

Date: July 30, 2015  
Subject: Public and Redacted Version of Request for Confidential Treatment and Complementary Exhibits  
FCC File Number: 0829-EX-ST-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 complementary to its above-referenced application for Special Temporary Authority (STA) 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 STA 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 5.61 of the Federal Communications Commission's (FCC's or Commission's) Rules, 47 C.F.R. § 5.61, Google Inc. (Google) requests Special Temporary Authority (STA) to conduct demonstrations of experimental transmitters. The STA is sought for a period of 180 days beginning on August 31, 2015. Google outlines below its need for the requested STA and the reasons that the STA should be granted expeditiously.

The STA is needed for development of [REDACTED].<sup>1</sup> [REDACTED]. [REDACTED].

Testing will involve [REDACTED]. [REDACTED]. As noted above, Google will test [REDACTED].

The equipment used will include [REDACTED]. In the 2.5 GHz band, [REDACTED]. In this band, [REDACTED]. [REDACTED].

In the 71-76 GHz and 81-86 GHz bands, [REDACTED]. In these bands, [REDACTED]. [REDACTED].

[REDACTED], Google may also conduct [REDACTED] testing. This testing will occur at the following locations:

- Location 1: 32° 59' 39" N, 106° 58' 29" W (32.99° N, 106.97° W)
- Location 2: 44° 51' 32" N, 121° 10' 49" W (44.86° N, 121.18° W)

In these locations, the equipment used will include two types of radios: one that operates in the frequencies between 5775 MHz-5825 MHz (5.8 GHz) and one that operates at 24.2 GHz. [REDACTED]. [REDACTED].

The maximum conducted power and maximum EIRP for each radio will be as set forth below:

Radio <sup>2</sup>	Maximum Transmit Power	Maximum EIRP
5.8 GHz Radio	0.1 W	19 dBW
24.2 GHz Radio	0.1 W	31 dBW

Grant of this STA will not adversely impact any authorized user of RF spectrum for the reasons stated below.

**Operations in the 2.5 GHz band:** Google's operations will not cause harmful interference to other users of the 2.5 GHz band. There are no licensed users of the 2.5 GHz frequencies requested within the proposed test area. Google will limit its transmit power and antenna patterns such that the received power

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<sup>1</sup> [REDACTED]. [REDACTED].

<sup>2</sup> While Google may test radios in the frequencies ranging between 5775 MHz and 5825 MHz, 72500 MHz and 72550 MHz, and 82500 MHz and 82550 MHz, the actual bandwidth of the signals employed will continue to be extremely narrow, and the operation will continue to occupy no more than 10 Hz at any given time. See Exhibit B in support of this application for further details.

outside of the proposed radius of operations will be less than -107dBm/5.5MHz.<sup>3</sup> Google's approach comports with the FCC's co-channel interference protection standards for this band, which accord protection to licensees that experience undesired signal levels in excess of -107 dBm/5.5 MHz at their receivers, provided the licensees seeking protection have met applicable height benchmarks.<sup>4</sup>

Google expects to meet this requirement regardless of [REDACTED], and will base its calculations on the following considerations:

- the height of the transmitter,
- the conducted power,
- the maximum antenna gain at the angle that would emit signals beyond the above radius, and
- the free space path loss over this distance.

**Operations in the 5.8 GHz band:** Google's 5.8 GHz tests will not cause harmful interference to any other authorized user of spectrum in the 5.8 GHz band. The conducted power of Google's operation is just one-tenth of the 1 Watt limit allowed for unlicensed devices in this band.<sup>5</sup> Although the proposed operation exceeds the field strength limitations set forth in 47 C.F.R. § 15.249, the transmission will comply with the power spectral density requirements set forth in 47 C.F.R. § 15.407(a)(3). The following attributes of the testing will further mitigate any potential interference concerns:

(1) The transmitters will be placed [REDACTED]. The other principal operations in this band are Part 15 unlicensed devices, Part 18 ISM devices, and amateur radio operators.<sup>6</sup> [REDACTED]. [REDACTED], the closest possible operations would be at least 900 meters away. Once Google's signal travels 900 meters, the signal in the line-of-sight (LOS) path will have attenuated by 106.8 dB, assuming free-space propagation. The signal power received by an omnidirectional antenna placed at 900 meters from the transmitter, if the receiver is centered with the correct polarization in the beam of the LOS link and there are no intervening obstructions, would be at most -54.8 dBm. This signal power is well below the signal strengths from typical Wi-Fi transmitters in the 5.8 GHz band and is not expected to cause harmful interference. By comparison, interference from commercial Wi-Fi equipment can be as much as -10 dBm in an urban environment. For receivers not in the LOS path, or located on the ground and obscured by buildings or foliage, the strength of Google's signals will be significantly less than the strength predicted by the ideal free space calculation set forth above.

