

Date: November 24, 2015  
Subject: Public and Redacted Version of Request for Confidential Treatment and Complementary Exhibits  
File No: 0747-EX-PL-2015

To Whom It May Concern:

Google Inc. (Google), pursuant to 5 U.S.C. § 552 and Sections 0.457 and 0.459 of the Commission's Rules, 47 C.F.R. §§ 0.457, 0.459, hereby requests that certain information provided in its above-referenced Experimental Radio Service License (Experimental License) be treated as confidential and not subject to public inspection. The designated information constitutes confidential and proprietary information that, if subject to public disclosure, would cause significant commercial, economic, and competitive harm. As described below, Google's request satisfies the standards for grant of such requests set forth in Sections 0.457 and 0.459 of the Commission's Rules.

In accordance with Section 0.459(b) and in support of this request, Google provides the following information:

**1. Identification of the Information for Which Confidential Treatment is Sought:**

Google's request for confidential treatment is limited to the following information that has been redacted from the Experimental License and complementary exhibits. Google does not seek to withhold from public inspection information necessary for interference mitigation, including applicant name, contact information, test location, frequency, output power, effective radiated power, emission characteristics, and modulation.

**Exhibit A - Narrative Statement:**

Google requests confidential treatment of the following underlined text from Exhibit A that contains confidential and proprietary information regarding the proposed tests/experiments:

Consistent with the standards set forth in Section 5.63 of the Federal Communications Commission's (FCC's or Commission's) Rules, 47 C.F.R. § 5.63, Google Inc. (Google) requests an Experimental Radio Service License (Experimental License) and outlines below the compelling reasons why 0747-EX-PL-2015 should be granted expeditiously.

Google requests that the Experimental License be granted for a period of 24 months beginning on January 1, 2016. The Experimental License is needed for continued development of [REDACTED]. [REDACTED]. The Experimental License

builds on testing conducted under Call Sign WH9XYD (File Nos. 0842-EX-ST-2014 and 0377-EX-ST-2015) and Call Sign WH2XUP (File No. 0271-EX-PL-2015).

As under Call Signs WH9XYD and WH2XUP, testing will primarily involve [REDACTED]. [REDACTED]. [REDACTED] will automatically disable any transmitter [REDACTED] under the Experimental License if [REDACTED] exits the test area covered by the Experimental License.

Google will test [REDACTED]. The requested authorization includes [REDACTED]. [REDACTED]. [REDACTED].

[REDACTED] will operate with [REDACTED] directional antennas.<sup>1</sup> Google will operate the [REDACTED] equipment with a minimum antenna gain of 38 dBi and an equivalent isotropically radiated power (EIRP) of no greater than 31 dBW. In some tests, an antenna gain of 43 dBi may be used, resulting in an EIRP of no greater than 41 dBW. [REDACTED] will typically operate with [REDACTED] directional antennas with a gain of 53 dBi, and in no case will the maximum EIRP exceed 55 dBW.<sup>2</sup> Occasionally, Google may use [REDACTED] antenna with a gain of 43 dBi; when using this antenna, Google will limit its EIRP to 41 dBW.

Grant of this Experimental License will not adversely impact any authorized user of RF spectrum. An interference study assessing the risk of harmful interference associated with Google's proposed test operations is attached as Exhibit C,<sup>3</sup> and a detailed description of Google's proposed interference-avoidance methods is set forth in Exhibit D.

**Antenna specifications:** As with testing authorized under Call Signs WH9XYD and WH2XUP, Google will use [REDACTED].<sup>4</sup> [REDACTED].

**Protection of specific users:** As fully explained in Exhibits C and D, Google's proposed operations will not cause harmful interference to other users of the millimeter wave bands. We discuss each set of users below.

*Commercial millimeter wave band users:* Google proposes to protect commercial millimeter wave users as follows: Using data gathered by the GPS receiver [REDACTED], each [REDACTED] transmitter will continually communicate its

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<sup>1</sup> Specifications for these antennas are set forth in Exhibit B.

<sup>2</sup> Specifications for these antennas are also set forth in Exhibit B.

<sup>3</sup> See *generally* Exhibit C (Technical Declaration).

