Date: November 20, 2015

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

FCC File No: 1234-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 21, 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].[1] Among other parameters, Google will evaluate [REDACTED].

Testing will involve [REDACTED]. [REDACTED]. [REDACTED]. [REDACTED].

The equipment used will include [REDACTED] and [REDACTED] at any given time. [REDACTED] radio will be used with [REDACTED] antenna with a gain not to exceed 47.5 dBi, and in no case will the maximum equivalent isotropically radiated power (EIRP) exceed 58.3 dBW. [REDACTED] radio will be used with [REDACTED] antennas with a gain not to exceed 36 dBi. Maximum EIRP from [REDACTED] radio will not exceed 42 dBW.

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

***1745-1755 MHz and 2145-2155 MHz band users (the 1.7 and 2.1 GHz bands)*:** Google's proposed operations will not cause harmful interference to other users of the 1.7 and 2.1 GHz bands. [REDACTED][2] [REDACTED][3] [REDACTED]. Operation of the proposed transmitters [REDACTED].

***27.9-28.2 GHz band users (the 28 GHz band)*:** Google's operations will not cause harmful interference to other users of the 28 GHz band.

- *Terrestrial licensees*: On Google's behalf, Comsearch identified 28 GHz band licensees in the common carrier fixed point-to-point microwave service, local television transmission service (LTTS), and local multipoint distribution service (LMDS).[4] Notification letters were sent to each of the licensees operating within the vicinity of Google's proposed testing, informing them of the technical parameters of the proposed experimentation.[5] No licensee objected.[6]

- *Satellite operations*: Google's proposed testing will not interfere with satellite receivers operating in the 28 GHz band. Google has conducted analyses evaluating the potential for interference to geostationary

[1] [REDACTED].
[2] *See* [REDACTED].
[3] *See* [REDACTED].
[4] *See* Exhibit C (28 GHz Frequency Coordination Report).
[5] *Id.* at 1.
[6] *Id.* The technical coordination report specified that Google would use an antenna with a gain of 36 dBi in its proposed operation. The request for an STA seeks authorization to operate antennas with gains as low as 19 dBi. However, if Google uses a lower antenna gain, the EIRP in the direction of other authorized operations will be correspondingly reduced, lessening the potential for interference to those operations. In addition, Google's operation will be conducted over a smaller test area than that contemplated in the coordination report.

(GSO) satellites, medium-earth orbit (MEO) satellites, and low-earth orbit (LEO) satellites. Each of these analyses is described below.

GSO satellites: To assess potential interference to GSO satellites, Google calculated interference levels from the sidelobes of the planned [REDACTED] antenna into the satellite receiver. The 28 GHz band is allocated for earth-to-space transmissions, so interference with satellite receivers on the ground is not a concern,[7] and Google's [REDACTED] transmitter will be [REDACTED], so the main beam will never be pointing toward the satellite receiver. In performing its calculations, Google relied on the technical parameters for GSO satellites set forth in ITU-R Recommendation SF 1601-2.[8] In particular, this recommendation suggests a GSO satellite has a maximum receive antenna gain of 55 dBi and a system noise temperature of 500K.[9] To approximate worst case conditions, Google assumed that [REDACTED] was directly in the spot beam of the satellite receiver. The analysis also assumed that the [REDACTED] antenna had a +10 dBi gain in the direction of the GSO satellite receiver—another worst case assumption.[10] Assuming free space propagation between the transmitter and the satellite's receive antenna, Google's analysis demonstrated that any interference from the transmitter is at least 24 dB below the satellite receiver's thermal noise floor. This equates to at most 0.017 dB in degradation. ITU Recommendation S.1323-2 recommends that internetwork interference caused by the earth and space station emissions of any one other GSO FSS network operating in the same frequency band or bands be limited to 6% of the total system noise power under clear-sky conditions.[11] Link degradation of 0.017 dB corresponds to 0.4% of total system noise power, or less than one-tenth of the ITU-recommended level.

Moreover, the received signal at the satellite is likely is to be even weaker because the satellite antenna will in fact be pointing away from Google's proposed transmitter location, rather than directly toward the Google transmitter as assumed in the interference analysis. The closest earth station to Google's proposed operation is located 147 kilometers away in El Paso, Texas. As a result, any satellite receiver

---

[7] *See* 47 C.F.R. § 2.106.

