

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

In the Matter of

Expanding the Economic and Innovation  
Opportunities of Spectrum Through Incentive  
Auctions

GN Docket No. 12-268

**REPLY COMMENTS OF GOOGLE INC.**

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## I. INTRODUCTION AND SUMMARY.

Comments in response to the FCC's Notice of Public rulemaking ("NPRM") strongly support an incentive auction process that produces substantial and usable licensed and unlicensed spectrum resources. In particular, the record supports:

- Allowing unlicensed technologies to operate in the 600 MHz band and recognizing that such operation need not cause harmful interference to licensed networks;
- Adopting an FDD band plan with ample duplex gap and guard bands where consumers can use unlicensed technologies;
- Permitting consumers to use unlicensed devices in both of the two channels currently reserved for wireless microphones and Channel 37; and
- Repacking broadcasters in a way that facilitates continued availability of white spaces for unlicensed technologies.

By taking these steps, the Commission can protect incumbent operations while also "promot[ing] the efficient use of spectrum in order to meet the current and future needs of the American public."<sup>1</sup>

## II. THE COMMISSION SHOULD SUPPORT INNOVATION AND ECONOMIC GROWTH THROUGH ROBUST UNLICENSED DESIGNATIONS IN THE 600 MHZ GUARD BANDS AND DUPLEX GAP.

In response to the Commission's NPRM, technology companies, cable providers, broadcasters, ISPs, and public interest groups all agree that a balance of licensed and unlicensed spectrum resources in the 600 MHz band will support economic growth and innovation.<sup>2</sup> A new

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<sup>1</sup> *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, 27 FCC Rcd. 12357 ¶ 23 ("NPRM").

<sup>2</sup> *See, e.g.*, Comments of Comcast Corporation and NBCUniversal Media, LLC ("Comcast NBCU Comments") at 20, 44; Comments of the National Cable & Telecommunications Association ("NCTA Comments") at 4-6; Comments of the Wireless Internet Service Providers Association ("WISPA Comments") at 7-8; Comments of the Public Interest Spectrum Coalition ("PISC Comments") at 8-18; Comments of Free Press ("Free Press Comments") at 7-12; Comments of WhiteSpace Alliance ("WhiteSpace Alliance

analysis by Google Chief Economist Hal Varian, attached as Appendix A, further supports this conclusion, finding that smartphone use over unlicensed networks alone contributes \$30-38 billion per year to the national economy.<sup>3</sup> To accommodate both licensed and unlicensed technologies in this band, the FCC should: (1) find that unlicensed technologies can operate in the band without causing harmful interference to licensed networks; (2) adopt a band plan and technical rules that allow strong and sustainable unlicensed operations in the duplex gap and guard bands; and (3) reject arguments that it should auction the duplex gap and guard bands.

**A. Unlicensed Technologies Can Operate in the 600 MHz Band Without Causing Harmful Interference to Licensed Networks.**

A broad cross-section of commenters, including licensed carriers that would operate in close proximity to unlicensed devices, support permitting unlicensed technologies to use the 600 MHz band.<sup>4</sup> For example, Verizon explains that “[a]ppropriate low-power Part-15 type devices could operate in the guard band and the duplexer gap on a non-interfering basis.”<sup>5</sup> Similarly, Sprint, while supporting a TDD-based band plan that would not require a duplex gap, supports unlicensed operations in the guard bands.<sup>6</sup> CTIA observes that, because “unlicensed services have played an important role in the provision of wireless broadband service,” “spectrum in the guard bands should be identified for unlicensed use, to the extent technically

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Comments”) at 10-13. Unless otherwise noted, all comment citations herein are to GN Docket 12-268.

<sup>3</sup> See generally Appendix A, Declaration of Hal Varian.

<sup>4</sup> Although Qualcomm suggests that white spaces devices may cause interference to LTE networks based on “a preliminary analysis,” Qualcomm has not submitted any details regarding its admittedly tentative view. Comments of Qualcomm Incorporated (“Qualcomm Comments”) at 22. Google, therefore, cannot comment on these statements.

<sup>5</sup> Comments of Verizon and Verizon Wireless (“Verizon Comments”) at 20.

<sup>6</sup> Comments of Sprint Nextel (“Sprint Nextel Comments”) at 23.

feasible.”<sup>7</sup> Furthermore, the National Association of Broadcasters notes that the 600 MHz band plan can accommodate “additional services” such as unlicensed devices, “so that each megahertz cleared is a valuable one.”<sup>8</sup>

**B. An FDD Band Plan with Ample Guard Bands and a Duplex Gap Will Protect Against Harmful Interference and Support a Balance of Licensed and Unlicensed Operations.**

The record confirms that the Commission should implement a proven FDD band plan for the 600 MHz band.<sup>9</sup> This band plan should not place television or other high power operations in the duplex gap. It should incorporate a guard band between LTE downlink operations and remaining broadcasters that is large enough to protect both types of licensees from interference—which the record shows requires considerably more than the 6 MHz proposed by the FCC.

A traditional FDD band plan—similar to the FCC’s alternative plan depicted in figure 12 of the NPRM—enjoys widespread support from parties whose participation will be critical to maximize the value of the 600 MHz band, including incumbent broadcasters,<sup>10</sup> carriers who will bid for and build out licensed networks,<sup>11</sup> unlicensed wireless network operators,<sup>12</sup> and equipment manufacturers.<sup>13</sup> As discussed below, implementing an FDD band plan with ample spectrum designated for guard band between LTE downlink and DTV, and a duplex gap, will

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<sup>7</sup> Comments of CTIA–The Wireless Association® (“CTIA Comments”) at 3.