<sup>4</sup> In general, the minimum antenna gain required is 50 dBi. 47 C.F.R. § 101.115. However, antenna gains of as low as 43 dBi are permitted if the operator employs a proportional reduction in power. See 47 C.F.R. §101.115 n.15. ("Antenna gain less than 50 dBi (but greater than or equal to 43 dBi) is permitted only with a proportional reduction in maximum authorized EIRP in a ratio of 2 dB of power per 1 dB of gain, so that the maximum allowable EIRP (in dBW) for antennas of less than 50 dBi gain becomes  $+55-2(50-G)$ , where G is the antenna gain in dBi.").

location and velocity to [REDACTED].<sup>5</sup> This information, [REDACTED], allows Google [REDACTED].<sup>6</sup> This predictive analysis is repeated periodically so that [REDACTED].<sup>7</sup>

For these bounded areas, Google will [REDACTED] assess potential interference from Google's operations ([REDACTED]) into terrestrial millimeter wave links.<sup>8</sup> This analysis takes into account location, antenna and radio parameters, pointing direction, and frequency and bandwidth of receive operation for the registered users, as collected daily from an FCC-authorized coordination database.<sup>9</sup> It considers the location, antenna, and radio parameters, frequency, and bandwidth of [REDACTED], which are provided as an input.<sup>10</sup> Using these inputs and the assumptions regarding potential interference set forth in Exhibit C,<sup>11</sup> the path loss between each of the transmitters and all registered users that could be affected is computed.<sup>12</sup> Various combinations of transmit center frequency and bandwidth are then assessed for potential interference.<sup>13</sup> [REDACTED].<sup>14</sup> Of the combinations that fulfill the non-interference objective set forth in 47 C.F.R. § 101.105(a)(5)(i), one is selected for use.<sup>15</sup> [REDACTED].<sup>16</sup>

As set forth in Exhibit C, [REDACTED] transmitting in the frequencies between 73 and 74 GHz and 83 and 84 GHz, for example, will be able to communicate with other [REDACTED] transmitters at power levels [REDACTED] over 88.6% of the land area of the continental United States, based on current FCC registrations.<sup>17</sup> In the limited geographic areas where there is possible harmful interference from [REDACTED] communication under operating parameters that would yield a desired data rate, Google will prevent interference by relying upon one or more of the following measures:

- Changing and limiting transmission frequencies to those that avoid harmful interference;
- Reducing transmitter power below the level needed for throughput optimization;
- Reducing transmitter bandwidth;
- Aiming the relevant transmit antenna toward a different [REDACTED] receiver at an azimuth or elevation angle that is not aligned with vulnerable receivers;

<sup>5</sup> See Exhibit D (Interference Mitigation Strategies) ¶ 2.

<sup>6</sup> *Id.* ¶ 3.

<sup>7</sup> *Id.*

<sup>8</sup> *Id.* ¶ 4.

<sup>9</sup> *Id.*

<sup>10</sup> *Id.* ¶ 5.

<sup>11</sup> See Exhibit C (Technical Declaration).

<sup>12</sup> Exhibit D ¶ 5.

<sup>13</sup> *Id.*

<sup>14</sup> *Id.*

<sup>15</sup> *Id.* ¶ 6.

<sup>16</sup> *Id.*

<sup>17</sup> Exhibit C ¶ 33.

- [REDACTED];
- Employing cross-polarization to reduce the amount of power received by registered users employing different polarization than [REDACTED]; and
- As a last resort in cases where the above techniques would not eliminate potential harmful interference, discontinuing transmission.

After this process, [REDACTED].<sup>18</sup> [REDACTED].<sup>19</sup> The [REDACTED] will shut down its transmissions [REDACTED].<sup>20</sup>

While implementing these techniques to avoid harmful interference, Google can operate [REDACTED] between [REDACTED] at 96.1% of the sample point locations within the continental United States—[REDACTED].<sup>21</sup> In the 3.9% of locations where potential interference is predicted under some transmitter orientations, at least [REDACTED] is available without potential interference in 40% of the hypothetical orientations studied.<sup>22</sup> In all locations, [REDACTED] will be able to have the desired quality of communication with at least [REDACTED].<sup>23</sup> The same analysis predicts that, using the interference avoidance techniques described above and in Exhibit D, Google will be able to establish [REDACTED] between [REDACTED] transmitters and [REDACTED] receivers at 99.6% of the sample point locations within the continental United States.<sup>24</sup>

Where there are very few registered links in a large geographic area, Google may use [REDACTED], protection methods.<sup>25</sup> In these cases, Google will conduct an analysis similar to the one set forth above for a much larger area—e.g., an entire state or U.S. territory—and determine non-interfering operating parameters for that larger area.<sup>26</sup> [REDACTED]; instead, they would operate under transmission parameters selected to avoid harmful interference, and stop operating if they exit the defined geographic area without a new authorization [REDACTED].<sup>27</sup>

The same [REDACTED] interference-avoidance methods described above will be employed during the brief periods [REDACTED].<sup>28</sup> [REDACTED].<sup>29</sup> While the methodology used is the same, [REDACTED].<sup>30</sup>

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<sup>18</sup> Exhibit D ¶ 7.