[8] ITU-R Recommendation SF 1601-2, *Methodologies for Interference Evaluation from the Downlink of the Fixed Service Using High Altitude Platform Stations to the Uplink of the Fixed-satellite Service Using the Geostationary Satellites Within the Band 27.5-28.35 GHz* (2007), *available at* http://www.itu.int/rec/R-REC-SF.1601-2-200702-I (ITU-R Recommendation SF 1601-2).

[9] *Id.* at 8.

[10] [REDACTED].

[11] ITU-R Recommendation S.1323-2, *Maximum Permissible Levels of Interference in a Satellite Network (GSO/FSS; Non-GSO/FSS; Non-GSO/MSS Feeder Links) in the Fixed-satellite Service Caused by Other Codirectional FSS Networks Below 30 GHz* (2002), *available at* https://www.itu.int/rec/R-REC-S.1323/en (ITU-R Recommendation S.1323-2).

operating in this band will be pointed at a terrestrial location at least 147 kilometers away from Google's location, ensuring that its receiver will be a minimum of 0.23 degrees off-boresight from Google's proposed operation.[12]

MEO and LEO satellites: Google's proposed testing will not interfere with MEO or LEO satellites. A search of the FCC's IBFS database shows that there are no MEO or LEO earth stations registered in New Mexico, Arizona, or Texas. Therefore, the closest earth station to Google's proposed operation can be no closer than the Colorado border, roughly 370 kilometers away from Google's proposed operations. If a MEO satellite operates at roughly 8,000 kilometers above the earth's surface [13] and points at an earth station at least 370 kilometers from the edge of Google's proposed operating area, the MEO satellite's receive antenna will be off axis from the direction of the proposed test area by at least 2.6 degrees. Relying on the antenna patterns recommended in ITU-R Recommendation F.699-7,[14] the satellite receive antenna gain in the direction of Google's operation is at most 30 dBi for MEO satellites. Using a worst case antenna gain of +10 dBi [REDACTED] in the direction of the satellite, and a satellite receiver noise temperature of 500K,[15] the signal received by a MEO satellite from Google's [REDACTED] will be at least 36 dB below the noise floor. This noise level is undetectable on a data link. As noted above, ITU Recommendation S.1323-2 recommends that internetwork interference caused by the earth and space station emissions of any one other GSO FSS network operating in the same frequency band or bands be limited to 6% of the total system noise power under clear-sky conditions.[16] Transmissions at 36 dB below the noise floor correspond to 0.03% of total system noise power and will not cause harmful interference to MEO satellites.

To assess potential interference to LEO satellites, Google assumed that such satellites would operate at orbital heights between 500 and 2000

[12] A search of the FCC's IBFS database shows the nearest GSO satellite earth station located at El Paso, 147 kilometers from the perimeter of Google's proposed testing. As a result, a GSO satellite will not point directly at Google's operation, but instead will point no closer than El Paso.

[13] O3b Networks operates a MEO satellite in this band, and that satellite operates at an orbital height of 8062 kilometers.

[14] ITU-R Recommendation F.699, *Reference Radiation Patterns for Fixed Wireless System Antennas for Use in Coordination Studies and Interference Assessment in the Frequency Range From 100 MHz to About 70 GHz* (2006), *available at* https://www.itu.int/rec/R-REC-F.699/en.

[15] ITU-R Recommendation SF 1601-2.

[16] ITU-R Recommendation S.1323-2. The ITU has not issued similar recommendations for MEO and LEO satellites, so Google has assumed that the system noise temperature and antenna gain characteristics for LEOs and MEOs are similar to those provided in the ITU-R Recommendation S.1323-2.

kilometers above mean sea level and conducted the same analysis described above.[17] We summarize our results in the table below:

Satellite height	**500 km**	**1000 km**	**2000 km**
Angle off-boresight from Google operations	36 degrees	20 degrees	10 degrees
Maximum receive antenna gain in direction of Google operations	7.5 dBi	12.6 dBi	18.5 dBi
Maximum power of Google signal received by satellite	35 dBm below noise floor	36 dBm below noise floor	36 dBm below noise floor

Based on this analysis, the signal received by a LEO satellite from Google's proposed operation will be at least 35 dB below the receiver noise floor. This noise level, too, is undetectable on a data link, and corresponds to 0.03% of total system noise power. Accordingly, Google's proposed operation will not cause harmful interference to MEO and LEO satellites.