<sup>8</sup> Comments of the National Association of Broadcasters (“NAB Comments”) at 46.

<sup>9</sup> *See, e.g.*, NAB Comments at 46; Verizon Comments at 18-20; CTIA Comments at 28; Comments of AT&T Inc. (“AT&T Comments”) at 34; NCTA Comments at 7; Comcast NBCU Comments at 30; Qualcomm Comments at 4.

<sup>10</sup> *See* NAB Comments at 46.

<sup>11</sup> *See, e.g.*, Verizon Comments at 18-20; CTIA Comments at 28; AT&T Comments at 34.

<sup>12</sup> *See, e.g.*, NCTA Comments at 7; Comcast NBCU Comments at 30.

<sup>13</sup> *See, e.g.*, Qualcomm Comments at 4.

reasonably protect against harmful interference and ensure that the public benefits from access to robust licensed and unlicensed wireless broadband networks.

**1. The Commission should establish an ample, fixed guard band between licensed downlink and remaining broadcasters to manage interference.**

As incumbent broadcasters confirm, the Commission must address the “interference challenges normally present between high power broadcast and commercial mobile wireless operations” by “providing an ample guard band” to separate LTE downlink from remaining broadcasters.<sup>14</sup> The 6 MHz guard band the NPRM proposes is far too small to serve this purpose—particularly given that DTV broadcast operations may transmit at up to one megawatt. The record establishes that, to avoid interference between licensed services, the Commission should adopt a guard band that: (1) is at least 12-14 MHz wide; (2) does not vary in size based on adjacent television transmitter power; and (3) includes remainder spectrum in geographic areas where reclaimed spectrum cannot be evenly assigned to 5 MHz blocks.

*Guard Band Size.* Research in Motion correctly observes that mobile receivers “must reject the strong television signals operating on a nearby channel in order to receive a weaker signal from the network base station.”<sup>15</sup> For DTV stations transmitting using 100 kW of power or more, this would require a separation of “at least 12 MHz” by RIM’s conservative estimate.<sup>16</sup> Similarly, Qualcomm notes that, “based on information from filter vendors to date,” placing

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<sup>14</sup> NAB Comments at 45.

<sup>15</sup> Comments of Research in Motion Corporation (“RIM Comments”) at 11.

<sup>16</sup> *Id.* RIM indicates that it used a Hata/COST231 L50 urban propagation model in its analysis. *Id.* Because this model tends to average out propagation anomalies, it is not a worst-case analysis. Accordingly, a separation in excess of 12 MHz may be appropriate.

megawatt TV broadcast operations near downlink could require 12 MHz guard bands.<sup>17</sup>

Motorola Mobility cautions that the Commission's smaller proposed separation may be "insufficient given the performance limitations of today's filters."<sup>18</sup> AT&T states that "a much wider guard band [than that proposed in the NPRM] would be needed to protect downlink spectrum from harmful adjacent-channel interference caused by higher-power stations."<sup>19</sup> These comments confirm that 12-14 MHz is the minimum required guard band size for the 600 MHz band plan, particularly given the dearth of experience and published information on DTV and LTE system interaction.<sup>20</sup>

The Commission should reject proposals for smaller guard bands.<sup>21</sup> Sacrificing guard-band size to add a couple of extra megahertz to the auctioned spectrum blocks would be shortsighted and reckless. A small guard band would threaten both proximate television broadcast and LTE operations, require more expensive filters, and therefore result in higher costs for consumers and/or lower auction revenues for the Treasury. A guard band of roughly 12-14

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<sup>17</sup> Qualcomm Comments at 5 n.7. Qualcomm recommends a guard band separation distance of 10 MHz for band plans that implement supplemental downlink below the 600 MHz band downlink, but does not explain why supplemental downlink operations would require less separation under that scenario. *Id.* at 21.

<sup>18</sup> Comments of Motorola Mobility LLC at 12.

<sup>19</sup> AT&T Comments at 5.

<sup>20</sup> *See* Comments of Google Inc. and Microsoft Corporation ("Google/Microsoft Comments") at 40.

<sup>21</sup> A few commenters have suggested that the Commission could establish guard bands of less than 12 MHz. *See, e.g.*, Comments of Mobile Future at 16; Comments of T-Mobile ("T-Mobile Comments") at 10-11; Comments of Alcatel-Lucent ("Alcatel-Lucent Comments") at 20-21, 24, Verizon Comments at 18-20. Even these commenters, however, agree that the Commission's proposed 6 MHz guard band is too small. *But see, e.g.*, Comments of MetroPCS Communications, Inc. at 25; Comments of the Competitive Carriers Association at 16 (arguing for guard bands smaller than 6 MHz).

MHz is the minimum size required to make the auction successful, so as to ensure widespread, sustainable mobile broadband use of the band.

*Fixed Guard Band.* While AT&T agrees that a 6 MHz guard band is too small to effectively separate LTE downlink and full power DTV transmitters, it suggests that the Commission could vary the guard band size by creating a larger guard band between high-power TV and LTE operations, and a smaller guard band between reduced-power TV and LTE, “if possible.”<sup>22</sup> The Commission should reject this proposal and establish a uniform, fixed guard band size for the 600 MHz band.

Variable guard bands would substantially restrict future use of the DTV channel immediately adjacent to the guard band. Any DTV station transmitting on that channel at reduced power would be forced to continue to do so, as would any future broadcast uses on those frequencies. Moreover, attempting to accommodate variable guard bands would restrict the Commission’s flexibility when repacking remaining broadcasters in each market in a manner that ensures optimal use of remaining television band spectrum for both broadcast and unlicensed broadband services. A variable guard band would also increase the threat of interference at the borders between license areas when a high-power station is operating in an adjoining geographic market. In these border areas, the smaller guard band would result in LTE and high-power broadcast operations operating without adequate spectral separation in the very places where TV signals are weakest.