<sup>19</sup> *Id.*

<sup>20</sup> *Id.*

<sup>21</sup> Exhibit C ¶ 41

<sup>22</sup> *Id.* ¶ 42.

<sup>23</sup> *Id.*

<sup>24</sup> *Id.* ¶ 43.

<sup>25</sup> Exhibit D ¶ 8.

<sup>26</sup> *Id.*

<sup>27</sup> *Id.*

<sup>28</sup> *Id.* ¶¶ 9-11.

<sup>29</sup> *Id.*

<sup>30</sup> *Id.*

[REDACTED].<sup>31</sup> [REDACTED].<sup>32</sup>

On account of these methods, Google's operations will pose no material risk of harmful interference to other commercial millimeter wave band users.

*Federal users:* Google has a coordination agreement in place with the National Radio Astronomy Observatory (NRAO) to ensure that that operations under [REDACTED] current experimental authorizations (Call signs WH9XYD and WH2XUP) do not cause interference to radio astronomy observations at NRAO's Owens Valley location. Google is prepared to coordinate with the National Telecommunications and Information Administration to ensure that other federal operations in the band do not experience harmful interference from Google's testing in the expanded geographic area described in this application.

As under [REDACTED] existing authorizations, Google [REDACTED]. As explained above, [REDACTED]. [REDACTED]. [REDACTED].

*International users:* Google proposes to coordinate with international users as necessary to avoid harmful interference, and in accordance with international agreements. Canada and the United States have negotiated a sharing arrangement regarding coordination of 71-76 GHz and 81-86 GHz transmissions.<sup>33</sup> Google will use the methods set forth in that agreement for coordinating with Canadian licensees, thus protecting all Canadian licensed facilities from harmful interference.

In Mexico, the 71-76 GHz and 81-86 GHz bands are available for unlicensed operations. [REDACTED] proposed in Google's request for an Experimental License are consistent with the antenna gain, power level, EIRP, and power spectral density requirements set forth in Mexico's regulations for unlicensed use of these bands.<sup>34</sup> Therefore, terrestrial operations in Mexico are no more likely to experience harmful interference from Google's [REDACTED] than from in-country terrestrial operations that Mexican law currently allows.<sup>35</sup> Indeed, because Google's operations necessarily will be across the U.S. border, they are less likely than Mexican unlicensed operations to cause interference in Mexico.<sup>36</sup> [REDACTED] will operate at even greater distances

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<sup>31</sup> *Id.* ¶ 12.

<sup>32</sup> *Id.*

<sup>33</sup> *Arrangement V: Sharing Arrangement between the Department of Industry of Canada and the Federal Communications Commission and the National Telecommunications and Information Administration of the United States of America Concerning the Use Of the Frequency Bands 71-76 GHz, 81-86 GHz, 92-94 GHz and 94.1-95 GHz by the Fixed Service Along the Canada-United States Border, available at [https://transition.fcc.gov/ib/sand/agree/can\\_frequency.html](https://transition.fcc.gov/ib/sand/agree/can_frequency.html) and <http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10755.html>.*

<sup>34</sup> *Acuerdo por el Que se Establecen las Bandas de Frecuencias de 71 a 76 GHz y de 81 a 86 GHz, Como Bandas de Frecuencias del Espectro Radioeléctrico de Uso Libre, y las Condiciones de Operación a Que Deberán Sujetarse los Sistemas y Dispositivos Para su Operación en Estas Bandas (2012), available at [http://dof.gob.mx/nota\\_detalle.php?codigo=5237903&fecha=09/03/2012](http://dof.gob.mx/nota_detalle.php?codigo=5237903&fecha=09/03/2012).*

<sup>35</sup> Exhibit C at ¶ 45.