- *Unlicensed operations*: Google's proposed testing will not interfere with unlicensed users of the 24.05-29.00 GHz band. Unlicensed use of the band is limited to level sensing radars.[18] These low-power radars measure the level, or relative height, of various substances in man-made or natural containers. For example, they may be used to measure water basin levels, coal piles, or grain levels in a grain silo.[19] The Commission's rules require their transmit antennas to be oriented downward. Google's proposed operation will [REDACTED], and [REDACTED] the test emissions will not exceed the −14 dBm/MHz EIRP density set forth in the rules for these radars.[20] [REDACTED]. Moreover, many level probing radars are used in confined spaces where Google's signal will be further attenuated by obstructions. As a result, there is no significant risk of harmful interference to unlicensed operations in this band.

[17] Mark A. Sturza, LEOs: The Communications Satellites of the 21st Century 1, *available at* http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=564754&tag=1.
[18] *See* 47 C.F.R. §15.256.
[19] *In the Matter of Amendment of Part 15 of the Commission's Rules To Establish Regulations for Tank Level Probing Radars in the Frequency Band 77-81 GHz*, *et al.*, Report and Order and Order, 29 FCC Rcd. 761 ¶ 1 (2014).
[20] *See* 47 C.F.R. §15.256(g)(3).

31.0-31.3 GHz band users (31 GHz band):

- *Terrestrial licensees*: Google's operations also will not cause harmful interference to other users of the 31 GHz band. On Google's behalf, Comsearch identified the common carrier fixed point-to-point microwave service, LTTS, and LMDS licensees operating in this band in the vicinity of Google's proposed operations.[21] A notification was sent to each of these licensees, informing them of the technical parameters of the proposed experimentation.[22] No licensee objected.[23]

  Comsearch also identified site-based licenses in the microwave public safety and industrial/business pool services.[24] Comsearch then performed an analysis to assess the interference into all potentially affected site-based 31 GHz stations in the microwave public safety and industrial/business pool services.[25] This analysis shows that no incumbent fixed operations should be affected by the proposed experimental operation.[26]

- *Federal operations*: The Table of Frequency Allocations reflects a federal allocation for standard frequency and time signal-satellite (space-to-earth) operations. Google is not aware of any federal standard frequency and time signal-satellites using the 31 GHz band, but is prepared to coordinate with such satellites as necessary.

Federal operations adjacent to the 31 GHz band: Google's operations will not interfere with earth exploration satellites operating in the 31.3-31.8 GHz band. These satellites carry passive sensors and are operated by the National Oceanic and Atmospheric Association, the National Aeronautics and Space Administration, and EUMETSAT. ITU-R Recommendation RS.2017[27] provides interference protection guidelines for these satellite operations. The recommendation suggests that an interference signal level should not exceed -166 dBW for more than 0.01% of the time the signal is active or 0.01% of the area covered by the signal operation. Google has conducted a comprehensive simulation of the impact of its proposed operations on Advanced Microwave Sounding Unit-A (AMSU-A) radiometer systems operating in the 31.3-31.5 GHz band. The analysis shows that by complying with an out-of-band emissions (OOBE) level of -38 dBW / 100 MHz, the received signal from Google's

[21] See Exhibit D (31 GHz Frequency Coordination Report).
[22] *Id.* at 1. When Comsearch issued these notification letters, Google had contemplated requesting authority to operate at higher EIRPs than proposed in this application. As a result, the parameters of the proposed operation are more restrictive of Google than those discussed in the coordination report.
[23] *Id.*
[24] *Id.*
[25] *Id.*
[26] *Id.*
[27] ITU-R Recommendation RS.2017, *Performance and Interference Criteria for Satellite Passive Remote Sensing* (2012), *available at* https://www.itu.int/rec/R-REC-RS.2017/en.

operations exceeds -166 dBW less than 0.01% of the time.[28] This analysis assumes Google's [REDACTED]. Google will operate consistent with these assumptions when under the authority of the requested STA, thus ensuring that Google's operations will not interfere with AMSU-A operations.

