

Date: November 11, 2015

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

FCC File No: 1203-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 provided in 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 December 11, 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] in a carefully controlled environment. Among other parameters, Google will evaluate [REDACTED]. Google will also conduct [REDACTED]. [REDACTED].

The equipment used will include [REDACTED] at any given time. [REDACTED] will operate in the frequencies between 72 and 74 GHz (70 GHz radios), and [REDACTED] will operate in the frequencies between 82 and 84 GHz (80 GHz radios). [REDACTED] will be used with [REDACTED] antenna with a gain not to exceed 38 dBi, and in no case will the maximum equivalent isotropically radiated power (EIRP) exceed 16 dBW. [REDACTED] will be used with [REDACTED] antenna with a gain not to exceed 43 dBi. Maximum EIRP from [REDACTED] will not exceed 36 dBW.

Grant of this STA will not adversely impact any authorized user of RF spectrum. Potential interference to commercial millimeter wave users, federal users, and international users is discussed below.

Commercial millimeter wave band users (70 GHz band): In assessing the potential for harmful interference to other U.S. commercial users in the 70 GHz band (71-76 GHz), Comsearch conducted an analysis of proposed digital operations under the requested STA.¹ The analysis assesses potential interference to 70 GHz millimeter wave links within 100 kilometers of Google's test sites by relying on assumptions regarding transmitter characteristics and antenna patterns that are consistent with Google's proposed operations.² Consistent with Section 101.105 of the Commission's Rules and Telecommunications Industry Association's Telecommunications Systems Bulletin 10-F, potential interference that may degrade the performance of a 70 GHz receiver by less than 1 dB was considered not to be harmful.³ For each receiver, the analysis assessed the potential interference level in free space conditions, as compared to the 1 dB threshold degradation objective, to determine whether harmful interference could occur.⁴ The results demonstrate that Google's proposed experimental transmissions will be below the 1 dB threshold degradation objective at each of the licensed receivers in the vicinity of Google's operations.⁵ As a result, Google's proposed operations in the 70 GHz band do not present a risk of harmful interference to authorized users in the 70 GHz band.

Prior to commencing test operations, Google will register its proposed links with an authorized third-party database manager for this band.

Commercial millimeter wave band users (80 GHz band): Google's proposal for operations in the 80 GHz band complies with the technical specifications set forth in Part 101 for commercial millimeter wave operations and Google believes no experimental authorization is necessary. Nevertheless, because [REDACTED], Google

¹ See Exhibit C (Interference Analysis).

² See *id.* at 3.

³ See *id.* at 6; 47 C.F.R. §101.105(a)(5)(ii).

⁴ See Exhibit C at 7.

⁵ See *id.*

requests special temporary authority to conduct its test operations in the band to the extent that the Commission determines such experimental authority is necessary. The analysis set forth in Exhibit C also confirms that no harmful interference is expected from Google's 80 GHz digital transmissions.⁶

Prior to commencing test operations, Google will register its proposed links with an authorized third-party database manager for this band.

International users: Because the test sites are more than 700 kilometers away from U.S. borders, no international coordination is required.⁷

Federal users: Google is prepared to coordinate with the National Telecommunications and Information Administration to ensure that federal operations in the band do not experience harmful interference.

The proposed experimental operations in the 70 and 80 GHz bands accordingly will be conducted without harmful interference to other authorized users. For these reasons, Google requests approval of this STA request.

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 |

⁶ *Id.*

⁷ See 47 C.F.R. § 101.1527.

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 |

70 GHz Band Station Details*Radio Equipment*

| | |
|----------------------------|--|
| Equipment | [REDACTED] |
| Number of Terminals | [REDACTED] |
| Locations | <ul style="list-style-type: none"> • Location 1: 37°24'53"N, 122°2'36"W • Location 2: 37°25'2"N, 122°2'41"W • Location 3: 37°25'32"N, 122°4'22"W • Location 4: 37°20'41"N, 122°12'56"W • Location 5: Mobile: straight line between two end points <ul style="list-style-type: none"> ○ End point A: 37°25'27"N, 122°3'16"W ○ End point B: 37°25'4"N, 122°3'4"W |

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

| Radio | Modulation | Emission Designator | Bandwidth of Modulation | Maximum Power Out | Maximum EIRP |
|--------------|---------------------|----------------------------|--------------------------------|--------------------------|---------------------|
| [REDACTED] | Continuous waveform | 100HK0N | 100 Hz | 0.15 W | +16 dBW |
| [REDACTED] | Digital | 2G00G2D | 2 GHz | 0.15 W | +16 dBW |