<sup>36</sup> *Id.*

from terrestrial operations in Mexico.<sup>37</sup> This similarly lessens the potential for interference [REDACTED].<sup>38</sup>

**Exhibit B - Technical Information:**

Google requests confidential treatment of the following underlined text from Exhibit B that contains confidential and proprietary information regarding the proposed tests/experiments:

Applicant Name: Google Inc.  
Applicant FRN: 0016069502

**Legal Contact Details**

<b>Name of Contact</b>	Aparna Sridhar
<b>Contact Details</b>	Counsel 25 Massachusetts Avenue NW, Ninth Floor Washington DC 20001

**Technical Contact Details**

<b>Name of Contact</b>	Jeff Gilbert
<b>Contact Details</b>	1600 Amphitheatre Parkway Mountain View, CA 94043 Phone: (650) 933-7471 Email: jegilbert@google.com

**Areas of Operation**

Google seeks to operate in all 50 states and in the territory of Puerto Rico.

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

<sup>38</sup> *Id.*

**[REDACTED] Transmitter Equipment and Station Details**

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Station Class</b>	Mobile

<b>Frequency Ranges</b>	<b>Low (GHz)</b>	<b>High (GHz)</b>
[REDACTED] <sup>a</sup>	71.000	76.000
	81.000	86.000

<sup>a</sup> Google will limit its transmissions to those channels where it will not cause interference to licensed users in the vicinity of its operations. See additional details set forth in Exhibits A, C, and D.

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED] <sup>b</sup>	Digital	60M0D1D-580MD1D <sup>c</sup>	60-580 MHz	0.631 W with 43 dBi antenna 0.447 W with 41.5 dBi antenna 0.200 W with 38 dBi antenna	41 dBW with 43 dBi antenna 38 dBW with 41.5 dBi antenna 31 dBW with 38 dBi antenna

<sup>b</sup> In all cases, this transmitter will operate within the broader frequency ranges described above in the "Frequency Ranges" table.

<sup>c</sup> During the course of testing, Google plans to operate transmitters with a range of bandwidths between 60 and 580 MHz. In no case will the bandwidth be smaller than 60 MHz or exceed 580 MHz. Nevertheless, precise emissions designators for the transmitters will vary according to the bandwidth of operation.

<b>Antenna #1 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #2 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #3 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	38.1 dBi gain @ 71-76 GHz 39.9 dBi gain @ 81-86 GHz
<b>Beam Width at Half-Power Point</b>	1.9 degrees @ 71-76 GHz 1.8 degrees @ 81-86 GHz
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A



<b>Antenna #4 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	41.5 dBi gain @ 71-76 GHz 43 dBi gain @ 81-86 GHz
<b>Beam Width at Half-Power Point</b>	1.0 degrees @ 71-76 GHz 0.8 degrees @ 81-86 GHz
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #5 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	38 dBi
<b>Beam Width at Half-Power Point</b>	2.0 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #6 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<sup>d</sup> [REDACTED].

**[REDACTED] Transmitter Equipment and Station Details**

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Station Class</b>	Fixed

<b>Frequency Ranges</b>	<b>Low (GHz)</b>	<b>High (GHz)</b>
[REDACTED] <sup>e</sup>	71.000	76.000
	81.000	86.000

<sup>e</sup> Google will limit its transmissions to those channels where it will not cause interference to licensed users in the vicinity of its operations. See additional details set forth in Exhibits A, C, and D.

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED] <sup>f</sup>	Digital	60M0D1D-580MD1D <sup>g</sup>	60-580 MHz	1.585 W with 53 dBi antenna  0.631 W with 43 dBi antenna	55 dBW with 53 dBi antenna  41 dBW with 43 dBi antenna

<sup>f</sup> This transmitter will operate within the broader frequency ranges described above in the "Frequency Ranges" table.

<sup>g</sup> During the course of testing, Google plans to operate transmitters with a range of bandwidths between 60 and 580 MHz. In no case will the bandwidth be smaller than 60 MHz or exceed 580 MHz. Nevertheless, precise emissions designators for the transmitters will vary according to the bandwidth of operation.

<b>Antenna #1 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>h</sup>
<b>Gain</b>	53 dBi
<b>Beam Width at Half-Power Point</b>	0.37 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #2 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>h</sup>
<b>Gain</b>	53 dBi
<b>Beam Width at Half-Power Point</b>	0.37 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #3 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>h</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<sup>h</sup> [REDACTED].

[REDACTED]

[REDACTED]. [REDACTED].