Google has also analyzed potential interference to the Advanced Technology Microwave Sounder (ATMS) sensor. The ATMS is similar in many respects to the AMSU-A radiometer systems; however, the ATMS beamwidth is 5.2 degrees instead of 3.3 degrees for AMSU-A, and the cross-track scan rate is 2.7 seconds compared to 8 seconds for the AMSU-A. Google's simulations also confirm that if Google limits its OOBE to -38 dBW / 100 MHz into the 31.3-31.5 GHz band and [REDACTED], the received power at the ATMS satellite will not exceed -166 dBW more than 0.01% of the time. Thus, no interference to the AMTS satellite is expected.

Google, moreover, is prepared to coordinate with NTIA to ensure that federal operations in the band do not experience harmful interference.

International users: Because the proposed test area is more than 39 miles from the Mexican border, no international coordination is required.[29] Moreover, operations in the southernmost part of the proposed test area will use directional antennas pointing northward (i.e., away from the Mexican border), further reducing any potential for harmful interference.

The proposed experimental operations 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

[28] The proposed OOBE level is also consistent with the OOBE recommendations set forth in Resolution 750 of the 2007 World Radio Conference, which urges administrations to take all reasonable steps to limit OOBE to -38dBW / 100 MHz or less. *See* Final Acts, WRC-07, Res. 750 (2007), *available at* http://www.itu.int/dms_pub/itu-s/oth/02/01/S020100002C4006PDFE.PDF.

[29] Where Part 101 of the FCC's rules specifies a coordination distance for operations in the frequency bands above 1 GHz, it typically requires coordination within 35 miles of the Mexican border. *See*, *e.g.*, 47 C.F.R. § 101.31(b)(v); *id.* §101.1527(b); *id.* §101.1423.

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

Ka-Band Transmitter Equipment and Station Details

[REDACTED] Transmitter Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Mobile
Location	Operations not to exceed 70 km from the following geographic centerpoint: • 32° 59’ 25” N, 106° 58’ 11” W

Frequency Range	**Low (GHz)**	**High (GHz)**
[REDACTED]	27.900	28.200

Radio	**Modulation**	**Emission Designator**	**Modulation Bandwidth**	**Maximum Power Out**	**Maximum EIRP**
[REDACTED]	QAM	300MA2D	300 MHz	4 W	42 dBW (with 36 dBi antenna)

[REDACTED] Antenna Information

Antenna #1	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED][a]
Gain	19-27 dBi
Beam Width at Half-Power Point	0.5-3 degrees in azimuth, 10-50 degrees in elevation
Orientation in Horizontal Plane	0° to 360°
Orientation in Vertical Plane	-45° to +45° from Nadir

Antenna #2	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED][a]
Gain	27-36 dBi
Beam Width at Half-Power Point	0.1-0.5 degrees in azimuth, 10-50 degrees in elevation
Orientation in Horizontal Plane	0° to 360°
Orientation in Vertical Plane	-45° to +45° from Nadir

[a] [REDACTED]. [REDACTED].

[REDACTED] Transmitter Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Fixed
Locations	• Location 1: 32° 59’ 39” N, 106° 58’ 29” W • Location 2: 32° 56’ 27” N, 106° 55’ 15” W

Frequency Range	**Low (GHz)**	**High (GHz)**
[REDACTED]	31.000	31.300

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP (with highest gain antenna)
[REDACTED]	QAM	300MD1D	300 MHz	12 W	58.3 dBW

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED]
Gain	47.5 dBi
Beam Width at Half-Power Point	0.6°
Orientation in Horizontal Plane	0°-360°
Orientation in Vertical Plane	45°-85° in elevation from horizon

2.15 GHz Transmitter Equipment and Station Details

[REDACTED] Transmitter Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Mobile
Location #1	Operations not to exceed 40 km from the following geographic centerpoint: • 32° 59' 25” N, 106° 58' 11” W
Location #2	Operations within 160 km from the following geographic centerpoint: • 40° 25' 26" N, 116° 16' 34" W with the exception of a 40 km exclusion zone around the specified centerpoint: • 40° 50' 2" N, 115° 45' 41" W