Implementing smaller guard bands in certain cases also would be incompatible with one of the Commission’s core objectives in this proceeding—to make “a significant portion [of

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<sup>22</sup> AT&T Comments at 38; *see also* Qualcomm Comments at 21; RIM Comments at 11-12.

unlicensed spectrum] available on a uniform nationwide basis for the first time.”<sup>23</sup> As Google and others have explained, guaranteed access to a known amount of unlicensed spectrum in every market is critical to supporting investments by chipmakers, manufacturers, and service providers.<sup>24</sup> A variable guard band, moreover, would likely result in inadequate unlicensed spectrum resources in dense urban areas that already have few white spaces prior to repacking. These are precisely the locations where additional unlicensed spectrum will be of greatest benefit.

*Remainder Spectrum.* Finally, the Commission should implement its proposal to add remainder spectrum to the guard band.<sup>25</sup> As Google explained in its opening comments, augmenting the guard band with remainder spectrum is technically reasonable because increasing separation distance reduces the likelihood of harmful interference, improving customer experience and reducing costs for carriers and consumers.<sup>26</sup> Each additional megahertz provided to the guard band will result in a corresponding improvement in the interference environment. In particular, the signal from the DTV transmitter must necessarily be attenuated to an acceptable level before reaching the LTE device through a combination of physical separation and RF filtering. Adding additional spectrum to the guard band will enable LTE device receiver designs to accommodate more efficient filters, and could reduce the exclusion zone around DTV transmitters where LTE devices will not be able to operate.

Adding spectrum to the guard band will also enable unlicensed technologies to increase the utility of this otherwise hard-to-use spectrum. Indeed, as Verizon observes, in markets where

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<sup>23</sup> NPRM ¶ 9.

<sup>24</sup> *See, e.g.*, Google/Microsoft Comments at 32; Comments of Broadcom, CSR, and Marvell at 1-3.

<sup>25</sup> *See, e.g.*, Comments of the Consumer Electronics Association at 24; PISC Comments at 21.

<sup>26</sup> Google/Microsoft Comments at 42.

there is remainder spectrum, “the only reasonable place to locate [it] is in the guard band,” since “[t]acking on an extra MHz or two to an otherwise-generic block of auctionable spectrum would not make sense.”<sup>27</sup>

**2. The Commission should establish a sizable duplex gap between the uplink and downlink bands to reduce interference.**

In addition to a substantial guard band, the 600 MHz band plan should include a sizeable duplex gap between the licensed uplink and downlink bands to manage harmful interference. As noted above, the record confirms that this duplex gap should not accommodate television or other high power operations.<sup>28</sup> Even excluding these operations, the 600 MHz band will still require a sizable duplex gap to reduce interference between licensed uplink and downlink operations. In its opening comments, Google explained that a duplex gap of as much as 28 MHz (depending on the pass band size) could be technically reasonable, because this duplex gap would enable filter designs that result in less reduction in desired signal levels, and would provide more flexibility with respect to filter design, size, and cost.<sup>29</sup> Other commenters report similar analyses. For example, the WhiteSpace Alliance notes that a duplex gap of between 18 and 24 MHz would “allow filters that can provide sufficient isolation between the downlink and the uplink.”<sup>30</sup> Similarly, Comcast NBCU observes that a 20 MHz duplex gap would be reasonable given the amount of spectrum the Commission expects to have available, and that implementing a 20 MHz gap is important to “enhance mobile performance.”<sup>31</sup>

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<sup>27</sup> Verizon Comments at 20 n.28.

<sup>28</sup> See, e.g. Qualcomm Comments at 23; Comcast NBCU Comments at 45; NCTA Comments at 4.

<sup>29</sup> Google/Microsoft Comments at 37-39.

<sup>30</sup> WhiteSpace Alliance Comments at 29.

<sup>31</sup> Comcast NBCU Comments at 45 (citing NPRM ¶ 178).

Some parties suggest a duplex gap as small as 10 MHz depending on the size of the pass band.<sup>32</sup> As the NPRM explains, however, the only existing 3GPP band with a 10 MHz duplex gap has resulted in degraded receiver performance relative to bands with larger duplex gaps.<sup>33</sup> Accordingly, while the duplex gap must be “at least” 10 MHz, a larger duplex gap may be appropriate depending on the overall band design.<sup>34</sup> The Commission therefore should find that the smallest technically reasonable duplex gap would be at least 12 MHz wide if only a small number of broadcasters participate in the reverse auction, but that a substantially larger gap would be technically reasonable depending on the overall band plan.

### **C. The Commission Should Not Auction Guard Band or Duplex Gap Spectrum.**

While there is widespread record support for unlicensed operations, a few commenters argue that the Commission should consider licensing guard band or duplex gap spectrum.<sup>35</sup> The FCC should reject this proposal. Licensed operations in a guard band or the duplex gap would require very restrictive service rules to avoid harmful interference to neighboring licensees—with power levels and out-of-band emission masks usually reserved for unlicensed operations.

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<sup>32</sup> *See, e.g.*, Alcatel-Lucent Comments at 21; T-Mobile Comments at 10; Comments of Nokia Siemens Networks US LLC at 9; *see also* Comments of Sony Electronics Inc. at 4 (arguing that the duplex gap could be “as small as 11 MHz with today’s technology”).

<sup>33</sup> NPRM ¶ 178 n.262.

<sup>34</sup> *See, e.g.*, CTIA Comments at 28 (duplex gap should be “at least 10 MHz, and possibly more”); Verizon Comments at 18 (duplex gap “must be at least 10 MHz and possibly larger depending on the band plan design”).