Antenna Information

| | |
|--|---|
| Antenna | [REDACTED] |
| Type | [REDACTED] |
| Quantity | [REDACTED] |
| Gain | 24-38 dBi |
| Beam Width at Half-Power Point | 1-4 degrees (AZ) / 7.5-40 degrees (EL) |
| Orientation in Horizontal Plane | <ul style="list-style-type: none"> • Location 1: 0 degrees (due North) • Location 2: 180 degrees (due South) • Location 3: 234 degrees (SW) • Location 4: 54 degrees (NE) • Location 5: 276 degrees-295 degrees (NW) |
| Orientation in Vertical Plane | <ul style="list-style-type: none"> • Location 1: -45 degrees from horizontal • Location 2: -45 degrees from horizontal • Location 3: +2 degrees from horizontal • Location 4: -2 degrees from horizontal • Location 5: <ul style="list-style-type: none"> ○ End point A :+2 degrees from horizontal ○ End point B: +2 degrees from horizontal |

80 GHz Band Station Details*Radio Equipment*

| | |
|----------------------------|---|
| Equipment | [REDACTED] |
| Number of Terminals | [REDACTED] |
| Locations | <ul style="list-style-type: none"> • Location 6: 37°24'51"N, 122°2'36"W • Location 7: 37°25'4"N, 122°2'41"W • Location 8: 37°25'33"N, 122°4'22"W • Location 9: 37°20'41"N, 122°12'56"W • Location 10: 37°25'33"N, 122°4'19"W |

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

| Radio | Modulation | Emission Designator | Bandwidth of Modulation | Maximum Power Out | Maximum EIRP |
|------------|---------------------|---------------------|-------------------------|-------------------|--------------|
| [REDACTED] | Continuous waveform | 100HK0N | 100 Hz | 0.15 W | +36 dBW |
| [REDACTED] | Digital | 2G00G2D | 2 GHz | 0.15 W | +36 dBW |

Antenna Information

| | |
|--|---|
| Antenna | [REDACTED] |
| Type | [REDACTED] |
| Quantity | [REDACTED] |
| Gain | 44 dBi |
| Beam Width at Half-Power Point | 0.9 degrees |
| Orientation in Horizontal Plane | <ul style="list-style-type: none"> • Location 6: 180 degrees (due South) • Location 7: 0 degrees (due North) • Location 8: 234 degrees (SW) • Location 9: 54 degrees (NE) • Location 10: 96 degrees-115 degrees (SE) |
| Orientation in Vertical Plane | <ul style="list-style-type: none"> • Location 6: +45 degrees from horizontal • Location 7: +45 degrees from horizontal • Location 8: +2 degrees from horizontal • Location 9: -2 degrees from horizontal • Location 10: -2 degrees from horizontal |

Exhibit C - Interference Analysis:

Google does not request confidential treatment of Exhibit C.

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. The Exhibits were filed with the Office of Engineering and Technology on November 11, 2015. For additional information, please see File No. 1203-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.⁸ Google's tests/experiments and proprietary wireless applications using particular radio frequency equipment represent a "secret commercially valuable plan" within the meaning of a trade secret as recognized by the Commission.

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

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

⁸ *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).

"need to know" basis, and by requiring that any third parties involved in the preliminary analysis execute robust nondisclosure agreements.

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

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

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

8. Justification of the requested period of confidentiality.

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

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

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

Moreover, public disclosure of the sensitive information in the confidential exhibits to the 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 December 11, 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] in a carefully controlled environment. Among other parameters, Google will evaluate [REDACTED]. Google will also conduct [REDACTED]. [REDACTED].

The equipment used will include [REDACTED] at any given time. [REDACTED] will operate in the frequencies between 72 and 74 GHz (70 GHz radios), and [REDACTED] will operate in the frequencies between 82 and 84 GHz (80 GHz radios). [REDACTED] will be used with [REDACTED] antenna with a gain not to exceed 38 dBi, and in no case will the maximum equivalent isotropically radiated power (EIRP) exceed 16 dBW. [REDACTED] will be used with [REDACTED] antenna with a gain not to exceed 43 dBi. Maximum EIRP from [REDACTED] will not exceed 36 dBW.