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<sup>3</sup> As noted in Exhibit B, Google proposes a 25 kilometer radius of operations for equipment operating in both the 2568-2590 MHz and 2620-2640 MHz bands.

<sup>4</sup> See 47 C.F.R. §§ 27.1220, 27.1221(c).

<sup>5</sup> 47 C.F.R. §15.247(b)(3); *id.* §15.407(a)(3).

<sup>6</sup> See 47 C.F.R. § 2.106 (FCC Table of Frequency Allocations).

(2) Google will employ highly directional, narrow bandwidth transmissions. The full beamwidth of each antenna is only 6.2 degrees. Other users of the 5.8 GHz band are unlikely to be transmitting directly in the beamwidth, and as a result, their communications are unlikely to be affected.

**Operations in the 24 GHz band:** Google's testing in the 24 GHz band similarly will avoid harmful interference to other users of the band. There are three classes of non-federal users in the 24.05-24.25 GHz band: Part 18 ISM users, Part 90 private land mobile radio users, and Part 97 amateur radio users.

Google's operations will avoid interference with Part 18 users, who do not need a license to operate their equipment. Although Google's test equipment will exceed the field strength limitations set forth in 47 C.F.R. §15.249 for fixed, point-to-point operations in the 24.2 GHz band, the transmissions will employ extremely directional, narrow bandwidth transmissions. Indeed, the full beamwidth of the antenna at 24.2 GHz is only 1.4 degrees, making it extremely unlikely that unaffiliated transmissions will pass through the main beam of the antenna. And as with the 5.8 GHz transmissions, all of the 24.2 GHz transmitters will be placed [REDACTED].

Based on a query of the FCC's universal licensing system (ULS), there are no active, licensed Part 90 users operating in Wasco County, Oregon, Jefferson County, Oregon, or Sierra County, New Mexico, in the spectrum between 24.05 GHz and 24.25 GHz.<sup>7</sup>

Nor are there any active, licensed Part 97 users in Jefferson County, Oregon, Wasco County, Oregon, or Sierra County, New Mexico, in the spectrum between 24.05 GHz and 24.25 GHz.

Operations in other counties are unlikely to experience interference. The transmitter located in Wasco County will be located near the border of Wasco and Jefferson County, and will transmit from Wasco County into Jefferson County. The transmitter located in Sierra County will be located at least 24 kilometers from the county line.

Google is prepared to coordinate with the National Telecommunications and Information Administration (NTIA) to ensure that testing does not interfere with any earth exploration satellite services in this band.<sup>8</sup>

**Operations in the millimeter wave bands:** Finally, Google's millimeter wave operations will not impact other users of those bands.

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<sup>7</sup> A geographic search in the Commission's Universal Licensing System limited to Jefferson County, Oregon, and Sierra County, New Mexico, did not yield any active, Part 90 licenses. A nationwide search, however, yielded 32 active, licensed Part 90 users, but none of these users maintain control points or locations in these counties.

<sup>8</sup> See 47 C.F.R. § 2.106 (FCC Table of Frequency Allocations).

*Commercial millimeter wave band users:* An interference study to assess the risk of harmful interference associated with Google's proposed test operations in the 71-76 GHz and 81-86 GHz bands is attached as Exhibit C.<sup>9</sup> Using conservative assumptions regarding Google's proposed operation, the study considers all registered terrestrial E-band links within a distance of 600 kilometers from the test locations.<sup>10</sup>

Analysis of potential interference from [REDACTED] transmissions was done in three steps. First, the operations of the Google [REDACTED] transmitter in each test area were screened using the 1 dB threshold degradation interference objective set forth in 47 C.F.R. § 101.105(a)(5)(i) and worst-case assumptions (e.g., clear conditions, no frequency offset).<sup>11</sup> Receivers where the worst-case predicted interference level was below this objective were considered non-interfering.<sup>12</sup>

For the cases with higher predicted worst-case interference levels, frequency offset—the lack of any overlap between the desired channel and Google's proposed [REDACTED] channel (2.0 GHz bandwidth at 73.0 GHz)—was then considered to determine whether such offset resolved the potential for harmful interference.<sup>13</sup> Considering frequency offset resolved a number of cases.<sup>14</sup>

Finally, in the remaining cases, the minimum carrier/interference objective set forth in 47 C.F.R. § 101.105(a)(5)(i) was used to assess potential interference.<sup>15</sup> In these cases, the azimuth of the interference path was compared to the receiver antenna alignment azimuth.<sup>16</sup> A small (or zero) azimuth separation angle validated the underlying assumption of correlated rain fading for these cases.<sup>17</sup> Each of these remaining cases satisfies the minimum C/I objective by a significant margin.<sup>18</sup>

Assessing potential interference for [REDACTED] transmitters was done in two steps.<sup>19</sup> First, the analysis of the Google [REDACTED] transmitters considered whether the Google transmitters meet the 1 dB threshold degradation interference objectives using free space path loss.<sup>20</sup> In cases where the non-interference objective was not met in these initial calculations, terrain blockage and

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<sup>9</sup> See generally Exhibit C.