<sup>35</sup> *See, e.g.*, Comments of the Telecommunications Industry Association (“TIA Comments”) at 11-12. AT&T also noted, as one of several options presented in its comments, that the FCC could explore the use of licensed supplemental downlink in the duplex gap, but only if such use would be “technically feasible.” AT&T Comments at 34.

These restrictive rules would render the spectrum unattractive for the vast majority of potential bidders.<sup>36</sup> As a result, any auction revenues would be small.

While the benefits of licensing guard bands therefore are illusory, such a decision would create real harms. First, as Qualcomm notes, licensed supplemental downlink operations in the duplex gap could lead to technical challenges for LTE operations by “rais[ing] antenna issues.”<sup>37</sup> Second, even assuming that the Commission could establish viable licensed guard band service rules, soliciting separate bids for guard band licenses in the simultaneous forward and reverse auction would introduce still more complexity to an already difficult auction process. Third, the record overwhelmingly confirms that designating spectrum for unlicensed use in the 600 MHz band will generate enormous economic value for the national economy.<sup>38</sup>

Furthermore, as Comcast NBCU explains, arguments that the Spectrum Act prohibits the Commission from making an unlicensed designation and instead requires it to auction guard bands are incorrect.<sup>39</sup> The Spectrum Act specifically allows the Commission to permit unlicensed use in the guard bands when it states in Section 6407(c) that the “Commission may permit the use of such guard bands for unlicensed use.”<sup>40</sup> Section 6403(c)(1)(A), which instructs the Commission to conduct a forward auction in which it “assigns *licenses* for the use of the

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<sup>36</sup> Alternatively, allowing the types of service rules that would have any chance of attracting bids, such as rules that would allow supplemental downlink operations, would, as Qualcomm explained, require the Commission to expand the size of the duplex gap. Qualcomm Comments at 23. An extended gap that includes high power supplemental downlink operations would also “detract[] from the total amount of usable paired spectrum.” *Id.*

<sup>37</sup> *Id.*

<sup>38</sup> See footnote 2, *supra*.

<sup>39</sup> Comcast NBCU Comments at 42.

<sup>40</sup> Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. 112-96, § 6407(c), 126 Stat. 156 (“Spectrum Act”).

spectrum that the Commission reallocates,”<sup>41</sup> does not remove the Commission’s express authority to permit *unlicensed* use of the 600 MHz band. The Commission must “give meaning to every clause of the statute,”<sup>42</sup> and reading Section 6403(c)(1)(A) to prohibit an unlicensed designation would “render[] Section 6407(c) a nullity.”<sup>43</sup> The only reasonable reading of the Spectrum Act that gives meaning to both clauses is that the FCC must assign licenses through a forward auction, but may permit unlicensed use of any of the guard bands it establishes to reasonably protect against interference to these licensees.

### **III. FCC RULES SHOULD PROMOTE EFFICIENT SPECTRUM USE ON CHANNELS CURRENTLY RESERVED FOR WIRELESS MICROPHONE, RADIO ASTRONOMY, AND MEDICAL TELEMETRY OPERATIONS.**

The NPRM proposes allowing unlicensed devices to share spectrum resources with wireless microphone, radio astronomy, and medical telemetry users.<sup>44</sup> The record supports these proposals, and they would advance the FCC’s goal of promoting greater efficiency and intensity of use of scarce spectrum resources.<sup>45</sup> The FCC should therefore permit unlicensed technologies to use a TV white spaces database to access both the two channels currently reserved for exclusive use by wireless microphones and Channel 37.

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<sup>41</sup> *Id.* § 6403(c)(1)(A) (emphasis added).

<sup>42</sup> Comcast NBCU Comments at 42 (citing *Williams v. Taylor*, 529 U.S. 362, 407 (2000) (O’Connor, J. concurring)).

<sup>43</sup> Comcast NBCU Comments at 43.

<sup>44</sup> *See, e.g.*, NPRM ¶¶ 9, 237-38.

<sup>45</sup> *See, e.g.*, PISC Comments at 27-45; Comments of Spectrum Bridge, Inc. (“Spectrum Bridge Comments”) at 7-8, 9-10; WISPA Comments at 14-21; Comments of Neul (“Neul Comments”) at 2-3; WhiteSpace Alliance Comments at 27-28, 34-35.

**A. The Commission Should Permit Unlicensed TV Band Devices to Operate in the Two Channels Currently Set Aside for Wireless Microphones.**

Commenters demonstrate that consumer demand for unlicensed connectivity is growing rapidly and that current unlicensed designations will not be able to support this growth.<sup>46</sup> In fact, the incentive auction process may reduce the number of currently available unlicensed TV white spaces, exacerbating this problem. The Commission’s proposal to permit unlicensed technologies to use the two channels currently reserved for wireless microphone channels would provide consumers with 12 additional MHz of desperately needed unlicensed spectrum.<sup>47</sup> The Commission’s rules should continue to give Part 74 wireless microphones priority in these two channels, while treating the channels as white spaces under the existing rules. Therefore, Part 74 microphone licensees could register events in TV white spaces databases. Certain non-Part-74 unlicensed microphone users, if they use microphones “at venues of events and productions/shows that use large numbers of wireless microphones that cannot be accommodated” in any other available channel, could also register events in the white spaces database.<sup>48</sup> And non-Part-74 microphone users that do not meet this test could continue to operate in these channels on an unlicensed basis.

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<sup>46</sup> See Comcast NBCU Comments at 29-30; NCTA Comments at 2-3; WISPA Comments at 5-6; Google/Microsoft Comments at 2.

