

Date: February 5, 2016

Subject: Public and Redacted Version of Request for Confidential Treatment and Complementary Exhibits

FCC File Number: 0093-EX-ST-2016

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 extension of Special Temporary Authority (STA Extension) 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 Extension 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) outlines below its need for the requested extension of Special Temporary Authority (STA Extension) and the compelling reasons why 0093-EX-ST-2016 should be granted expeditiously.

Google requests that the STA Extension be granted for a period of 180 days. The STA Extension is needed for continued demonstration and testing of experimental transmitters.

Consistent with 0829-EX-ST-2015 (Call Sign WI9XZE), the STA Extension is needed for continued development of [REDACTED].¹ [REDACTED]. [REDACTED].

Continued testing will involve [REDACTED]. [REDACTED]. As noted above, Google will continue to test [REDACTED].

The equipment used will continue to 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 testing over a [REDACTED]. This transmitter used in this link will be placed at 32° 59' 39" N, 106° 58' 29" W. In this location, the equipment used will continue to include two types of radios: one that operates in the frequencies between 5775 MHz and 5825 MHz (5.8 GHz) and one that operates at 24.2 GHz. [REDACTED]. The maximum conducted power, maximum EIRP, and maximum ERP for each radio will be as set forth below:

Radio ²	Maximum Transmit Power	Maximum EIRP	Maximum ERP
5.8 GHz Radio	0.1 W	19 dBW	48 W
24.2 GHz Radio	0.1 W	31 dBW	768 W

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

Operations in the 2.5 GHz band: Google's continued 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 continue to 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.³ Google's approach comports with the FCC's co-channel interference protection standards for this band, which accord protection to licensees that experience

¹ [REDACTED]. [REDACTED].

² While Google may continue to 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.

³ As noted in Exhibit B, a 25 kilometer radius of operations for equipment operating in both the 2568-2590 MHz and 2620-2640 MHz bands will continue to be used.

undesired signal levels in excess of -107 dBm/5.5 MHz at their receivers, provided the licensees seeking protection have met applicable height benchmarks.⁴

Google expects to meet this requirement regardless of [REDACTED], and will continue to 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 continued 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 continued operation is just one-tenth of the 1 Watt limit allowed for unlicensed devices in this band.⁵ Although the continued operation exceeds the field strength limitations set forth in 47 C.F.R. § 15.249, the transmission will continue to 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 continue to be placed [REDACTED]. The other principal operations in this band are Part 15 unlicensed devices, Part 18 ISM devices, and amateur radio operators.⁶ [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.

(2) Google will continue to 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.

⁴ See 47 C.F.R. §§ 27.1220, 27.1221(c).

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

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

Operations in the 24 GHz band: Google's testing in the 24 GHz band similarly will continue to 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 continue to avoid interference with Part 18 users, who do not need a license to operate their equipment. Although Google's test equipment will continue to 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 continue to 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 continue to 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 Sierra County, New Mexico, in the spectrum between 24.05 GHz and 24.25 GHz.⁷ Nor are there any active, licensed Part 97 users in 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 Sierra County will continue to 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 continued testing does not interfere with any earth exploration satellite services in this band.⁸

Operations in the millimeter wave bands: Finally, Google's continued 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 to 0829-EX-ST-2015 (Call Sign WI9XZE).⁹ Using conservative assumptions regarding Google's operation, the study considers all registered terrestrial E-band links within a distance of 600 kilometers from the test locations.¹⁰

Analysis of potential interference from [REDACTED] transmissions was done in three steps. First, the operations of the Google [REDACTED] transmitter in each test

⁷ 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.

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

⁹ See *generally* Exhibit C to 0829-EX-ST-2015 (Call Sign WI9XZE).

¹⁰ Exhibit C to 0829-EX-ST-2015 (Call Sign WI9XZE) at 7.