<sup>10</sup> Exhibit C at 7.

<sup>11</sup> *Id.* at 13.

<sup>12</sup> *Id.*

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

<sup>14</sup> See *id.*

<sup>15</sup> *Id.*

<sup>16</sup> *Id.* at 13-14.

<sup>17</sup> *Id.* at 14.

<sup>18</sup> *Id.*

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

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

over-the-horizon (OH) loss calculations were considered, allowing all [REDACTED] operations to meet the objective.<sup>21</sup>

Overall, the analysis shows that any potential interference from Google's operations falls below the thresholds established by the Commission 47 C.F.R. § 101.115(a)(5)(i) for avoidance of harmful interference in these bands.

*Federal users:* Google is prepared to coordinate with NTIA to ensure that federal operations in the band do not experience harmful interference.

*International users:*

- *Spaceport America, New Mexico:* Google's proposed operation in the vicinity of Spaceport America, New Mexico, is more than 39 miles from the Mexican border. Because the FCC's Part 101 rules only require coordination for stations within 35 miles of the border, no coordination is needed for the Spaceport America site.<sup>22</sup> Moreover, operations in the southernmost part of the Spaceport America testing area will use directional antennas pointing northward (i.e., away from the Mexican border), further reducing any potential for harmful interference.
- *Warm Springs, Oregon:* Google's proposed operation in the vicinity of Warm Springs, Oregon, is 320 kilometers from the Canadian border. Because the Commission only require coordination for stations within 27 kilometers of the Canadian border, no coordination is needed for the Warm Springs site.<sup>23</sup> Moreover, operations in the northernmost part of the Warm Springs testing area will use directional antennas pointing southward (i.e., away from the Canadian border), further reducing any potential for harmful interference.
- *Pescadero, California:* Google's proposed operation in the vicinity of Pescadero, California is more than 600 kilometers from the closest international border. Therefore, no coordination is needed for this site.

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<sup>21</sup> *Id.*

<sup>22</sup> See 47 C.F.R. § 101.1527(b).

<sup>23</sup> See 47 C.F.R. § 1.928(f); *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*, § 2.1.1 (2013), available at [http://transition.fcc.gov/bureaus/ib/sand/agree/files/Arrangement\\_V.pdf](http://transition.fcc.gov/bureaus/ib/sand/agree/files/Arrangement_V.pdf)

The proposed experimental operations accordingly will be conducted without harmful interference to other authorized users. For these reasons, Google requests approval of this application.

**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>	Paul Husted
<b>Contact Details</b>	1600 Amphitheatre Parkway Mountain View, CA 94043 Phone: (408) 309-0026 Email: phusted@google.com

**2.5 GHz Transmitter Equipment and Station Details**

*[REDACTED] Transmitter Equipment*

<b>Equipment</b>	[REDACTED] [REDACTED] [REDACTED]
<b>Number of Terminals</b>	[REDACTED] <sup>24</sup>
<b>Location</b>	Operations not to exceed 25 km from the following geographic centerpoint: <ul style="list-style-type: none"> <li>• 32° 59' 25" N, 106° 58' 10.9" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	2590.000	2568.000
[REDACTED]	2590.000	2568.000
[REDACTED]	2640.000	2620.000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW

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<sup>24</sup> [REDACTED].



*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	10 dBi
<b>Beam Width at Half-Power Point</b>	70°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	-30° to +30° from Nadir

*[REDACTED] Transmitter Equipment*

<b>Equipment<sup>25</sup></b>	<p>[REDACTED]</p> <ul style="list-style-type: none"> <li>• [REDACTED]</li> </ul> <p>[REDACTED]</p> <ul style="list-style-type: none"> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> <li>• [REDACTED]</li> </ul>
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>• 2.6 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>• 2.6 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W</li> </ul>

<sup>25</sup> [REDACTED]. [REDACTED].