<sup>47</sup> See, e.g., WISPA Comments at 17 (“[W]ireless microphones operate on 200 kHz of spectrum, yet obtain registration rights in the TV bands database for a full six megahertz channel. WISPA believes that the current two-channel set-aside is overprotective and an inefficient use of spectrum, and that wireless microphones can be protected through more spectrally efficient means without prejudicing their operational ability.”); Spectrum Bridge Comments at 8 (“The two (2) reserved channels, along with the channels that are effectively off limits to white space devices results in many urban areas in which there are 5 or more channels reserved for microphones, yet few if any available for white space devices. Further interaction with microphone users has shown that the reserved channels are often useless to the user, based on actual frequencies that their equipment can utilize.”); PISC Comments at 32-37, 41.

<sup>48</sup> 47 C.F.R. § 15.713(h)(9).

Wireless microphone interests argue that the FCC should retain two channels for exclusive use by wireless microphones to protect the use of microphones for unscheduled activities such as breaking news events.<sup>49</sup> The Commission should reject this argument because wireless microphone users can accommodate such events even without these inefficient and costly channel reservations.

Wireless microphone users have several more reasonable options when faced with an unscheduled event. First, wireless microphones can and do successfully operate on a co-channel basis on broadcast TV channels, the very entities gathering the news.<sup>50</sup> Broadcast microphone users can operate co-channel during an unscheduled event if they do not wish to register in the databases. Second, even without wireless microphone exclusive channels, there will be available channels in every market where FCC rules will not permit white spaces devices to operate, because the rules prohibit fixed white space device operation on first adjacent channels, and prohibit personal/portable white spaces device operation below channel 21.<sup>51</sup> Third, as Spectrum Bridge notes, “[e]xperiments have validated that [wireless microphones and unlicensed white space devices] can co-exist except when they are in very close proximity (1-2 meters).”<sup>52</sup> As a result, wireless microphones can be used during unscheduled events even in channels that a database enables white spaces devices to access. This combination of solutions protects unscheduled wireless microphone use while ensuring maximum efficient use of all available spectrum in the 600 MHz band.

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<sup>49</sup> NAB Comments at 48.

<sup>50</sup> See PISC Comments at 35-37.

<sup>51</sup> See generally 47 C.F.R. Part 15 Subpart H.

<sup>52</sup> Spectrum Bridge Comments at 8.

Giving wireless microphones priority (though not exclusive) access to two channels does not, however, mean that they should have similar priority access to other unlicensed spectrum, such as spectrum in the new 600 MHz band.<sup>53</sup> Google does not oppose wireless microphone operation in unlicensed guard band or duplex gap spectrum, but the FCC should require these devices to operate in a guard band or duplex gap under the same rules that apply to other unlicensed devices. Giving wireless microphones the right to exclude other devices from guard band or duplex gap spectrum in the 600 MHz band would substantially reduce access to the very limited unlicensed spectrum resources that will be available to consumers in this band after the auction, at a time when demand is exploding.

**B. The Commission Should Permit the Use of Unlicensed Technologies in Channel 37.**

Commenters similarly recognize the spectrum-efficiency benefits of allowing unlicensed technologies to be used in Channel 37.<sup>54</sup> Google agrees with the Commission’s plan to open Channel 37 for unlicensed use in areas where there are no WMTS or radio astronomy uses, governed by a white spaces database.<sup>55</sup> In addition, Google supports removing the deep emissions notch (in Channels 36 and 38), at least outside of areas where WMTS operates.<sup>56</sup>

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<sup>53</sup> See Shure Comments at 17 (asking “that the Commission apply the White Space rules to the guard bands and allow wireless microphone users priority access to the guard bands at specific locations and at specific times”).

<sup>54</sup> See WISPA Comments at 15 (“There is no public policy reason to impose a nationwide restriction on six megahertz of spectrum when incumbents are using that spectrum in a limited number of clearly defined areas. Channel 37 users receive protection through inclusion in the existing geolocation database with protection zones to be determined based on realistic propagation models.”); PISC Comments at 27-32; Spectrum Bridge Comments at 9-10; Neul Comments at 2-3; WhiteSpace Alliance Comments at 27-28.

<sup>55</sup> Spectrum Bridge Comments at 10; WhiteSpace Alliance Comments at 27-28; PISC Comments at 28.

<sup>56</sup> See Neul Comments at 2.

The few commenters that support a prohibition of unlicensed use in Channel 37 argue that such use will cause harmful interference into WMTS devices.<sup>57</sup> But rules that exclude unlicensed use where WMTS devices are operating will protect all active WMTS users and are far more efficient than a nationwide exclusion. Completely excluding unlicensed devices from Channel 37 results in valuable spectrum remaining completely unused in the vast majority of the country where there are no WMTS operations. A more tailored system that relies on a TV white spaces database would therefore protect incumbents from harmful interference while allowing consumers to access the channel when outside of the appropriate exclusion zone. A TV white spaces database can accurately identify the locations of hospitals with registered WMTS systems and can protect all of those locations. Much like broadcast transmitters, hospitals are located at known, fixed locations, and WMTS systems are not mobile. Once their locations appear in a database, no unlicensed device will be permitted to operate close enough to the systems to cause harmful interference.<sup>58</sup>

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<sup>57</sup> See, e.g., Comments of the WMTS Coalition at 2 (“If any new services are allowed to use Channel 37, they should only be authorized to do so after it can be conclusively demonstrated that such use will not create even the smallest threat of interference to the WMTS licensees who are operating in the band.”); Comments of GE Healthcare at 19. There appears to be less concern that radio astronomy devices could not be adequately protected with sufficient exclusion zones. See Comments of the National Academy of Sciences’ Committee on Radio Frequencies at 9 (“CORF does not oppose the proposed operation of TVBDs on Channel 37 (or whichever channel is ultimately allocated to the RAS in the TV Band), subject to the establishment of appropriate RAS protection areas.”).

