&T Comments at 9-11; Microsoft Comments at 9-10; PISC Comments at 13; Ericsson Comments at 4-7; Motorola Solutions Comments at 2; UTC, EEI, NRECA Comments at 14; Vanu Comments at 2.

¹³ Qualcomm Comments at 9; Nokia Siemens Comments at 15-21; CTIA Comments at 2-4, 15-16; Comments of T-Mobile USA, Inc. at 6 (“T-Mobile Comments”).

¹⁴ Qualcomm Comments at 14.

innovative devices and spectrum-sharing models that would not be economically feasible if every user had to make an upfront investment in infrastructure, make substantial service commitments, or meet other requirements that are likely to govern access to secondary exclusive licenses.

For example, the success of technologies such as Wi-Fi, RFID, Bluetooth, and ZigBee depended on access to spectrum bands that do not have high upfront deployment costs or other barriers to entry.¹⁵ These technologies contribute substantially to the U.S. economy. Recent studies calculate the combined annual contribution of the unlicensed wireless sector to be between \$50 billion and \$100 billion per year.¹⁶

Conversely, if Commission rules allowed only incumbents and GAA users access to the band without a secondary exclusive access tier that supports broad eligibility, as some other commenters urge, the band would be unlikely to attract major investments from commercial network operators. Commenters therefore support the inclusion of a broad secondary exclusive access tier, recognizing the benefits it would provide to those users that do have quality of service needs.¹⁷ Providing options for both secondary exclusive and GAA use, and letting the market decide the optimal mix, will increase the likelihood of successful commercial use of the 3.5 GHz band.

¹⁵ See Comments of Google Inc. and Microsoft Corporation at 3-6, GN Docket No. 12-268, (filed Jan. 25, 2013) (“Google and Microsoft Comments”); see also, Reply Comments of Google Inc. at App. A, GN Docket No 12-268 (filed Mar. 13, 2013).

¹⁶ Google and Microsoft Comments at 7 (citing Mark Cooper, *Efficiency Gains and Consumer Benefits of Unlicensed Access to the Public Airwaves* (Jan. 2012); GSMA, *The Connected Life: A USD 4.5 Trillion Global Impact in 2020* (Feb. 2012), available at http://connectedlife.gsma.com/wp-content/uploads/2012/02/Global_Impact_2012.pdf).

¹⁷ AT&T Comments at 7-8; Ericsson Comments at 5-6; Alcatel-Lucent Comments at 4-5; ITI Comments at 3.

To that end, the FCC’s rules should allow the SAS to assign spectrum rights to secondary exclusive and GAA users dynamically at different times and in different locations. Some commenters propose to partition spectrum statically between GAA and secondary exclusive users, with each set of users confined to their own portion of the 3.5 GHz band.¹⁸ But this approach would limit efficiency and intensity of use. Without dynamic assignment, valuable spectrum in a dedicated secondary exclusive portion of the band would lie fallow when not in use by incumbents or secondary exclusive users. With dynamic assignment, GAA users would have access to this spectrum where no one else is making use of it. Accordingly, Google and other commenters support the Commission’s proposal to permit GAA use throughout the band, including in vacant spectrum that is available to be used by a secondary exclusive licensee.¹⁹

Finally, the 3.5 GHz rules should account for the possibility that eventually there may be a few locations where the demand for secondary exclusive access use ultimately becomes so high as to preclude GAA operations, even though this scenario is unlikely to occur in the near term. The Commission’s rules therefore should reserve some spectrum in this band for GAA. That way, GAA devices can operate even in any areas that become heavily populated by secondary exclusive users.²⁰ As the Commission has recognized elsewhere, making non-exclusive spectrum available on a nationwide basis “will help to create certainty for ... industry and promote greater innovation in new services.”²¹ Without access to spectrum in the 3.5 GHz band

¹⁸ T-Mobile Comments at 1, 4-5, 8-10; UTC, EEI, NRECA Comments at 5, 13-14, 25; Motorola Solutions Comments at 5.

¹⁹ See NPRM at ¶¶ 56, 74; see also Google Comments at 10; PISC Comments at 28; Spectrum Bridge Comments at 8; WISPA Comments at 4.

²⁰ Google Comments at 7; Spectrum Bridge Comments at 8.

²¹ *Expanding the Economic and Innovation Opportunities of Spectrum through Incentive Auctions*, Notice of Proposed Rulemaking, 27 FCC Rcd. 12357, ¶ 232 (2012).

in every geographic market, GAA application, device, and service providers may not invest in developing new products.