**PUBLIC REDACTED VERSION**

Google Inc.  
File No. 0829-EX-ST-2015

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	2590.000	2568.000
[REDACTED]	2570.000	2550.000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP (with highest gain antenna)</b>
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	1.5 dBi
<b>Beam Width at Half-Power Point</b>	360°
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	1.5 dBi
<b>Beam Width at Half-Power Point</b>	360°
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	Not to exceed 3 dBi
<b>Beam Width at Half-Power Point</b>	180°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	0°-360°

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	Not to exceed 8 dBi
<b>Beam Width at Half-Power Point</b>	56°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	0°-360°

**5 GHz Equipment and Station Details**

*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>• 5 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>• 5 GHz Band Location 2: 44° 51' 32" N, 121° 10' 49" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	5825.0000	5775.0000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	19 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	29 dBi
<b>Beam Width at Half-Power Point</b>	6.2 degrees
<b>Orientation in Horizontal Plane</b>	<ul style="list-style-type: none"> <li>• 5 GHz Band Location 1: 139.692° (SE)</li> <li>• 5 GHz Band Location 2: 213.91° (SW)</li> </ul>
<b>Orientation in Vertical Plane</b>	<ul style="list-style-type: none"> <li>• 5 GHz Band Location 1: -0.2°</li> <li>• 5 GHz Band Location 2: 0.77°</li> </ul>

**24.2 GHz Transmitter Equipment and Station Details**

*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>• 24.2 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>• 24.2 GHz Band Location 2: 44° 51' 32" N, 121° 10' 49" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	24200.1200	24199.8800

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	31 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	41 dBi
<b>Beam Width at Half-Power Point</b>	1.4 degrees
<b>Orientation in Horizontal Plane</b>	<ul style="list-style-type: none"> <li>● 24.2 GHz Band Location 1: 139.692° (SE)</li> <li>● 24.2 GHz Band Location 2: 213.91° (SW)</li> </ul>
<b>Orientation in Vertical Plane</b>	<ul style="list-style-type: none"> <li>● 24.2 GHz Band Location 1: -0.2°</li> <li>● 24.2 GHz Band Location 2: 0.77°</li> </ul>

**71-76/81-86 GHz Transmitter Equipment and Station Details**

*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>● 70 GHz Band Location 1: Operation not to exceed 70 km from the following geographic centerpoint:             <ul style="list-style-type: none"> <li>○ 32° 59' 25" N, 106° 58' 10.9" W</li> </ul> </li> <li>● 70 GHz Band Location 2: Operation not to exceed 100 km from the following geographic centerpoint:             <ul style="list-style-type: none"> <li>○ 44° 45' 37" N, 121° 16' 6" W</li> </ul> </li> <li>● 70 GHz Band Location 3: Operation not to exceed 10 km from the following geographic centerpoint:             <ul style="list-style-type: none"> <li>○ 37° 15' 18" N, 122° 22' 53" W</li> </ul> </li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	74000.0000	72000.0000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	33 dBW

*[REDACTED] Antenna Details*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	24, 30, or 36 dBi (3 designs to be tested)
<b>Beam Width at Half-Power Point</b>	24 dBi: Az 35° / El 4° 30 dBi: Az 35° / El 0.8° 36 dBi: Az 11° / El 0.8°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	-45° to +45° from Nadir

*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>• 80 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>• 80 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W</li> <li>• 80 GHz Band Location 3: 44° 51' 32" N, 121° 10' 49" W</li> <li>• 80 GHz Band Location 4: 44° 46' 15" N, 121° 15' 49" W</li> <li>• 80 GHz Band Location 5: 44° 50' 23" N, 121° 14' 1" W</li> <li>• 80 GHz Band Location 6: 37° 15' 18" N, 122° 22' 53" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	84000.0000	82000.0000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	52 dBW

*[REDACTED] Antenna Details*

<b>Antenna</b>	[REDACTED]	[REDACTED]	[REDACTED]
<b>Type</b>	[REDACTED]	[REDACTED]	[REDACTED]
<b>Quantity</b> <sup>26</sup>	[REDACTED]	[REDACTED]	[REDACTED]
<b>Gain</b>	46 dBi	52 dBi	55 dBi
<b>Beam Width at Half-Power Point</b>	0.822°	0.382°	0.284°
<b>Orientation in Horizontal Plane</b>	0-360°	0-360°	0-360°
<b>Orientation in Vertical Plane</b>	0°-45° from azimuth	0°-45° from azimuth	0°-45° from azimuth

**Exhibit C - Technical Report and Addendum:**

Google requests confidential treatment of Exhibit C in its entirety.

**Exhibit D - [REDACTED]:**

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 STA. These Exhibits were filed with the Office of Engineering and Technology on July 30, 2015. For additional information, please see File No. 0829-EX-ST-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 STA tests/experiments may include trade secret information. The Commission has clarified that confidential treatment should be afforded to trade secrets.<sup>27</sup> Google's

<sup>26</sup> [REDACTED].

<sup>27</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).



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.