**Exhibit C - Technical Declaration:**

Google requests confidential treatment of Exhibit C in its entirety.

**Exhibit D - Interference Mitigation Strategies:**

Google requests confidential treatment of Exhibit D in its entirety.

**2. Identification of the Commission proceeding in which the information was submitted or a description of the circumstances giving rise to the submission.**

The above-referenced Exhibits were submitted to the Commission in support of the Experimental License. The Exhibits were filed with the Office of Engineering and Technology on November 24, 2015. For additional information, please see File No. 0747-EX-PL-2015.

**3. Explanation of the degree to which the information is commercial or financial or contains a trade secret or is privileged.**

The information requested to be kept confidential has significant commercial value. The details of the Experimental License tests/experiments may include trade secret information. The Commission has clarified that confidential treatment should be afforded to trade secrets.<sup>39</sup> Google's tests/experiments and proprietary wireless applications using particular radio frequency equipment represent a "secret commercially valuable plan" within the meaning of a trade secret as recognized by the Commission.

In addition, agreements entered into between Google and the parties that provided equipment for testing or will provide analysis of test results require that confidential information of the parties be held in strict confidence, and that such information not be disclosed to any third party (with limited exceptions not applicable to this request). The manufacturer name and model number constitutes confidential trade secrets, technical information, and business information under the agreements.

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<sup>39</sup> *Examination of Current Policy Concerning the Treatment of Confidential Information Submitted to the Commission*, Report and Order, GC Docket No. 96-55, at para. 3, (released Aug. 4, 1998) (defining "trade secrets" for purpose of Commission rules on confidential treatment).

**4. Explanation of the degree to which the information concerns a service that is competitive.**

The services and technologies that are the subject of this Experimental License have not yet been fully developed but are expected to lead to material developments in markets subject to competition from multiple U.S. and non-U.S. third parties.

**5. Explanation of how disclosure of the information could result in substantial competitive harm.**

The technology under development is highly sensitive and confidential in nature. The release of such information would provide valuable insight into Google's technology innovations and potential business plans and strategies. Public disclosure would jeopardize the value of the technology under examination by enabling others to utilize Google's information to develop similar products in a similar time frame.

**6. Identification of any measures taken by the requesting party to prevent unauthorized disclosure.**

Google has taken steps to keep confidential the information set forth in the confidential exhibits by limiting the number of people involved in the tests/experiments to only those on a "need to know" basis, and by requiring that any third parties involved in the preliminary analysis execute robust nondisclosure agreements.

**7. Identification of whether the information is available to the public and the extent of any previous disclosures of the information to any third parties.**

The information contained in the confidential exhibits is not available to the public, and has only been disclosed to third parties pursuant to restrictive safeguards.

Google voluntarily provides the information to the Commission at this time with the expectation that it will be treated confidentially in accordance with the Commission's rules. See *Critical Mass Energy Project v. Nuclear Regulatory Comm'n*, 975 F.2d 871, 879 (D.C. Cir. 1992) (commercial information provided on a voluntary basis "is 'confidential' for the purpose of Freedom of Information Act (FOIA) Exemption 4 if it is of a kind that would customarily not be released to the public by the person from whom it was obtained.")

**8. Justification of the requested period of confidentiality.**

Google expects that confidential treatment will be necessary for the length of the proposed experiment and thereafter in order to protect its evolving business and technology strategies.

**9. Any other information that would be useful in assessing whether this request should be submitted.**

The information subject to this request for confidentiality should not be made available for public disclosure at any time. There is nothing material that public review of this information would add to the Commission's analysis of Google's request for an experimental authorization.

Moreover, public disclosure of the sensitive information in the confidential exhibits to the Experimental License after the Commission has ruled on the Request for Confidentiality is not necessary for the Commission to fulfill its regulatory responsibilities.

Consistent with 47 C.F.R. § 0.459(d)(1), Google requests notification if release of the information subject to this request is requested pursuant to the FOIA or otherwise, so that Google may have an opportunity to oppose grant of any such request.

Sincerely yours,



Aparna Sridhar

**EXHIBIT A – NARRATIVE STATEMENT**

Consistent with the standards set forth in Section 5.63 of the Federal Communications Commission's (FCC's or Commission's) Rules, 47 C.F.R. § 5.63, Google Inc. (Google) requests an Experimental Radio Service License (Experimental License) and outlines below the compelling reasons why 0747-EX-PL-2015 should be granted expeditiously.