<sup>58</sup> See, e.g., PISC Comments at 28; see also *Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd. 16807 (2008) ¶ 85 (“*White Spaces Second Report & Order*”) (“The service areas of fixed transmitter TV and low power TV stations, PLMRS/CMRS operations, production locations that use wireless microphones, and other operations with defined operating areas do not change often and their channel numbers, transmitter geographic coordinates, and other operating parameters can be stored in a database.”).

**IV. AUCTION AND REPACKING RULES SHOULD FACILITATE THE CONTINUED AVAILABILITY OF SPECTRUM FOR UNLICENSED TECHNOLOGIES.**

**A. The Commission Should Permit Unlicensed Access to Cleared Spectrum Prior to Build-Out.**

The full process of the reverse and forward auctions, relocation, and repacking is likely to take a substantial period of time. During this time, spectrum that the FCC has cleared and reallocated may remain unused by licensees for a variety of reasons. For example, there will be periods when spectrum is not in use because: (1) a channel is slated for, but is still awaiting, repacking; (2) a provider has won a license at auction but has not yet begun to offer service; or (3) a licensee has failed to meet its build out requirements.<sup>59</sup>

Any of these situations could result in spectrum lying fallow at a time when demand for spectrum resources continues to grow. The record supports making this temporarily unused spectrum available for opportunistic unlicensed operations, as proposed by the NPRM.<sup>60</sup> As the WhiteSpace Alliance correctly observes, “spectrum should not remain unused in the broadcast bands if there are radio technologies that can make opportunistic use of this spectrum.”<sup>61</sup> Google agrees, and believes that permitting unlicensed uses in frequencies where licensed use has not yet been deployed—with appropriate and robust protections for licensees—will allow efficient and intensive use of that spectrum, even though those uses will be limited to the interim period.

CTIA and Verizon oppose the Commission’s proposal. Their objections, however, do not account for the safeguards provided by the TV white spaces database system. CTIA opposes

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<sup>59</sup> See Comments of the White Space Database Administrators Group (“White Space Database Administrators Comments”) at 2-3; NPRM ¶¶ 396-406.

<sup>60</sup> See Comments of the Computer & Communications Industry Association at 13-14; Google/Microsoft Comments at 44-45; White Space Database Administrators Comments at 2-3; WhiteSpace Alliance Comments at 18-19; Spectrum Bridge Comments at 5.

<sup>61</sup> WhiteSpace Alliance Comments at 19.

unlicensed use of auctioned spectrum based on concerns that spectrum will be encumbered when licensees are ready to begin using it, arguing that “[b]y permitting unlicensed access to exclusively licensed spectrum, the Commission would be creating substantial uncertainty for the licensee as to whether it would be able to clear the band when needed” for testing of equipment and services.<sup>62</sup> Verizon further appears to presume that the share-before-use approach would require bilateral agreements between the licensee and any temporary user.<sup>63</sup>

The TV white spaces database technology resolves these concerns. White spaces devices must connect with a database to check availability at least once a day.<sup>64</sup> As a result, a licensed frequency block can be cleared of all unlicensed use as soon as a licensee reports that it is ready to use the spectrum in an area.<sup>65</sup> Reliance on a database also removes the need for parties to negotiate bilaterally for access to unused spectrum. The rules would permit unlicensed users access to the frequencies without the need to contact the licensee if a database showed the block as being available. But as soon as the relevant licensee reported to the FCC that it was ready to begin testing or operations, a database would block access, again without any need for the licensee to contact unlicensed users directly.<sup>66</sup>

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<sup>62</sup> CTIA Comments at 40.

<sup>63</sup> Verizon Comments at 67.

<sup>64</sup> See 47 C.F.R. § 15.711(b)(3)(iii).

<sup>65</sup> See Google/Microsoft Comments at 45.

<sup>66</sup> As the Commission explained in the white spaces proceeding, its database rules “provide for timely protection of new or modified licensed facilities...[and] account[] for continual changes that will occur over time as new licenses are issued...” *White Spaces Second Report & Order* ¶ 206.

**B. In Repacking Broadcasters, the Commission Should Give Weight to Unlicensed Use of White Spaces.**

The Spectrum Act gives the Commission considerable discretion to repack broadcasters in the manner it deems “appropriate,” provided it takes “all reasonable efforts” to preserve service areas.<sup>67</sup> The Commission is therefore free to balance the needs of broadcasters and their viewers, the value of preserving white spaces for unlicensed applications, and the goal of freeing spectrum for auctioning to licensed use. To achieve this balance, the FCC should adopt rules that: (1) prohibit broadcasters from reducing coverage areas or accepting more interference in order to achieve a tighter repack; (2) do not expand protections appropriate to full power and Class A stations to low power stations; (3) repack stations above Channel 21 in a manner that permits as much contiguous white space as possible; and (4) use the same calculation models for TV white spaces rules as the FCC uses for television broadcast coverage rules.

**1. The Commission should not compensate broadcasters for reducing coverage areas or accepting additional interference.**

Some commenters have called for rules permitting broadcasters to accept additional interference or reduce their coverage areas in order to facilitate a tighter repack of remaining broadcast spectrum.<sup>68</sup> The Commission should reject these proposals. Congress already has addressed this issue in the Spectrum Act. Specifically, Section 6403(b)(2) of the Spectrum Act requires the Commission to “make all reasonable efforts to preserve” existing broadcaster coverage areas and populations.<sup>69</sup> Encouraging broadcasters to effectively reduce their coverage

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<sup>67</sup> Spectrum Act §§ 6403(b)(1)(B)(i); 6403(b)(2).