**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 STA 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 all third parties involved in the testing process to 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 STA 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)(l), 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 5.61 of the Federal Communications Commission’s (FCC’s or Commission’s) Rules, 47 C.F.R. § 5.61, Google Inc. (Google) requests Special Temporary Authority (STA) to conduct demonstrations of experimental transmitters. The STA is sought for a period of 180 days beginning on August 31, 2015. Google outlines below its need for the requested STA and the reasons that the STA should be granted expeditiously.

The STA is needed for development of [REDACTED].<sup>1</sup> [REDACTED]. [REDACTED].

Testing will involve [REDACTED]. [REDACTED]. As noted above, Google will test [REDACTED].

The equipment used will include [REDACTED]. In the 2.5 GHz band, [REDACTED]. In this band, [REDACTED]. [REDACTED].

In the 71-76 GHz and 81-86 GHz bands, [REDACTED]. In these bands, [REDACTED]. [REDACTED].

[REDACTED], Google may also conduct [REDACTED] testing. This testing will occur at the following locations:

- Location 1: 32° 59’ 39” N, 106° 58’ 29” W (32.99° N, 106.97° W)
- Location 2: 44° 51’ 32” N, 121° 10’ 49” W (44.86° N, 121.18° W)

In these locations, the equipment used will include two types of radios: one that operates in the frequencies between 5775 MHz-5825 MHz (5.8 GHz) and one that operates at 24.2 GHz. [REDACTED]. [REDACTED].

The maximum conducted power and maximum EIRP for each radio will be as set forth below:

<b>Radio<sup>2</sup></b>	<b>Maximum Transmit Power</b>	<b>Maximum EIRP</b>
5.8 GHz Radio	0.1 W	19 dBW
24.2 GHz Radio	0.1 W	31 dBW

<sup>1</sup> [REDACTED]. [REDACTED].

<sup>2</sup> While Google may test radios in the frequencies ranging between 5775 MHz and 5825 MHz, 72500 MHz and 72550 MHz, and 82500 MHz and 82550 MHz, the actual bandwidth of the signals employed will continue to be extremely narrow, and the operation will continue to occupy no more than 10 Hz at any given time. See Exhibit B in support of this application for further details.

Grant of this STA will not adversely impact any authorized user of RF spectrum for the reasons stated below.

**Operations in the 2.5 GHz band:** Google's operations will not cause harmful interference to other users of the 2.5 GHz band. There are no licensed users of the 2.5 GHz frequencies requested within the proposed test area. Google will limit its transmit power and antenna patterns such that the received power outside of the proposed radius of operations will be less than -107dBm/5.5MHz.<sup>3</sup> Google's approach comports with the FCC's co-channel interference protection standards for this band, which accord protection to licensees that experience undesired signal levels in excess of -107 dBm/5.5 MHz at their receivers, provided the licensees seeking protection have met applicable height benchmarks.<sup>4</sup>

Google expects to meet this requirement regardless of [REDACTED], and will base its calculations on the following considerations:

- the height of the transmitter,
- the conducted power,
- the maximum antenna gain at the angle that would emit signals beyond the above radius, and
- the free space path loss over this distance.

**Operations in the 5.8 GHz band:** Google's 5.8 GHz tests will not cause harmful interference to any other authorized user of spectrum in the 5.8 GHz band. The conducted power of Google's operation is just one-tenth of the 1 Watt limit allowed for unlicensed devices in this band.<sup>5</sup> Although the proposed operation exceeds the field strength limitations set forth in 47 C.F.R. § 15.249, the transmission will comply with the power spectral density requirements set forth in 47 C.F.R. § 15.407(a)(3). The following attributes of the testing will further mitigate any potential interference concerns:

(1) The transmitters will be placed [REDACTED]. The other principal operations in this band are Part 15 unlicensed devices, Part 18 ISM devices, and amateur radio operators.<sup>6</sup> [REDACTED]. [REDACTED], the closest possible operations would be at least 900 meters away. Once Google's signal travels 900 meters, the signal in the line-of-sight (LOS) path will have attenuated by 106.8 dB, assuming free-space propagation. The signal power received by an omnidirectional antenna placed at 900 meters from the transmitter, if the receiver is centered with the correct polarization in the beam of the LOS link and there are no intervening obstructions, would be at most -54.8 dBm. This signal power is well below the signal strengths from typical Wi-Fi transmitters in the 5.8 GHz band and is not expected to cause harmful interference. By comparison, interference from commercial Wi-Fi equipment can be as much as

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<sup>3</sup> As noted in Exhibit B, Google proposes a 25 kilometer radius of operations for equipment operating in both the 2568-2590 MHz and 2620-2640 MHz bands.

<sup>4</sup> See 47 C.F.R. §§ 27.1220, 27.1221(c).