Frequency Range	Low (GHz)	High (GHz)
[REDACTED]	2.145	2.155

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP
[REDACTED]	64QAM OFDM	10M0A2D	10 MHz	5 W	23 dBW

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	Directional
Quantity	[REDACTED]
Gain	16 dBi
Beam Width at Half-Power Point	32°
Orientation in Horizontal Plane	0°-360°
Orientation in Vertical Plane	-45° to +45° from Nadir

1.75 GHz Transmitter Equipment and Station Details

[REDACTED] Transmitter Equipment

Equipment[30]	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Mobile
Location #1	Operations not to exceed 40 km from the following geographic centerpoint: • 32° 59' 25” N, 106° 58' 11” W
Location #2	Operations within 160 km from the following geographic centerpoint: • 40° 25' 26" N, 116° 16' 34" W with the exception of a 40 km exclusion zone around the specified centerpoint: • 40° 50' 2" N, 115° 45' 41" W

Frequency Range	Low (GHz)	High (GHz)
[REDACTED]	1.745	1.755

[30] Google plans to use the equipment listed in this table but may supplement it with standard, retail equipment certified by the FCC for operation in the 1745-1755 MHz band. [REDACTED].

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP (with highest gain antenna)
[REDACTED]	64QAM	10M0A2D	10 MHz	0.25 W	2 dBW

[REDACTED] Antenna Information

Antenna #1	[REDACTED]
Type	Dipole (Nearly Omnidirectional)
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 #2	[REDACTED]
Type	Dipole (Nearly Omnidirectional)
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 #3	[REDACTED]
Type	Directional
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 #4	[REDACTED]
Type	Directional
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°

Exhibit C - 28 GHz Frequency Coordination Report:

Google does not request confidential treatment of Exhibit C.

Exhibit D - 31 GHz Frequency Coordination Report:

Google does not request confidential treatment of Exhibit D.

Exhibit E - [REDACTED]:

Google requests confidential treatment of Exhibit E in its entirety.

Exhibit F - [REDACTED]:

Google requests confidential treatment of Exhibit F 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. The Exhibits were filed with the Office of Engineering and Technology on November 20, 2015. For additional information, please see File No. 1234-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.[31] 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

[31] *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

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 21, 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].[1] Among other parameters, Google will evaluate [REDACTED].

Testing will involve [REDACTED]. [REDACTED]. [REDACTED]. [REDACTED].

The equipment used will include [REDACTED] and [REDACTED] at any given time. [REDACTED] radio will be used with [REDACTED] antenna with a gain not to exceed 47.5 dBi, and in no case will the maximum equivalent isotropically radiated power (EIRP) exceed 58.3 dBW. [REDACTED] radio will be used with [REDACTED] antennas with a gain not to exceed 36 dBi. Maximum EIRP from [REDACTED] radio will not exceed 42 dBW.

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

***1745-1755 MHz and 2145-2155 MHz band users (the 1.7 and 2.1 GHz bands)*:** Google's proposed operations will not cause harmful interference to other users of the 1.7 and 2.1 GHz bands. [REDACTED][2] [REDACTED][3] [REDACTED]. Operation of the proposed transmitters [REDACTED].

***27.9-28.2 GHz band users (the 28 GHz band)*:** Google's operations will not cause harmful interference to other users of the 28 GHz band.

- *Terrestrial licensees*: On Google's behalf, Comsearch identified 28 GHz band licensees in the common carrier fixed point-to-point microwave service, local television transmission service (LTTS), and local multipoint distribution service (LMDS).[4] Notification letters were sent to each of the licensees operating within the vicinity of Google's proposed testing, informing them of the technical parameters of the proposed experimentation.[5] No licensee objected.[6]

---

[1] [REDACTED].
[2] *See* [REDACTED].
[3] *See* [REDACTED].
[4] *See* Exhibit C (28 GHz Frequency Coordination Report).
[5] *Id.* at 1.
[6] *Id.* The technical coordination report specified that Google would use an antenna with a gain of 36 dBi in its proposed operation. The request for an STA seeks authorization to operate antennas with gains as low as 19 dBi. However, if Google uses a lower antenna gain, the EIRP in the direction of other authorized operations will be correspondingly reduced, lessening the potential for interference to those operations.