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**Protection of specific users:** As fully explained in Exhibits C and D, Google's proposed operations will not cause harmful interference to other users of the millimeter wave bands. We discuss each set of users below.

*Commercial millimeter wave band users:* Google proposes to protect commercial millimeter wave users as follows: Using data gathered by the GPS receiver [REDACTED], each [REDACTED] transmitter will continually communicate its location and velocity to [REDACTED].<sup>5</sup> This information, [REDACTED], allows Google [REDACTED].<sup>6</sup> This predictive analysis is repeated periodically so that [REDACTED].<sup>7</sup>

For these bounded areas, Google will [REDACTED] assess potential interference from Google's operations ([REDACTED]) into terrestrial millimeter wave links.<sup>8</sup> This analysis takes into account location, antenna and radio parameters, pointing direction, and frequency and bandwidth of receive operation for the registered users, as collected daily from an FCC-authorized coordination database.<sup>9</sup> It considers the location, antenna, and radio parameters, frequency, and bandwidth of [REDACTED], which are provided as an input.<sup>10</sup> Using these inputs and the assumptions regarding potential interference set forth in Exhibit C,<sup>11</sup> the path loss between each of the transmitters and all registered users that could be affected is computed.<sup>12</sup> Various combinations of transmit center frequency and bandwidth are then assessed for potential interference.<sup>13</sup> [REDACTED].<sup>14</sup> Of the combinations that fulfill the non-interference objective set forth in 47 C.F.R. § 101.105(a)(5)(i), one is selected for use.<sup>15</sup> [REDACTED].<sup>16</sup>

As set forth in Exhibit C, [REDACTED] transmitting in the frequencies between 73 and 74 GHz and 83 and 84 GHz, for example, will be able to communicate with other [REDACTED] transmitters at power levels [REDACTED] over 88.6% of the land area of the continental United States, based on current FCC registrations.<sup>17</sup> In the limited geographic areas where there is possible harmful interference from [REDACTED] communication under operating parameters that would yield a desired data rate, Google will prevent interference by relying upon one or more of the following measures:

- Changing and limiting transmission frequencies to those that avoid harmful interference;
- Reducing transmitter power below the level needed for throughput optimization;

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<sup>5</sup> See Exhibit D (Interference Mitigation Strategies) ¶ 2.

<sup>6</sup> *Id.* ¶ 3.

<sup>7</sup> *Id.*

<sup>8</sup> *Id.* ¶ 4.

<sup>9</sup> *Id.*

<sup>10</sup> *Id.* ¶ 5.

<sup>11</sup> See Exhibit C (Technical Declaration).

<sup>12</sup> Exhibit D ¶ 5.

<sup>13</sup> *Id.*

<sup>14</sup> *Id.*

<sup>15</sup> *Id.* ¶ 6.

<sup>16</sup> *Id.*

<sup>17</sup> Exhibit C ¶ 33.



- Reducing transmitter bandwidth;
- Aiming the relevant transmit antenna toward a different [REDACTED] receiver at an azimuth or elevation angle that is not aligned with vulnerable receivers;
- [REDACTED];
- Employing cross-polarization to reduce the amount of power received by registered users employing different polarization than [REDACTED]; and
- As a last resort in cases where the above techniques would not eliminate potential harmful interference, discontinuing transmission.

After this process, [REDACTED].<sup>18</sup> [REDACTED].<sup>19</sup> The [REDACTED] will shut down its transmissions [REDACTED].<sup>20</sup>

While implementing these techniques to avoid harmful interference, Google can operate [REDACTED] between [REDACTED] at 96.1% of the sample point locations within the continental United States—[REDACTED].<sup>21</sup> In the 3.9% of locations where potential interference is predicted under some transmitter orientations, at least [REDACTED] is available without potential interference in 40% of the hypothetical orientations studied.<sup>22</sup> In all locations, [REDACTED] will be able to have the desired quality of communication with at least [REDACTED].<sup>23</sup> The same analysis predicts that, using the interference avoidance techniques described above and in Exhibit D, Google will be able to establish [REDACTED] between [REDACTED] transmitters and [REDACTED] receivers at 99.6% of the sample point locations within the continental United States.<sup>24</sup>

Where there are very few registered links in a large geographic area, Google may use [REDACTED], protection methods.<sup>25</sup> In these cases, Google will conduct an analysis similar to the one set forth above for a much larger area—e.g., an entire state or U.S. territory—and determine non-interfering operating parameters for that larger area.<sup>26</sup> [REDACTED]; instead, they would operate under transmission parameters selected to avoid harmful interference, and stop operating if they exit the defined geographic area without a new authorization [REDACTED].<sup>27</sup>

The same [REDACTED] interference-avoidance methods described above will be employed during the brief periods [REDACTED].<sup>28</sup> [REDACTED].<sup>29</sup> While the methodology used is the same, [REDACTED].<sup>30</sup>

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<sup>18</sup> Exhibit D ¶ 7.