C. The SAS Should Assign Rights in the Secondary Exclusive Tier so as to Privilege Efficient Use.

The Commission should define eligibility for the secondary exclusive access tier broadly to include any user that relies on quality of service and interference protection.²² To promote the most efficient use of the band by these secondary exclusive users, FCC rules should require the SAS to assign licenses in a manner that encourages the development of spectrally efficient small cell networks.

Due to the relatively poor signal propagation in the 3.5 GHz band, small cell networks using this spectrum are ideally suited to geographic spectrum sharing. Accordingly, small cell networks will promote spectrum efficiency in a way that macrocells, with their high-power operations and large geographic coverage, cannot.²³ To encourage the development of the 3.5 GHz band for efficient small cell use, the Commission should assign secondary exclusive licenses based on very small geographic areas. For example, the Commission could assign licenses based on the radius of a base station operating at a maximum power of 1 Watt prior to antenna gain with different radii for indoor and outdoor operations, rather than large regional or commercial market areas. In addition, the Commission should restrict licenses to comparatively short periods of time. The FCC should also adopt the PCAST Spectrum Report's recommendation to implement a "time to live" feature ("TTL") to encourage intensive and

²² Google Comments at 4.

²³ PISC Comments at 9.

efficient use.²⁴ Specifically, the Commission should grant incumbents permanent rights, secondary exclusive users a TTL of six months to one year, and GAA users a two-week TTL. The SAS would permit a quick and efficient renewal process.

Additionally, the Commission’s rules should encourage secondary exclusive operators to take explicit steps to make greater co-existence with neighboring secondary exclusive operations possible. For instance, as Qualcomm observes, if multiple hotspots operate at the same location and those operations are not coordinated, the result is substantially less efficient in the aggregate.²⁵ The FCC’s rules should therefore promote network deployments that coordinate operations with neighboring systems—for example, by implementing time synchronization protocols through a timing reference provided by the SAS.²⁶

The Commission could also increase spectrum efficiency and reduce potential contention among secondary licensees by encouraging licensees to account for receiver performance. As Dr. Marshall explained at the Workshop, receiver coexistence—not deconfliction of frequencies—“is often the constraint for maximizing density of spectrum usage.”²⁷ Put differently, in those situations, “receivers are at the heart of this proceeding.”²⁸

For example, Pierre de Vries recommends establishing “harm claim thresholds,” meaning “the interfering signal levels that must be exceeded before a service can claim harmful

²⁴ 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”).

²⁵ Qualcomm Comments at 18-19 and n. 31.

²⁶ See Google Comments at 8 and n.15.

²⁷ Marshall Presentation at 3.

²⁸ Comments of Pierre de Vries at 5 (“Pierre de Vries Comments”).

interference,” in order to encourage more intensive spectrum use without setting explicit receiver standards or otherwise attempting to prescriptively determine appropriate receiver performance characteristics.²⁹ The Commission can encourage development of more efficient receiver technology by limiting secondary exclusive access to applicants that are willing to set a specified harm claim threshold for their operations.³⁰

Finally, in areas where extensive deployment results in only one vacant secondary exclusive channel remaining available, the Commission’s rules should promote efficient spectrum use by preferencing access to the secondary exclusive tier for applicants whose systems utilize technical means such as those described above to avoid contention with other secondary licensees.

By affirmatively promoting spectrum efficiency in these ways, the Commission will reduce the likelihood of contention and ensure that mutually exclusive demands for secondary exclusive use will be rare. Efficient use of a band as large as the 3.5 GHz band,³¹ with propagation characteristics that result in short operating ranges, will result in an environment where many users can operate simultaneously without consuming all available spectral resources.

Indeed, if in the future the 3.5 GHz band becomes saturated at a particular location due to intensive use, this would indicate that the Commission’s sharing policies have been a resounding success. If, however, despite Commission rules requiring efficient operation, contention cannot

²⁹ *Id.* at 3.

³⁰ *See id.* at 9-10 (harm claim thresholds “provide ‘other access coordination and mitigation techniques [that] may be useful in managing access to the 3.5 GHz Band and preventing harmful interference between users’”) (quoting NPRM ¶ 146).

³¹ The 3.5 GHz band is capable of accommodating several 20 MHz channels even while reserving spectrum in every location for GAA uses.

be resolved by any means other than an auction, Google recommends that the Commission adopt a lightweight, fast, and flexible auction mechanism appropriate for what will be a dynamic 3.5 GHz band. An example of existing low cost, high speed, efficient auctions is the ad placement auctions used by Google, Microsoft, and Yahoo to determine prices and placement for billions of ads per day on a second-by-second basis. Use of such a mechanism to assign spectrum rights in the 3.5 GHz band would substantially reduce the barrier that FCC spectrum auctions present to innovators. Until such a mechanism is in place, the Commission should limit each secondary exclusive licensee to one 20 MHz channel in each geographic area to further reduce the possibility of mutual exclusivity.