Grant of this STA will not adversely impact any authorized user of RF spectrum. Potential interference to commercial millimeter wave users, federal users, and international users is discussed below.

Commercial millimeter wave band users (70 GHz band): In assessing the potential for harmful interference to other U.S. commercial users in the 70 GHz band (71-76 GHz), Comsearch conducted an analysis of proposed digital operations under the requested STA.¹ The analysis assesses potential interference to 70 GHz millimeter wave links within 100 kilometers of Google's test sites by relying on assumptions regarding transmitter characteristics and antenna patterns that are consistent with Google's proposed operations.² Consistent with Section 101.105 of the Commission's Rules and Telecommunications Industry Association's Telecommunications Systems Bulletin 10-F, potential interference that may degrade the performance of a 70 GHz receiver by less than 1 dB was considered not to be harmful.³ For each receiver, the analysis assessed the potential interference level in free space conditions, as compared to the 1 dB threshold degradation objective, to determine whether harmful interference could occur.⁴ The results demonstrate that Google's proposed experimental transmissions will be below the 1 dB threshold degradation objective at each of the licensed receivers in the vicinity of Google's operations.⁵ As a result, Google's proposed

¹ See Exhibit C (Interference Analysis).

² See *id.* at 3.

³ See *id.* at 6; 47 C.F.R. §101.105(a)(5)(ii).

⁴ See Exhibit C at 7.

⁵ See *id.*

operations in the 70 GHz band do not present a risk of harmful interference to authorized users in the 70 GHz band.

Prior to commencing test operations, Google will register its proposed links with an authorized third-party database manager for this band.

Commercial millimeter wave band users (80 GHz band): Google's proposal for operations in the 80 GHz band complies with the technical specifications set forth in Part 101 for commercial millimeter wave operations and Google believes no experimental authorization is necessary. Nevertheless, because [REDACTED], Google requests special temporary authority to conduct its test operations in the band to the extent that the Commission determines such experimental authority is necessary. The analysis set forth in Exhibit C also confirms that no harmful interference is expected from Google's 80 GHz digital transmissions.⁶

Prior to commencing test operations, Google will register its proposed links with an authorized third-party database manager for this band.

International users: Because the test sites are more than 700 kilometers away from U.S. borders, no international coordination is required.⁷

Federal users: Google is prepared to coordinate with the National Telecommunications and Information Administration to ensure that federal operations in the band do not experience harmful interference.

The proposed experimental operations in the 70 and 80 GHz bands accordingly will be conducted without harmful interference to other authorized users. For these reasons, Google requests approval of this STA request.

⁶ *Id.*

⁷ See 47 C.F.R. § 101.1527.

EXHIBIT B - TECHNICAL INFORMATION

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 |

70 GHz Band Station Details*Radio Equipment*

| | |
|----------------------------|--|
| Equipment | [REDACTED] |
| Number of Terminals | [REDACTED] |
| Locations | <ul style="list-style-type: none"> • Location 1: 37°24'53"N, 122°2'36"W • Location 2: 37°25'2"N, 122°2'41"W • Location 3: 37°25'32"N, 122°4'22"W • Location 4: 37°20'41"N, 122°12'56"W • Location 5: Mobile: straight line between two end points <ul style="list-style-type: none"> ○ End point A: 37°25'27"N, 122°3'16"W ○ End point B: 37°25'4"N, 122°3'4"W |

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

| Radio | Modulation | Emission Designator | Bandwidth of Modulation | Maximum Power Out | Maximum EIRP |
|------------|---------------------|---------------------|-------------------------|-------------------|--------------|
| [REDACTED] | Continuous waveform | 100HK0N | 100 Hz | 0.15 W | +16 dBW |
| [REDACTED] | Digital | 2G00G2D | 2 GHz | 0.15 W | +16 dBW |

Antenna Information

| | |
|--|---|
| Antenna | [REDACTED] |
| Type | [REDACTED] |
| Quantity | [REDACTED] |
| Gain | 24-38 dBi |
| Beam Width at Half-Power Point | 1-4 degrees (AZ) / 7.5-40 degrees (EL) |
| Orientation in Horizontal Plane | <ul style="list-style-type: none"> • Location 1: 0 degrees (due North) • Location 2: 180 degrees (due South) • Location 3: 234 degrees (SW) • Location 4: 54 degrees (NE) • Location 5: 276 degrees-295 degrees (NW) |
| Orientation in Vertical Plane | <ul style="list-style-type: none"> • Location 1: -45 degrees from horizontal • Location 2: -45 degrees from horizontal • Location 3: +2 degrees from horizontal • Location 4: -2 degrees from horizontal • Location 5: <ul style="list-style-type: none"> ○ End point A :+2 degrees from horizontal ○ End point B: +2 degrees from horizontal |