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).¹¹ Receivers where the worst-case predicted interference level was below this objective were considered non-interfering.¹²

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

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.¹⁵ In these cases, the azimuth of the interference path was compared to the receiver antenna alignment azimuth.¹⁶ A small (or zero) azimuth separation angle validated the underlying assumption of correlated rain fading for these cases.¹⁷ Each of these remaining cases satisfies the minimum C/I objective by a significant margin.¹⁸

Assessing potential interference for [REDACTED] transmitters was done in two steps.¹⁹ 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.²⁰ 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.²¹

Overall, the analysis shows that any potential interference from Google’s continued 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: Google’s continued 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

¹¹ *Id.* at 13.

¹² *Id.*

¹³ *Id.*

¹⁴ *See id.*

¹⁵ *Id.*

¹⁶ *Id.* at 13-14.

¹⁷ *Id.* at 14.

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ *Id.*

²¹ *Id.*

border, no coordination is needed for the Spaceport America site.²² Moreover, operations in the southernmost part of the Spaceport America testing area will continue to use directional antennas pointing northward (i.e., away from the Mexican border), further reducing any potential for harmful interference.

Finally, as noted, Google has already been conducting similar tests in this area under a grant of Special Temporary Authority, and no disruptions have been noted.

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

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

Technical Contact Details

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

²² See 47 C.F.R. § 101.1527(b).

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

Equipment	[REDACTED] [REDACTED] [REDACTED]
Number of Terminals	[REDACTED] ²³
Location	Operations not to exceed 25 km from the following geographic centerpoint: <ul style="list-style-type: none"> • 32° 59' 25" N, 106° 58' 10.9" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	2568.000	2590.000
[REDACTED]	2568.000	2590.000
[REDACTED]	2620.000	2640.000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW/ 24 W
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW/ 24 W
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW/ 24 W

[REDACTED] Antenna Information

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

²³ [REDACTED].

[REDACTED] Transmitter Equipment

Equipment²⁴	[REDACTED] <ul style="list-style-type: none"> • [REDACTED] [REDACTED] <ul style="list-style-type: none"> • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED]
Number of Terminals	[REDACTED]
Locations	<ul style="list-style-type: none"> • 2.6 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W • 2.6 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W

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

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP (with highest gain antenna)
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW/1 W
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW/1 W

²⁴ [REDACTED]. [REDACTED].

[REDACTED] Antenna Information

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

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

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

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

5 GHz Equipment and Station Details

[REDACTED] Radio Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Location	32° 59' 39" N, 106° 58' 29" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	5775.0000	5825.0000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	19 dBW/ 48 W

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED]
Gain	29 dBi
Beam Width at Half-Power Point	6.2 degrees
Orientation in Horizontal Plane	139.692° (SE)
Orientation in Vertical Plane	-0.2°

24.2 GHz Transmitter Equipment and Station Details*[REDACTED] Radio Equipment*

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Location	32° 59' 39" N, 106° 58' 29" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	24199.8800	24200.1200

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	31 dBW/ 768 W

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED]
Gain	41 dBi
Beam Width at Half-Power Point	1.4 degrees
Orientation in Horizontal Plane	139.692° (SE)
Orientation in Vertical Plane	-0.2°

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

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Location	Operation not to exceed 70 km from the following geographic centerpoint: <ul style="list-style-type: none"> 32° 59' 25" N, 106° 58' 10.9" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	72000.0000	74000.0000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	33 dBW/ 1214 W

[REDACTED] Antenna Details

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

[REDACTED] Radio Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Locations	<ul style="list-style-type: none"> 80 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W 80 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	82000.0000	84000.0000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP (with highest gain antenna)
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	52 dBW/ 96411 W

[REDACTED] Antenna Details

Antenna	[REDACTED]	[REDACTED]	[REDACTED]
Type	[REDACTED]	[REDACTED]	[REDACTED]
Quantity²⁵	[REDACTED]	[REDACTED]	[REDACTED]
Gain	46 dBi	52 dBi	55 dBi
Beam Width at Half-Power Point	0.822°	0.382°	0.284°
Orientation in Horizontal Plane	0-360°	0-360°	0-360°
Orientation in Vertical Plane	0°-45° from azimuth	0°-45° from azimuth	0°-45° from azimuth

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 Extension. These Exhibits were filed with the Office of Engineering and Technology on February 5, 2016. For additional information, please see File No. 0093-EX-ST-2016.