<sup>19</sup> *Id.*

<sup>20</sup> *Id.*

<sup>21</sup> Exhibit C ¶ 41

<sup>22</sup> *Id.* ¶ 42.

<sup>23</sup> *Id.*

<sup>24</sup> *Id.* ¶ 43.

<sup>25</sup> Exhibit D ¶ 8.

<sup>26</sup> *Id.*

<sup>27</sup> *Id.*

<sup>28</sup> *Id.* ¶¶ 9-11.

<sup>29</sup> *Id.*

<sup>30</sup> *Id.*

[REDACTED].<sup>31</sup> [REDACTED].<sup>32</sup>

On account of these methods, Google's operations will pose no material risk of harmful interference to other commercial millimeter wave band users.

*Federal users:* Google has a coordination agreement in place with the National Radio Astronomy Observatory (NRAO) to ensure that that operations under [REDACTED] current experimental authorizations (Call signs WH9XYD and WH2XUP) do not cause interference to radio astronomy observations at NRAO's Owens Valley location. Google is prepared to coordinate with the National Telecommunications and Information Administration to ensure that other federal operations in the band do not experience harmful interference from Google's testing in the expanded geographic area described in this application.

As under [REDACTED] existing authorizations, Google [REDACTED]. As explained above, [REDACTED]. [REDACTED]. [REDACTED].

*International users:* Google proposes to coordinate with international users as necessary to avoid harmful interference, and in accordance with international agreements. Canada and the United States have negotiated a sharing arrangement regarding coordination of 71-76 GHz and 81-86 GHz transmissions.<sup>33</sup> Google will use the methods set forth in that agreement for coordinating with Canadian licensees, thus protecting all Canadian licensed facilities from harmful interference.

In Mexico, the 71-76 GHz and 81-86 GHz bands are available for unlicensed operations. [REDACTED] proposed in Google's request for an Experimental License are consistent with the antenna gain, power level, EIRP, and power spectral density requirements set forth in Mexico's regulations for unlicensed use of these bands.<sup>34</sup> Therefore, terrestrial operations in Mexico are no more likely to experience harmful interference from Google's [REDACTED] than from in-country terrestrial operations that Mexican law currently allows.<sup>35</sup> Indeed, because Google's operations necessarily will be across the U.S. border, they are less likely than Mexican unlicensed operations to cause interference in Mexico.<sup>36</sup> [REDACTED] will operate at even

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<sup>31</sup> *Id.* ¶ 12.

<sup>32</sup> *Id.*

<sup>33</sup> *Arrangement V: Sharing Arrangement between the Department of Industry of Canada and the Federal Communications Commission and the National Telecommunications and Information Administration of the United States of America Concerning the Use Of the Frequency Bands 71-76 GHz, 81-86 GHz, 92-94 GHz and 94.1-95 GHz by the Fixed Service Along the Canada-United States Border, available at [https://transition.fcc.gov/ib/sand/agree/can\\_frequency.html](https://transition.fcc.gov/ib/sand/agree/can_frequency.html) and <http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10755.html>.*

<sup>34</sup> *Acuerdo por el Que se Establecen las Bandas de Frecuencias de 71 a 76 GHz y de 81 a 86 GHz, Como Bandas de Frecuencias del Espectro Radioeléctrico de Uso Libre, y las Condiciones de Operación a Que Deberán Sujetarse los Sistemas y Dispositivos Para su Operación en Estas Bandas (2012), available at [http://dof.gob.mx/nota\\_detalle.php?codigo=5237903&fecha=09/03/2012](http://dof.gob.mx/nota_detalle.php?codigo=5237903&fecha=09/03/2012).*

<sup>35</sup> Exhibit C at ¶ 45.