80 GHz Band Station Details*Radio Equipment*

| | |
|----------------------------|---|
| Equipment | [REDACTED] |
| Number of Terminals | [REDACTED] |
| Locations | <ul style="list-style-type: none"> • Location 6: 37°24'51"N, 122°2'36"W • Location 7: 37°25'4"N, 122°2'41"W • Location 8: 37°25'33"N, 122°4'22"W • Location 9: 37°20'41"N, 122°12'56"W • Location 10: 37°25'33"N, 122°4'19"W |

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

| Radio | Modulation | Emission Designator | Bandwidth of Modulation | Maximum Power Out | Maximum EIRP |
|------------|---------------------|---------------------|-------------------------|-------------------|--------------|
| [REDACTED] | Continuous waveform | 100HK0N | 100 Hz | 0.15 W | +36 dBW |
| [REDACTED] | Digital | 2G00G2D | 2 GHz | 0.15 W | +36 dBW |

Antenna Information

| | |
|--|---|
| Antenna | [REDACTED] |
| Type | [REDACTED] |
| Quantity | [REDACTED] |
| Gain | 44 dBi |
| Beam Width at Half-Power Point | 0.9 degrees |
| Orientation in Horizontal Plane | <ul style="list-style-type: none"> • Location 6: 180 degrees (due South) • Location 7: 0 degrees (due North) • Location 8: 234 degrees (SW) • Location 9: 54 degrees (NE) • Location 10: 96 degrees-115 degrees (SE) |
| Orientation in Vertical Plane | <ul style="list-style-type: none"> • Location 6: +45 degrees from horizontal • Location 7: +45 degrees from horizontal • Location 8: +2 degrees from horizontal • Location 9: -2 degrees from horizontal • Location 10: -2 degrees from horizontal |

EXHIBIT C – INTERFERENCE ANALYSIS

Experimental Operation

Mountain View, CA

Interference Analysis Report – 71 to 86 GHz



Prepared on Behalf of
Google Inc.

November 6, 2015



COMSEARCH
A CommScope Company

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1. Summary of Results

In support of proposed experimental operations in the 71 - 86 GHz E-Band, Comsearch performed an interference analysis considering all registered links within 100 km of the experimental system.

Calculations were performed to assess the interference into all potentially affected links. The results of this analysis show that no registered links will be affected by the proposed experimental operation.

2. Experimental Link Data

The technical parameters for the proposed experimental operation in Mountain View, California are shown below.

Summary of Proposed Experimental Operations

Location Data

| Site 1 | Coordinates | Elevation (m) | Site 2 | Coordinates | Elevation (m) |
|--------------|-------------------------|---------------|-------------|-------------------------|---------------|
| Location 1 | 37-24-53 N, 122-2-36 W | 5.11 | Location 6 | 37-24-51 N, 122-2-36 W | 5.06 |
| Location 2 | 37-25-2 N, 122-2-41 W | 4.93 | Location 7 | 37-25-4 N, 122-2-41 W | 4.67 |
| Location 3 | 37-25-33 N, 122-4-22 W | 5.36 | Location 9 | 37-20-41 N, 122-12-56 W | 497.3 |
| Location 4 | 37-20-41 N, 122-12-56 W | 497.3 | Location 8 | 37-25-33 N, 122-4-22 W | 5.48 |
| Location 5A* | 37-25-27 N, 122-3-16 W | 2.55 | Location 10 | 37-25-33 N, 122-4-19 W | 5.58 |
| Location 5B* | 37-25-4 N, 122-3-4 W | 4.95 | Location 10 | 37-25-33 N, 122-4-19 W | 5.58 |
| Location 5C* | 37-25-9 N, 122-3-5 W | 2.55 | Location 10 | 37-25-33 N, 122-4-19 W | 5.58 |

* Google intends to operate transmitters on a fixed path between locations 5A and 5B. A number of points along this line were modeled. Location 5C is included in the table as one representative point along the line between locations 5A and 5B.