<sup>68</sup> *See, e.g.*, Verizon Comments at 33-34; Qualcomm Comments at 24-25; TIA Comments at 14-15.

<sup>69</sup> *See* Spectrum Act § 6403(b)(2).

areas and served populations by accepting payment for additional interference would directly violate this requirement and undermine service to the public.

**2. The Commission should not expand protections appropriate to full power and Class A stations to low power stations.**

The record also supports a Commission decision to protect access to local over-the-air broadcasts without extending low power, translator, and repeater stations the protections due to full power and Class A broadcasters.<sup>70</sup> Google agrees with other commenters that the FCC should rescind the rights of individual low power, translator, and repeater stations that either do not provide service or provide only a minimal level of service in order to preserve spectrum rights, and maintain but not expand in any way the rights of stations that remain in service.

**3. The Commission should repack stations above Channel 20 in a manner that permits as much contiguous white space as possible.**

WISPA and PISC note correctly that repacking will more effectively expand broadband access and protect broadcast operations if the Commission explicitly takes existing white spaces rules and decisions into account in its methodology. In particular, the Commission's repacking methodology should recognize that personal and portable white space devices cannot operate below Channel 21, and even fixed white space use occurs mostly above Channel 20 because of the lack of channel availability below Channel 21.<sup>71</sup> As a consequence, the Commission should

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<sup>70</sup> TIA argues that “under its longstanding statutory authority to distinguish between primary and secondary uses, the agency should rescind the licenses of non-Class A low-power TV stations or other secondary users where doing so facilitates efficient repacking.” *See* TIA Comments at 8. Spectrum Bridge similarly states that the Commission should “both strictly enforce the LPTV rules to flush out those that are providing marginal service to simply protect a broadcast right, or not broadcasting at all, while finding a way to ensure that those LPTV stations that are legitimate and providing a public good and public value are protected.” Spectrum Bridge Comments at 7.

<sup>71</sup> *See* PISC Comments at 48.

repack stations above Channel 20 in a manner that maximizes contiguous white space.<sup>72</sup>

Applying this methodology would give the Commission flexibility to repack broadcasters more tightly in the spectrum below Channel 21 and would also enable white space devices to operate in a single band, lowering costs and increasing access.<sup>73</sup>

**4. The Commission should apply the same calculation models for television broadcast coverage rules and TV white spaces rules.**

Finally, the Commission should ensure that its repacking rules do not employ inconsistent FCC standards to predict television coverage for broadcasters. In particular, if the Commission uses the Longley-Rice model to calculate television coverage during repacking,<sup>74</sup> the TV white spaces rules should similarly use the Longley-Rice model going forward.<sup>75</sup> Using the same contours for both is not only equitable but also will result in greater spectral efficiency, as Longley-Rice contours are “more realistic than probabilistic.”<sup>76</sup>

**V. CONCLUSION.**

A balanced approach to the 600 MHz incentive auction process is critical to meeting consumers’ growing demand for both licensed and unlicensed wireless broadband. Google urges the Commission to advance this goal by: (1) concluding that unlicensed technologies can operate in the band without causing harmful interference to licensed networks; (2) adopting an FDD band plan with ample guard bands and duplex gaps designated for unlicensed operations; (3) allowing unlicensed technologies to share both the two channels currently reserved exclusively for wireless microphones and Channel 37; and (4) implementing a repacking methodology that

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<sup>72</sup> See, e.g., WISPA Comments at 13-14; PISC Comments at 48.

<sup>73</sup> See WISPA Comments at 13-14.

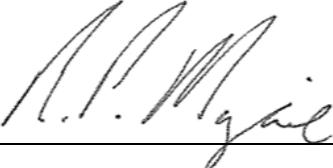
<sup>74</sup> See NPRM ¶¶ 92, 98-99.

<sup>75</sup> See WhiteSpace Alliance Comments at 31.

<sup>76</sup> See *id.*

preserves TV white spaces channels. The record submitted in response to the NPRM shows that taking these actions will protect incumbents, produce a successful auction of licensed spectrum, and support innovation and economic growth by expanding unlicensed spectrum resources.

Respectfully submitted,



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March 12, 2013

*Counsel for Google Inc.*

**APPENDIX A:**  
**DECLARATION OF HAL VARIAN**

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

In the Matter of

Expanding the Economic and Innovation  
Opportunities of Spectrum Through Incentive  
Auctions

Docket No. 12-268

**DECLARATION OF HAL VARIAN**

1. My name is Hal Varian. I am the Chief Economist at Google Inc. Since 2002, I have been involved in many aspects of the company, including auction design, econometric analysis, finance, corporate strategy, and public policy. I previously held academic appointments at the University of California, Berkeley, in three departments: business, economics, and information management. I am also a fellow of the Guggenheim Foundation, the Econometric Society, and the American Academy of Arts and Sciences. I have published numerous papers in economic theory, industrial organization, financial economics, econometrics, and information economics. I am also the author of two major economics textbooks that have been translated into 22 languages. I was Co-Editor of the *American Economic Review* from 1987-1990 and hold honorary doctorates from the University of Oulu, Finland, and the University of Karlsruhe, Germany. I received my S.B. degree from MIT and my M.A. in mathematics and Ph.D. in economics from the University of California, Berkeley.

2. I have reviewed the FCC's *Notice of Proposed Rulemaking* as well as Google and Microsoft's joint comments in this proceeding. This declaration describes simple methods of approximating the minimum economic value associated with unlicensed-spectrum uses of

smartphones that include both a licensed (either LTE, 3G, or 2G) mobile broadband radio and a Wi-Fi radio.