<sup>5</sup> 47 C.F.R. §15.247(b)(3); *id.* §15.407(a)(3).

<sup>6</sup> See 47 C.F.R. § 2.106 (FCC Table of Frequency Allocations).

-10 dBm in an urban environment. For receivers not in the LOS path, or located on the ground and obscured by buildings or foliage, the strength of Google's signals will be significantly less than the strength predicted by the ideal free space calculation set forth above.

(2) Google will employ highly directional, narrow bandwidth transmissions. The full beamwidth of each antenna is only 6.2 degrees. Other users of the 5.8 GHz band are unlikely to be transmitting directly in the beamwidth, and as a result, their communications are unlikely to be affected.

**Operations in the 24 GHz band:** Google's testing in the 24 GHz band similarly will avoid harmful interference to other users of the band. There are three classes of non-federal users in the 24.05-24.25 GHz band: Part 18 ISM users, Part 90 private land mobile radio users, and Part 97 amateur radio users.

Google's operations will avoid interference with Part 18 users, who do not need a license to operate their equipment. Although Google's test equipment will exceed the field strength limitations set forth in 47 C.F.R. §15.249 for fixed, point-to-point operations in the 24.2 GHz band, the transmissions will employ extremely directional, narrow bandwidth transmissions. Indeed, the full beamwidth of the antenna at 24.2 GHz is only 1.4 degrees, making it extremely unlikely that unaffiliated transmissions will pass through the main beam of the antenna. And as with the 5.8 GHz transmissions, all of the 24.2 GHz transmitters will be placed [REDACTED].

Based on a query of the FCC's universal licensing system (ULS), there are no active, licensed Part 90 users operating in Wasco County, Oregon, Jefferson County, Oregon, or Sierra County, New Mexico, in the spectrum between 24.05 GHz and 24.25 GHz.<sup>7</sup>

Nor are there any active, licensed Part 97 users in Jefferson County, Oregon, Wasco County, Oregon, or Sierra County, New Mexico, in the spectrum between 24.05 GHz and 24.25 GHz.

Operations in other counties are unlikely to experience interference. The transmitter located in Wasco County will be located near the border of Wasco and Jefferson County, and will transmit from Wasco County into Jefferson County. The transmitter located in Sierra County will be located at least 24 kilometers from the county line.

Google is prepared to coordinate with the National Telecommunications and Information Administration (NTIA) to ensure that testing does not interfere with any earth exploration satellite services in this band.<sup>8</sup>

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<sup>7</sup> A geographic search in the Commission's Universal Licensing System limited to Jefferson County, Oregon, and Sierra County, New Mexico, did not yield any active, Part 90 licenses. A nationwide search, however, yielded 32 active, licensed Part 90 users, but none of these users maintain control points or locations in these counties.

<sup>8</sup> See 47 C.F.R. § 2.106 (FCC Table of Frequency Allocations).

**Operations in the millimeter wave bands:** Finally, Google's millimeter wave operations will not impact other users of those bands.

*Commercial millimeter wave band users:* An interference study to assess the risk of harmful interference associated with Google's proposed test operations in the 71-76 GHz and 81-86 GHz bands is attached as Exhibit C.<sup>9</sup> Using conservative assumptions regarding Google's proposed operation, the study considers all registered terrestrial E-band links within a distance of 600 kilometers from the test locations.<sup>10</sup>

Analysis of potential interference from [REDACTED] transmissions was done in three steps. First, the operations of the Google [REDACTED] transmitter in each test area were screened using the 1 dB threshold degradation interference objective set forth in 47 C.F.R. § 101.105(a)(5)(i) and worst-case assumptions (e.g., clear conditions, no frequency offset).<sup>11</sup> Receivers where the worst-case predicted interference level was below this objective were considered non-interfering.<sup>12</sup>

For the cases with higher predicted worst-case interference levels, frequency offset—the lack of any overlap between the desired channel and Google's proposed [REDACTED] channel (2.0 GHz bandwidth at 73.0 GHz)—was then considered to determine whether such offset resolved the potential for harmful interference.<sup>13</sup> Considering frequency offset resolved a number of cases.<sup>14</sup>

Finally, in the remaining cases, the minimum carrier/interference objective set forth in 47 C.F.R. § 101.105(a)(5)(i) was used to assess potential interference.<sup>15</sup> In these cases, the azimuth of the interference path was compared to the receiver antenna alignment azimuth.<sup>16</sup> A small (or zero) azimuth separation angle validated the underlying assumption of correlated rain fading for these cases.<sup>17</sup> Each of these remaining cases satisfies the minimum C/I objective by a significant margin.<sup>18</sup>

Assessing potential interference for [REDACTED] transmitters was done in two steps.<sup>19</sup> First, the analysis of the Google [REDACTED] transmitters considered whether the Google

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<sup>9</sup> See generally Exhibit C.