III. THE COMMISSION SHOULD ADOPT RULES EXPEDITIOUSLY.

Finally, the Commission can support investment and innovation by adopting final rules for the 3.5 GHz band quickly. As the 3.5 GHz Workshop confirms, parties have already made substantial progress in developing technologies that will help enable rapid deployment of SAS systems.³² Google has started preliminary work on a prototype SAS based on the three-tier hierarchical model proposed in the PCAST Spectrum Report. This prototype will provide cloud-hosted secure interfaces to primary users of spectrum, secondary licensees, and GAA devices. In

³² See, e.g., 3.5 GHz Workshop Presentation of John P. Malyar, Chief Architect, iconectiv, at 5, available at [http://wireless.fcc.gov/workshop/Panel%202-5%20%20John%20Malyar%20-%20iconectiv%20\(Telcordia\).pdf](http://wireless.fcc.gov/workshop/Panel%202-5%20%20John%20Malyar%20-%20iconectiv%20(Telcordia).pdf); 3.5 GHz Workshop Presentation of Peter Stanforth, CTO, Spectrum Bridge, at 2, available at <http://wireless.fcc.gov/workshop/Panel%202-1%20%20Peter%20Stanforth.pdf> (“Stanforth Presentation”). The fact that several different innovators are working on SAS technologies also indicates that Commission rules should authorize multiple SAS databases that interact with one another. By doing so, the Commission can build on the successful database administrator approach taken in the white spaces proceeding. As Spectrum Bridge explains, industry participants collaborated with each other and with the Commission not only to enable effective synchronization across TV white spaces database systems, but also to achieve consistency for calculations necessary to implement the TV white spaces rules. Stanforth Presentation at 3.

addition, Google is developing an experimental shared spectrum network that will enable cellular base stations and “best efforts” devices to interact with the prototype SAS.

Although Google’s prototype SAS necessarily is not a complete system, it already includes several core features that should be included in production systems. The prototype SAS allows primary license holders to add or delete exclusion zones, as well as to enforce temporary suspension areas, all within parameters defined in the SAS to reflect the governing rules for the band. Prospective secondary licensees can query the SAS to determine spectrum availability in a given geographic area and place reservations for spectrum. Network infrastructure that operates under these reservations will maintain communication with the SAS through access points, base stations, or associated network management systems exchanging messages over secured channels.

Significantly, Google designed this prototype framework to allow standards-based mobile devices to operate in secondary exclusive spectrum reservations. Google’s prototype SAS will not require that mobile devices have internal geolocation technology or communicate directly with the SAS. The base station will register the interference contours of client mobile devices in the database in addition to the contours of its own operation, thereby avoiding the need for mobile devices to register themselves. GAA devices may also query the SAS and receive a time-bound permission to operate, provided that they do not conflict with higher priority primary or secondary licensees. For GAA devices, Google intends to use mechanisms that closely mirror those approved in the TV white spaces proceeding.

Google, and other companies working on spectrum sharing innovations, need 3.5 GHz band sharing rules to make test systems into operating systems. Rules will provide engineers with the details they need to ensure that their systems will meet Commission requirements. A

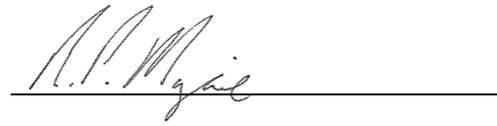
final order will also send a strong signal from the FCC that companies that build SAS technologies will have a band where they can be used. This signal will help justify the substantial investments required to move from the lab to the marketplace.

Importantly, the FCC should not attempt to produce 3.5 GHz rules that solve every spectrum sharing challenge that exists in any band where sharing may be possible in the future. Such a project would cause great and unnecessary delay—and would be unlikely to succeed. The balanced and flexible approach suggested by Google would instead enable rapid adoption of the SAS model across bands, without becoming bogged down in a quest to produce rules that would work in any band.

IV. CONCLUSION.

The record in this proceeding confirms that shared spectrum access in the 3.5 GHz band can expand access to wireless broadband in the near term, promote efficient spectrum use, and establish a framework for successful shared access in other federally allocated bands. Adopting the recommendations described above will maximize utility of the band and encourage sustained investment, while fully protecting incumbent operations.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "P. Margie", is written above a solid horizontal line.

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