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 Extension tests/experiments may include trade secret information. The Commission has clarified that confidential treatment should be afforded to trade secrets.²⁶ Google's tests/experiments and proprietary wireless applications using particular radio

²⁵ [REDACTED].

²⁶ *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).

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 Extension 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 Extension 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) outlines below its need for the requested extension of Special Temporary Authority (STA Extension) and the compelling reasons why 0093-EX-ST-2016 should be granted expeditiously.

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

[REDACTED], Google may also conduct testing over a [REDACTED]. This transmitter used in this link will be placed at 32° 59' 39" N, 106° 58' 29" W. In this location, the equipment used will continue to include two types of radios: one that operates in the frequencies between 5775 MHz and 5825 MHz (5.8 GHz) and one that operates at 24.2 GHz. [REDACTED]. The maximum conducted power, maximum EIRP, and maximum ERP for each radio will be as set forth below:

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power and antenna patterns such that the received power outside of the proposed radius of operations will be less than -107dBm/5.5MHz.³ 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.⁴

Google expects to meet this requirement regardless of [REDACTED], and will continue to 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 continued 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 continued operation is just one-tenth of the 1 Watt limit allowed for unlicensed devices in this band.⁵ Although the continued operation exceeds the field strength limitations set forth in 47 C.F.R. § 15.249, the transmission will continue to 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 continue to be placed [REDACTED]. The other principal operations in this band are Part 15 unlicensed devices, Part 18 ISM devices, and amateur radio operators.⁶ [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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³ As noted in Exhibit B, a 25 kilometer radius of operations for equipment operating in both the 2568-2590 MHz and 2620-2640 MHz bands will continue to be used.

⁴ See 47 C.F.R. §§ 27.1220, 27.1221(c).

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

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

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 continue to 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 continue to avoid interference with Part 18 users, who do not need a license to operate their equipment. Although Google's test equipment will continue to 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 continue to 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 continue to 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 Sierra County, New Mexico, in the spectrum between 24.05 GHz and 24.25 GHz.⁷ Nor are there any active, licensed Part 97 users in 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 Sierra County will continue to 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 continued testing does not interfere with any earth exploration satellite services in this band.⁸

Operations in the millimeter wave bands: Finally, Google's continued 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 to 0829-EX-ST-2015 (Call Sign WI9XZE).⁹ Using conservative assumptions regarding Google's operation, the study considers all registered terrestrial E-band links within a distance of 600 kilometers from the test locations.¹⁰

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

⁷ 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.

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

⁹ See *generally* Exhibit C to 0829-EX-ST-2015 (Call Sign WI9XZE).

¹⁰ Exhibit C to 0829-EX-ST-2015 (Call Sign WI9XZE) at 7.

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).¹¹ Receivers where the worst-case predicted interference level was below this objective were considered non-interfering.¹²

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

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.¹⁵ In these cases, the azimuth of the interference path was compared to the receiver antenna alignment azimuth.¹⁶ A small (or zero) azimuth separation angle validated the underlying assumption of correlated rain fading for these cases.¹⁷ Each of these remaining cases satisfies the minimum C/I objective by a significant margin.¹⁸

Assessing potential interference for [REDACTED] transmitters was done in two steps.¹⁹ 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.²⁰ 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.²¹

Overall, the analysis shows that any potential interference from Google’s continued 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: Google’s continued 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.²² Moreover, operations in the southernmost part of the

¹¹ *Id.* at 13.