- *Satellite operations*: Google's proposed testing will not interfere with satellite receivers operating in the 28 GHz band. Google has conducted analyses evaluating the potential for interference to geostationary (GSO) satellites, medium-earth orbit (MEO) satellites, and low-earth orbit (LEO) satellites. Each of these analyses is described below.

  GSO satellites: To assess potential interference to GSO satellites, Google calculated interference levels from the sidelobes of the planned [REDACTED] antenna into the satellite receiver. The 28 GHz band is allocated for earth-to-space transmissions, so interference with satellite receivers on the ground is not a concern,[7] and Google's [REDACTED] transmitter will be [REDACTED], so the main beam will never be pointing toward the satellite receiver. In performing its calculations, Google relied on the technical parameters for GSO satellites set forth in ITU-R Recommendation SF 1601-2.[8] In particular, this recommendation suggests a GSO satellite has a maximum receive antenna gain of 55 dBi and a system noise temperature of 500K.[9] To approximate worst case conditions, Google assumed that [REDACTED] was directly in the spot beam of the satellite receiver. The analysis also assumed that the [REDACTED] antenna had a +10 dBi gain in the direction of the GSO satellite receiver—another worst case assumption.[10] Assuming free space propagation between the transmitter and the satellite's receive antenna, Google's analysis demonstrated that any interference from the transmitter is at least 24 dB below the satellite receiver's thermal noise floor. This equates to at most 0.017 dB in degradation. ITU Recommendation S.1323-2 recommends that internetwork interference caused by the earth and space station emissions of any one other GSO FSS network operating in the same frequency band or bands be limited to 6% of the total system noise power under clear-sky conditions.[11] Link degradation of 0.017 dB corresponds to 0.4% of total system noise power, or less than one-tenth of the ITU-recommended level.

  Moreover, the received signal at the satellite is likely is to be even weaker because the satellite antenna will in fact be pointing away from Google's proposed transmitter location, rather than directly toward the Google transmitter

---

In addition, Google's operation will be conducted over a smaller test area than that contemplated in the coordination report.

[7] *See* 47 C.F.R. § 2.106.

[8] ITU-R Recommendation SF 1601-2, *Methodologies for Interference Evaluation from the Downlink of the Fixed Service Using High Altitude Platform Stations to the Uplink of the Fixed-satellite Service Using the Geostationary Satellites Within the Band 27.5-28.35 GHz* (2007), *available at* http://www.itu.int/rec/R-REC-SF.1601-2-200702-I (ITU-R Recommendation SF 1601-2).

[9] *Id.* at 8.

[10] [REDACTED].

[11] ITU-R Recommendation S.1323-2, *Maximum Permissible Levels of Interference in a Satellite Network (GSO/FSS; Non-GSO/FSS; Non-GSO/MSS Feeder Links) in the Fixed-satellite Service Caused by Other Codirectional FSS Networks Below 30 GHz* (2002), *available at* https://www.itu.int/rec/R-REC-S.1323/en (ITU-R Recommendation S.1323-2).

as assumed in the interference analysis. The closest earth station to Google's proposed operation is located 147 kilometers away in El Paso, Texas. As a result, any satellite receiver operating in this band will be pointed at a terrestrial location at least 147 kilometers away from Google's location, ensuring that its receiver will be a minimum of 0.23 degrees off-boresight from Google's proposed operation.[12]