<sup>36</sup> *Id.*

greater distances from terrestrial operations in Mexico.<sup>37</sup> This similarly lessens the potential for interference [REDACTED].<sup>38</sup>

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

<sup>38</sup> *Id.*

**EXHIBIT B - TECHNICAL INFORMATION**

Applicant Name: Google Inc.  
Applicant FRN: 0016069502

**Legal Contact Details**

<b>Name of Contact</b>	Aparna Sridhar
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**Technical Contact Details**

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**Areas of Operation**

Google seeks to operate in all 50 states and in the territory of Puerto Rico.

**[REDACTED] Transmitter Equipment and Station Details**

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Station Class</b>	Mobile

<b>Frequency Ranges</b>	<b>Low (GHz)</b>	<b>High (GHz)</b>
[REDACTED] <sup>a</sup>	71.000	76.000
	81.000	86.000

<sup>a</sup> Google will limit its transmissions to those channels where it will not cause interference to licensed users in the vicinity of its operations. See additional details set forth in Exhibits A, C, and D.

Radio	Modulation	Emission Designator	Bandwidth	Maximum Power Out	Maximum EIRP
[REDACTED] <sup>b</sup>	Digital	60M0D1D-580MD1D <sup>c</sup>	60-580 MHz	0.631 W with 43 dBi antenna 0.447 W with 41.5 dBi antenna 0.200 W with 38 dBi antenna	41 dBW with 43 dBi antenna 38 dBW with 41.5 dBi antenna 31 dBW with 38 dBi antenna

<sup>b</sup> In all cases, this transmitter will operate within the broader frequency ranges described above in the "Frequency Ranges" table.

<sup>c</sup> During the course of testing, Google plans to operate transmitters with a range of bandwidths between 60 and 580 MHz. In no case will the bandwidth be smaller than 60 MHz or exceed 580 MHz. Nevertheless, precise emissions designators for the transmitters will vary according to the bandwidth of operation.

<b>Antenna #1 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #2 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #3 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	38.1 dBi gain @ 71-76 GHz 39.9 dBi gain @ 81-86 GHz
<b>Beam Width at Half-Power Point</b>	1.9 degrees @ 71-76 GHz 1.8 degrees @ 81-86 GHz
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #4 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	41.5 dBi gain @ 71-76 GHz 43 dBi gain @ 81-86 GHz
<b>Beam Width at Half-Power Point</b>	1.0 degrees @ 71-76 GHz 0.8 degrees @ 81-86 GHz
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #5 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	38 dBi
<b>Beam Width at Half-Power Point</b>	2.0 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #6 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>d</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<sup>d</sup> [REDACTED].

#### [REDACTED] Transmitter Equipment and Station Details

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Station Class</b>	Fixed

<b>Frequency Ranges</b>	<b>Low (GHz)</b>	<b>High (GHz)</b>
[REDACTED] <sup>e</sup>	71.000	76.000
	81.000	86.000

<sup>e</sup> Google will limit its transmissions to those channels where it will not cause interference to licensed users in the vicinity of its operations. See additional details set forth in Exhibits A, C, and D.

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED] <sup>f</sup>	Digital	60M0D1D-580MD1D <sup>g</sup>	60-580 MHz	1.585 W with 53 dBi antenna  0.631 W with 43 dBi antenna	55 dBW with 53 dBi antenna  41 dBW with 43 dBi antenna

<sup>f</sup> This transmitter will operate within the broader frequency ranges described above in the "Frequency Ranges" table.

<sup>g</sup> During the course of testing, Google plans to operate transmitters with a range of bandwidths between 60 and 580 MHz. In no case will the bandwidth be smaller than 60 MHz or exceed 580 MHz. Nevertheless, precise emissions designators for the transmitters will vary according to the bandwidth of operation.

<b>Antenna #1 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>h</sup>
<b>Gain</b>	53 dBi
<b>Beam Width at Half-Power Point</b>	0.37 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #2 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>h</sup>
<b>Gain</b>	53 dBi
<b>Beam Width at Half-Power Point</b>	0.37 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna #3 Details</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED] <sup>h</sup>
<b>Gain</b>	43 dBi
<b>Beam Width at Half-Power Point</b>	1.2 degrees
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<sup>h</sup> [REDACTED].

[REDACTED]

[REDACTED]. [REDACTED].



**EXHIBIT C – TECHNICAL DECLARATION**

[REDACTED]

**EXHIBIT D - INTERFERENCE MITIGATION STRATEGIES**

[REDACTED]