<sup>10</sup> Exhibit C at 7.

<sup>11</sup> *Id.* at 13.

<sup>12</sup> *Id.*

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

<sup>14</sup> See *id.*

<sup>15</sup> *Id.*

<sup>16</sup> *Id.* at 13-14.

<sup>17</sup> *Id.* at 14.

<sup>18</sup> *Id.*

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

transmitters meet the 1 dB threshold degradation interference objectives using free space path loss.<sup>20</sup> In cases where the non-interference objective was not met in these initial calculations, terrain blockage and over-the-horizon (OH) loss calculations were considered, allowing all [REDACTED] operations to meet the objective.<sup>21</sup>

Overall, the analysis shows that any potential interference from Google's operations falls below the thresholds established by the Commission 47 C.F.R. § 101.115(a)(5)(i) for avoidance of harmful interference in these bands.

*Federal users:* Google is prepared to coordinate with NTIA to ensure that federal operations in the band do not experience harmful interference.

*International users:*

- *Spaceport America, New Mexico:* Google's proposed operation in the vicinity of Spaceport America, New Mexico, is more than 39 miles from the Mexican border. Because the FCC's Part 101 rules only require coordination for stations within 35 miles of the border, no coordination is needed for the Spaceport America site.<sup>22</sup> Moreover, operations in the southernmost part of the Spaceport America testing area will use directional antennas pointing northward (i.e., away from the Mexican border), further reducing any potential for harmful interference.
- *Warm Springs, Oregon:* Google's proposed operation in the vicinity of Warm Springs, Oregon, is 320 kilometers from the Canadian border. Because the Commission only require coordination for stations within 27 kilometers of the Canadian border, no coordination is needed for the Warm Springs site.<sup>23</sup> Moreover, operations in the northernmost part of the Warm Springs testing area will use directional antennas pointing southward (i.e., away from the Canadian border), further reducing any potential for harmful interference.
- *Pescadero, California:* Google's proposed operation in the vicinity of Pescadero, California is more than 600 kilometers from the closest international border. Therefore, no coordination is needed for this site.

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

<sup>21</sup> *Id.*

<sup>22</sup> See 47 C.F.R. § 101.1527(b).

<sup>23</sup> See 47 C.F.R. § 1.928(f); *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*, § 2.1.1 (2013), available at [http://transition.fcc.gov/bureaus/ib/sand/agree/files/Arrangement\\_V.pdf](http://transition.fcc.gov/bureaus/ib/sand/agree/files/Arrangement_V.pdf)

The proposed experimental operations accordingly will be conducted without harmful interference to other authorized users. For these reasons, Google requests approval of this application.



**EXHIBIT B - TECHNICAL INFORMATION**

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>	Paul Husted
<b>Contact Details</b>	1600 Amphitheatre Parkway Mountain View, CA 94043 Phone: (408) 309-0026 Email: phusted@google.com

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

<b>Equipment</b>	[REDACTED] [REDACTED] [REDACTED]
<b>Number of Terminals</b>	[REDACTED] <sup>1</sup>
<b>Location</b>	Operations not to exceed 25 km from the following geographic centerpoint: <ul style="list-style-type: none"> <li>• 32° 59' 25" N, 106° 58' 10.9" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	2590.000	2568.000
[REDACTED]	2590.000	2568.000
[REDACTED]	2640.000	2620.000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	10 dBi
<b>Beam Width at Half-Power Point</b>	70°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	-30° to +30° from Nadir

<sup>1</sup> [REDACTED].

[REDACTED] Transmitter Equipment

<b>Equipment<sup>2</sup></b>	[REDACTED] <ul style="list-style-type: none"> <li>[REDACTED]</li> </ul> [REDACTED] <ul style="list-style-type: none"> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> <li>[REDACTED]</li> </ul>
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>2.6 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>2.6 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W</li> </ul>

Frequency Range	High (MHz)	Low (MHz)
[REDACTED]	2590.000	2568.000
[REDACTED]	2570.000	2550.000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP (with highest gain antenna)
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW

<sup>2</sup> [REDACTED]. [REDACTED].