¹² *Id.*

¹³ *Id.*

¹⁴ *See id.*

¹⁵ *Id.*

¹⁶ *Id.* at 13-14.

¹⁷ *Id.* at 14.

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ *Id.*

²¹ *Id.*

²² *See* 47 C.F.R. § 101.1527(b).

Spaceport America testing area will continue to use directional antennas pointing northward (i.e., away from the Mexican border), further reducing any potential for harmful interference.

Finally, as noted, Google has already been conducting similar tests in this area under a grant of Special Temporary Authority, and no disruptions have been noted.

EXHIBIT B - TECHNICAL INFORMATION

Applicant Name: Google Inc.
Applicant FRN: 0016069502

Legal Contact Details

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

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

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	2568.000	2590.000
[REDACTED]	2568.000	2590.000
[REDACTED]	2620.000	2640.000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW/ 24 W
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW/ 24 W
[REDACTED]	64QAM OFDM	20M0A2D	20 MHz	4 W	16 dBW/ 24 W

¹ [REDACTED].

[REDACTED] Antenna Information

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

[REDACTED] Transmitter Equipment

Equipment²	<p>[REDACTED]</p> <ul style="list-style-type: none"> • [REDACTED] <p>[REDACTED]</p> <ul style="list-style-type: none"> • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED] • [REDACTED]
Number of Terminals	[REDACTED]
Locations	<ul style="list-style-type: none"> • 2.6 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W • 2.6 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W

² [REDACTED]. [REDACTED].

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

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP (with highest gain antenna)
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW/1 W
[REDACTED]	64QAM	20M0A2D	20 MHz	0.25 W	2 dBW/1 W

[REDACTED] Antenna Information

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

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

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

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

5 GHz Equipment and Station Details*[REDACTED] Radio Equipment*

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Location	32° 59' 39" N, 106° 58' 29" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	5775.0000	5825.0000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	19 dBW/ 48 W

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED]
Gain	29 dBi
Beam Width at Half-Power Point	6.2 degrees
Orientation in Horizontal Plane	139.692° (SE)
Orientation in Vertical Plane	-0.2°

24.2 GHz Transmitter Equipment and Station Details*[REDACTED] Radio Equipment*

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Location	32° 59' 39" N, 106° 58' 29" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	24199.8800	24200.1200

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	0.1 W	31 dBW/ 768 W

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED]
Gain	41 dBi
Beam Width at Half-Power Point	1.4 degrees
Orientation in Horizontal Plane	139.692° (SE)
Orientation in Vertical Plane	-0.2°

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

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Location	Operation not to exceed 70 km from the following geographic centerpoint: <ul style="list-style-type: none"> • 32° 59' 25" N, 106° 58' 10.9" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	72000.0000	74000.0000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	33 dBW/ 1214 W

[REDACTED] Antenna Details

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

[REDACTED] Radio Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Locations	<ul style="list-style-type: none"> 80 GHz Band Location 1: 32° 59' 39" N, 106° 58' 29" W 80 GHz Band Location 2: 32° 56' 27" N, 106° 55' 15" W

Frequency Range	Low (MHz)	High (MHz)
[REDACTED]	82000.0000	84000.0000

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP/ERP (with highest gain antenna)
[REDACTED]	QPSK	2G00G2D	2 GHz	0.5 W	52 dBW/ 96411 W

[REDACTED] Antenna Details

Antenna	[REDACTED]	[REDACTED]	[REDACTED]
Type	[REDACTED]	[REDACTED]	[REDACTED]
Quantity³	[REDACTED]	[REDACTED]	[REDACTED]
Gain	46 dBi	52 dBi	55 dBi
Beam Width at Half-Power Point	0.822°	0.382°	0.284°
Orientation in Horizontal Plane	0-360°	0-360°	0-360°
Orientation in Vertical Plane	0°-45° from azimuth	0°-45° from azimuth	0°-45° from azimuth

³ [REDACTED].