3. I base my analysis on the following assumptions derived from publicly available industry materials and personal observation:

- a. Number of smartphone subscribers: There were approximately 125.9 million smartphone subscribers in the United States as of December 2012.<sup>1</sup>
- b. Average monthly charge of data: As of June 2012, a wireless subscriber's monthly average bill was approximately \$47.16.<sup>2</sup> At least 43% of total revenues come from data usage.<sup>3</sup> This suggests that the average smartphone subscriber pays \$20.28 per month for data. By inspecting my monthly bill, I have determined that the cost of a data plan for my smartphone is on the order of \$25 per month. These calculations suggest that the charge of data per month is between \$20 and \$25 per month.

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<sup>1</sup> Press Release, comScore, comScore Reports December 2012 U.S. Mobile Subscriber Market Share (Feb. 6, 2013), [http://www.comscore.com/Insights/Press\\_Releases/2013/2/comScore\\_Reports\\_December\\_2012\\_U.S.\\_Smartphone\\_Subscriber\\_Market\\_Share](http://www.comscore.com/Insights/Press_Releases/2013/2/comScore_Reports_December_2012_U.S._Smartphone_Subscriber_Market_Share).

<sup>2</sup> CTIA - The Wireless Association, Semi-Annual Mid-Year 2012 Top-Line Survey Results (2012), [http://files.ctia.org/pdf/CTIA\\_Survey\\_MY\\_2012\\_Graphics-\\_final.pdf](http://files.ctia.org/pdf/CTIA_Survey_MY_2012_Graphics-_final.pdf). It is not clear whether this average includes data connections for tablets or data cards. It does include bills for both feature phones and smartphones. Smartphone users typically incur higher monthly charges than feature phone users or tablet users. In general, smartphone users subscribe to both data and voice plans, whereas tablet users subscribe to data-only plans. Therefore, using the \$47.16-per-month figure as a proxy for the average cost of smartphone use per month is a conservative estimate.

<sup>3</sup> Chetan Sharma, US Mobile Data Market Update Q3 2012 (2012), <http://www.chetansharma.com/usmarketupdateq32012.htm> (“Sharma Q3 Update”); Chetan Sharma, US Mobile Data Market Update Q2 2012 (2012), <http://www.chetansharma.com/USmarketupdateQ22012.htm>; Chetan Sharma, US Mobile Data Market Update Q1 2012 (2012), <http://www.chetansharma.com/USmarketupdateQ12012.htm>.

- c. Percentage of data traveling over Wi-Fi networks: Estimates vary as to how much data traffic travels over unlicensed networks. In recent months, studies have found that between 50% and 80% of smartphone data traffic travels over Wi-Fi networks.<sup>4</sup> Therefore, we can estimate conservatively that 50% of smartphone data traffic travels over Wi-Fi networks unaffiliated with licensed mobile network operators.<sup>5</sup>

4. Based on these assumptions, I estimate that the minimum economic value associated solely with smartphone use over unlicensed networks is on the order of \$30-38 billion per year. Here are the calculations that go into that estimate:

- a. The expenditure for data per user per month is between \$20 and \$25, as noted above. Therefore, average data revenue per smartphone user per year is between \$20 x 12 (\$240) and \$25 x12 (\$300).<sup>6</sup>
- b. Given that the consumers are willing to pay approximately \$240-300 per year for the billed data usage on cellular networks and the fact that the

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<sup>4</sup> Informa Telecoms & Media, *Understanding Today's Smartphone User: Demystifying Data Usage Trends on Cellular & Wi-Fi Networks*, WHITE PAPER, at 3 (Feb. 2012); Press Release, Arbitron, Wi-Fi is the Data Beast of Burden Among SmartPhone Panelists (Mar. 5, 2013), <http://arbitron.mediaroom.com/index.php?s=43&item=863>; Informa Telecoms & Media, *Understanding Today's Smartphone User: Demystifying Data Usage Trends on Cellular & Wi-Fi Networks Part 2: An Expanded View by Data Plan Size, OS, Device Type, and LTE*, WHITE PAPER, at 5 (Aug. 2012).

<sup>5</sup> The portion of a user's monthly bill associated with carrier-provisioned Wi-Fi is likely to be de minimis for two reasons. First, Wi-Fi networks are cheap to build, so they do not contribute significantly to carrier costs. Second, licensed mobile network operators confirm that users tend to use their own or third-party Wi-Fi networks significantly more than the carriers'. See Randall Stephenson, *Spectrum and the Wireless Revolution*, WALL ST. J., Jun. 10, 2012, available at <http://online.wsj.com/article/SB10001424052702303665904577450222319683932.html>.

<sup>6</sup> Even if smartphone plans include a subsidy for device purchases, it is acceptable to include the device subsidy value in the calculations below because without connectivity, the device has little or no value.

data usage on Wi-Fi networks unaffiliated with the carriers is roughly the same size, the value of the Wi-Fi data usage should also be about \$240-\$300 per year per user.

- c. \$240 per user x 125.9 million subscriptions yields a lower bound on consumer value of approximately \$30 billion per year. \$300 per user x 125.9 million subscriptions yields a higher estimate of approximately \$38 billion per year.

5. This calculation does not come close to estimating the consumer value of the entire unlicensed ecosystem because it only applies to smartphones. Unlicensed spectrum is also used heavily by tablet computers, laptop computers, and a variety of other devices.

I, Hal Varian, declare under penalty of perjury that the foregoing is true and correct.

Executed on March 8, 2013.

A handwritten signature in black ink that reads "Hal R Varian". The signature is written in a cursive style with a horizontal line underneath it.

Hal Varian