[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	1.5 dBi
<b>Beam Width at Half-Power Point</b>	360°
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	1.5 dBi
<b>Beam Width at Half-Power Point</b>	360°
<b>Orientation in Horizontal Plane</b>	N/A
<b>Orientation in Vertical Plane</b>	N/A

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	Not to exceed 3 dBi
<b>Beam Width at Half-Power Point</b>	180°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	0°-360°

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	Not to exceed 8 dBi
<b>Beam Width at Half-Power Point</b>	56°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	0°-360°

**5 GHz Equipment and Station Details**

*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>5 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>5 GHz Band Location 2: 44° 51' 32" N, 121° 10' 49" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	5825.0000	5775.0000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	19 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	29 dBi
<b>Beam Width at Half-Power Point</b>	6.2 degrees
<b>Orientation in Horizontal Plane</b>	<ul style="list-style-type: none"> <li>5 GHz Band Location 1: 139.692° (SE)</li> <li>5 GHz Band Location 2: 213.91° (SW)</li> </ul>
<b>Orientation in Vertical Plane</b>	<ul style="list-style-type: none"> <li>5 GHz Band Location 1: -0.2°</li> <li>5 GHz Band Location 2: 0.77°</li> </ul>

**24.2 GHz Transmitter Equipment and Station Details**

*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>• 24.2 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>• 24.2 GHz Band Location 2: 44° 51' 32" N, 121° 10' 49" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	24200.1200	24199.8800

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	31 dBW

*[REDACTED] Antenna Information*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	41 dBi
<b>Beam Width at Half-Power Point</b>	1.4 degrees
<b>Orientation in Horizontal Plane</b>	<ul style="list-style-type: none"> <li>• 24.2 GHz Band Location 1: 139.692° (SE)</li> <li>• 24.2 GHz Band Location 2: 213.91° (SW)</li> </ul>
<b>Orientation in Vertical Plane</b>	<ul style="list-style-type: none"> <li>• 24.2 GHz Band Location 1: -0.2°</li> <li>• 24.2 GHz Band Location 2: 0.77°</li> </ul>

**71-76/81-86 GHz Transmitter Equipment and Station Details***[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>● 70 GHz Band Location 1: Operation not to exceed 70 km from the following geographic centerpoint: <ul style="list-style-type: none"> <li>○ 32° 59' 25" N, 106° 58' 10.9" W</li> </ul> </li> <li>● 70 GHz Band Location 2: Operation not to exceed 100 km from the following geographic centerpoint: <ul style="list-style-type: none"> <li>○ 44° 45' 37" N, 121° 16' 6" W</li> </ul> </li> <li>● 70 GHz Band Location 3: Operation not to exceed 10 km from the following geographic centerpoint: <ul style="list-style-type: none"> <li>○ 37° 15' 18" N, 122° 22' 53" W</li> </ul> </li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	74000.0000	72000.0000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	33 dBW

*[REDACTED] Antenna Details*

<b>Antenna</b>	[REDACTED]
<b>Type</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	24, 30, or 36 dBi ([REDACTED])
<b>Beam Width at Half-Power Point</b>	24 dBi: Az 35° / El 4° 30 dBi: Az 35° / El 0.8° 36 dBi: Az 11° / El 0.8°
<b>Orientation in Horizontal Plane</b>	0°-360°
<b>Orientation in Vertical Plane</b>	-45° to +45° from Nadir



*[REDACTED] Radio Equipment*

<b>Equipment</b>	[REDACTED]
<b>Number of Terminals</b>	[REDACTED]
<b>Locations</b>	<ul style="list-style-type: none"> <li>• 80 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W</li> <li>• 80 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W</li> <li>• 80 GHz Band Location 3: 44° 51' 32" N, 121° 10' 49" W</li> <li>• 80 GHz Band Location 4: 44° 46' 15" N, 121° 15' 49" W</li> <li>• 80 GHz Band Location 5: 44° 50' 23" N, 121° 14' 1" W</li> <li>• 80 GHz Band Location 6: 37° 15' 18" N, 122° 22' 53" W</li> </ul>

<b>Frequency Range</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	84000.0000	82000.0000

<b>Radio</b>	<b>Modulation</b>	<b>Emission Designator</b>	<b>Modulation Bandwidth</b>	<b>Maximum Power Out</b>	<b>Maximum EIRP</b>
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	52 dBW

*[REDACTED] Antenna Details*

<b>Antenna</b>	[REDACTED]	[REDACTED]	[REDACTED]
<b>Type</b>	[REDACTED]	[REDACTED]	[REDACTED]
<b>Quantity<sup>3</sup></b>	[REDACTED]	[REDACTED]	[REDACTED]
<b>Gain</b>	46 dBi	52 dBi	55 dBi
<b>Beam Width at Half-Power Point</b>	0.822°	0.382°	0.284°
<b>Orientation in Horizontal Plane</b>	0-360°	0-360°	0-360°
<b>Orientation in Vertical Plane</b>	0°-45° from azimuth	0°-45° from azimuth	0°-45° from azimuth

<sup>3</sup> [REDACTED].

**EXHIBIT C - TECHNICAL REPORT AND ADDENDUM**

[REDACTED]

**EXHIBIT D - [REDACTED]**

[REDACTED]