Antenna Data

| Site 1 | Antenna | Antenna Height (m) | Site 2 | Antenna | Antenna Height (m) |
|-------------|-------------|--------------------|-------------|-----------|--------------------|
| Location 1 | Directional | 45.72 | Location 6 | Parabolic | 1.83 |
| Location 2 | Directional | 45.72 | Location 7 | Parabolic | 1.83 |
| Location 3 | Directional | 19.82 | Location 9 | Parabolic | 1.83 |
| Location 4 | Directional | 1.83 | Location 8 | Parabolic | 19.82 |
| Location 5A | Directional | 1.83 | Location 10 | Parabolic | 19.82 |
| Location 5B | Directional | 1.83 | Location 10 | Parabolic | 19.82 |
| Location 5C | Directional | 1.83 | Location 10 | Parabolic | 19.82 |

Radio Data

| Site 1 | Emission Designator | Maximum EIRP (dBm) | Center Freq. (MHz) | Site 2 | Emission Designator | Maximum EIRP (dBm) | Center Freq. (MHz) |
|-------------|---------------------|--------------------|--------------------|-------------|---------------------|--------------------|--------------------|
| Location 1 | 2G00G2D 100KN0N | 46 | 73000 | Location 6 | 2G00G2D 100KN0N | 66 | 83000 |
| Location 2 | 2G00G2D 100KN0N | 46 | 73000 | Location 7 | 2G00G2D 100KN0N | 66 | 83000 |
| Location 3 | 2G00G2D 100KN0N | 46 | 73000 | Location 9 | 2G00G2D 100KN0N | 66 | 83000 |
| Location 4 | 2G00G2D 100KN0N | 46 | 73000 | Location 8 | 2G00G2D 100KN0N | 66 | 83000 |
| Location 5A | 2G00G2D 100KN0N | 46 | 73000 | Location 10 | 2G00G2D 100KN0N | 66 | 83000 |
| Location 5B | 2G00G2D 100KN0N | 46 | 73000 | Location 10 | 2G00G2D 100KN0N | 66 | 83000 |
| Location 5C | 2G00G2D 100KN0N | 46 | 73000 | Location 10 | 2G00G2D 100KN0N | 66 | 83000 |

3. Radio Specifications

For purposes of this study, we used the following parameters for the radio.

| Radio Specifications | | |
|----------------------------|--------------|-------------|
| Emission Designator | 2G00G2D | 100KN0 N |
| Modulation | QPSK | none |
| Default Loading Channels | 1 CH Digital | n/a |
| Composite Data Rate (Mbps) | 1000 | n/a |
| Low Frequency (MHz) | 72000 | 72000 |
| High Frequency (MHz) | 84000 | 84000 |

4. Antenna Specifications

For purposes of this study, we used the following parameters for the antennas.

Directional Antenna:

| Antenna Specifications | |
|--------------------------|----------------|
| Antenna Classification | Directional |
| Diameter (ft) | 0.41 |
| Polarized | LHCP |
| Low Frequency (MHz) | 72000 |
| High Frequency (MHz) | 74000 |
| Main beam Gain (dBi) | 24 |
| Front to Back Ratio (dB) | 35 |
| 3-dB Beamwidth (deg) | 3.5(EL)/26(AZ) |

Parabolic Antenna:

| Antenna Specifications | |
|--------------------------|-----------|
| Antenna Classification | Parabolic |
| Diameter (ft) | 1 |
| Polarized | Single |
| Low Frequency (MHz) | 82000 |
| High Frequency (MHz) | 84000 |
| Main beam Gain (dBi) | 44 |
| Front to Back Ratio (dB) | 62 |
| 3-dB Beamwidth (deg) | 0.9 |

5. Interference Analysis Into Registered Links

Comsearch performed interference calculations to determine the potential for interference from Google's proposed fixed links into 71-86 GHz links registered by all licensees.

As input to the interference study, Comsearch retrieved data for potentially affected 71-86 GHz links registered in the database as of October 21, 2015. The links retrieved for the analysis include 873 links within 100 km of the proposed transmitters. The distance limit imposed by this geographic selection is consistent with industry standards and is considered to be sufficient to ensure that harmful interference with systems outside this area will not occur.

The potential interference from the proposed Google operation into the 71-86 GHz band receivers is along fixed terrestrial point-to-point paths. Standard direct interference calculations were used to predict the interference level from each proposed transmitter into each registered receiver in the selected data.

For line-of-sight propagation, the interference level at the input to a 71-86 GHz band receiver is calculated as:

Where:

- P_t = The transmit power of the experimental transmitter (dBm)
- G_t = The transmit antenna gain (dBi) in direction of the licensed receiver
- FSL = The free-space path loss from experimental transmitter to the receiver (dB)
- ABS = The oxygen and water vapor absorption loss for the path from experimental transmitter to receiver (dB)
- G_r = The receiver antenna gain (dBi) in direction of experimental transmitter

Antenna gain considering the off-axis discrimination in the horizontal plane for the experimental transmitter and potentially affected receivers was used to calculate interference levels. Where necessary, elevation patterns provided by Google were used to calculate additional antenna discrimination. This additional discrimination values were then included to reduce the predicted interference levels.

This analysis assumes nominal absorption losses of 0.4 dB per km for water vapor and oxygen, which is more conservative than using a detailed method such as Recommendation ITU-R P.676-10.

Consistent with FCC rules Section 101.105 and TIA TSB10-F, interference low enough to degrade the performance of a 71-86 GHz receiver by less than 1 dB is considered not to be harmful. The interference objective used in the analysis to satisfy this condition was determined as follows.

The thermal noise power level in a receiver is:

Where:

BW = Receiver bandwidth in MHz
NF = Receiver noise figure (dB)

The receiver bandwidth is estimated to be the same as the transmitter emission bandwidth indicated on the license.

By power addition, interference at 6 dB below the receiver thermal noise power level would result in 1 dB degradation of the receiver performance. The interference objective for this condition is:

Based on the assumption of a typical 3 dB noise figure, the interference objective for this analysis is:

For each receiver, the predicted interference level under the assumption of line-of-sight propagation was first compared to the 1 dB threshold degradation objective to determine whether harmful interference could occur under free space conditions.

Interference Analysis Results

Analysis results for the proposed testing are listed in the table below. Interference calculation values for the reported cases are organized by the experimental transmit location and include the environment links' registration number, transmitter site name and receiver site name.

The interference level was calculated into each 71-86 GHz band receive site in the selected data. Of the 873 links evaluated, the 6 worst calculations are displayed in Table 1. As indicated, all 6 cases clear the direct case calculation, meaning that they meet the 1 dB threshold degradation objective after including free space loss, absorption loss, and off-axis discrimination in both the azimuth and elevation plane.

The analysis showed that the interference into all receivers meets the 1 dB threshold degradation objective and thus Google's operation is not predicted to cause interference to any of the 873 links.

| Experimental Transmit Location | Victim Link Registration Number | Victim Licensee | Receiver Site Name | Receiver Freq. (MHz) | Distance Interferer to Victim (km) | Int. Level (dBm) | Max Int. Level for 1 dB TD (dBm) | Margin for 1 dB TD (dB) | Resolution |
|--------------------------------|---------------------------------|-----------------|--------------------|----------------------|------------------------------------|------------------|----------------------------------|-------------------------|---------------------|
| Location 7 | MM0002667 | Aoptix | 10KM SHED | 83500 H | 19.7 | -114.995 | -112.1 | -2.9 | Clears Direct Case. |
| Location 10 to 5C | 100204COMS00018 | Clearwire | CA-SFO0418A | 83500 V | 14.5 | -83.775 | -80.3 | -3.5 | Clears Direct Case. |
| Location 4 | 140502COMS00001 | REMEC Broadband | 303 BLDG | 72500 H | 25.6 | -90.16 | -83.9 | -6.3 | Clears Direct Case. |
| Location 4 | MM0009644 | Wiline Spectrum | SFO0848 | 72375 V | 21.8 | -87.33 | -79.7 | -7.6 | Clears Direct Case. |
| Location 1 | 130114COMS00001 | REMEC Broadband | SC02 | 72625 V | 10.2 | -99.57 | -80.3 | -19.3 | Clears Direct Case. |
| Location 1 | 130114COMS00002 | REMEC Broadband | SC02 | 73625 H | 10.2 | -99.57 | -80.3 | -19.3 | Clears Direct Case. |

Table 1: Direct Interference Cases into Registered 71-86 GHz Links



6. Contact Information

For questions or information regarding the 71-86 GHz Interference Analysis Report, please contact:

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