MEO and LEO satellites: Google's proposed testing will not interfere with MEO or LEO satellites. A search of the FCC's IBFS database shows that there are no MEO or LEO earth stations registered in New Mexico, Arizona, or Texas. Therefore, the closest earth station to Google's proposed operation can be no closer than the Colorado border, roughly 370 kilometers away from Google's proposed operations. If a MEO satellite operates at roughly 8,000 kilometers above the earth's surface[13] and points at an earth station at least 370 kilometers from the edge of Google's proposed operating area, the MEO satellite's receive antenna will be off axis from the direction of the proposed test area by at least 2.6 degrees. Relying on the antenna patterns recommended in ITU-R Recommendation F.699-7,[14] the satellite receive antenna gain in the direction of Google's operation is at most 30 dBi for MEO satellites. Using a worst case antenna gain of +10 dBi [REDACTED] in the direction of the satellite, and a satellite receiver noise temperature of 500K,[15] the signal received by a MEO satellite from Google's [REDACTED] will be at least 36 dB below the noise floor. This noise level is undetectable on a data link. As noted above, ITU Recommendation S.1323-2 recommends that internetwork interference caused by the earth and space station emissions of any one other GSO FSS network operating in the same frequency band or bands be limited to 6% of the total system noise power under clear-sky conditions.[16] Transmissions at 36 dB below the noise floor correspond to 0.03% of total system noise power and will not cause harmful interference to MEO satellites.

To assess potential interference to LEO satellites, Google assumed that such satellites would operate at orbital heights between 500 and 2000 kilometers

---

[12] A search of the FCC's IBFS database shows the nearest GSO satellite earth station located at El Paso, 147 kilometers from the perimeter of Google's proposed testing. As a result, a GSO satellite will not point directly at Google's operation, but instead will point no closer than El Paso.

[13] O3b Networks operates a MEO satellite in this band, and that satellite operates at an orbital height of 8062 kilometers.

[14] ITU-R Recommendation F.699, *Reference Radiation Patterns for Fixed Wireless System Antennas for Use in Coordination Studies and Interference Assessment in the Frequency Range From 100 MHz to About 70 GHz* (2006), *available at* https://www.itu.int/rec/R-REC-F.699/en.

[15] ITU-R Recommendation SF 1601-2.

[16] ITU-R Recommendation S.1323-2. The ITU has not issued similar recommendations for MEO and LEO satellites, so Google has assumed that the system noise temperature and antenna gain characteristics for LEOs and MEOs are similar to those provided in the ITU-R Recommendation S.1323-2.

above mean sea level and conducted the same analysis described above.[17] We summarize our results in the table below:

Satellite height	**500 km**	**1000 km**	**2000 km**
Angle off-boresight from Google operations	36 degrees	20 degrees	10 degrees
Maximum receive antenna gain in direction of Google operations	7.5 dBi	12.6 dBi	18.5 dBi
Maximum power of Google signal received by satellite	35 dBm below noise floor	36 dBm below noise floor	36 dBm below noise floor

Based on this analysis, the signal received by a LEO satellite from Google's proposed operation will be at least 35 dB below the receiver noise floor. This noise level, too, is undetectable on a data link, and corresponds to 0.03% of total system noise power. Accordingly, Google's proposed operation will not cause harmful interference to MEO and LEO satellites.

- *Unlicensed operations*: Google's proposed testing will not interfere with unlicensed users of the 24.05-29.00 GHz band. Unlicensed use of the band is limited to level sensing radars.[18] These low-power radars measure the level, or relative height, of various substances in man-made or natural containers. For example, they may be used to measure water basin levels, coal piles, or grain levels in a grain silo.[19] The Commission's rules require their transmit antennas to be oriented downward. Google's proposed operation will [REDACTED], and [REDACTED] the test emissions will not exceed the −14 dBm/MHz EIRP density set forth in the rules for these radars.[20] [REDACTED]. Moreover, many level probing radars are used in confined spaces where Google's signal will be further attenuated by obstructions. As a result, there is no significant risk of harmful interference to unlicensed operations in this band.

31.0-31.3 GHz band users (31 GHz band):

- *Terrestrial licensees*: Google's operations also will not cause harmful interference to other users of the 31 GHz band. On Google's behalf, Comsearch identified the common carrier fixed point-to-point microwave service, LTTS, and LMDS

[17] Mark A. Sturza, LEOs: The Communications Satellites of the 21st Century 1, *available at* http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=564754&tag=1.
[18] *See* 47 C.F.R. §15.256.
[19] *In the Matter of Amendment of Part 15 of the Commission's Rules To Establish Regulations for Tank Level Probing Radars in the Frequency Band 77-81 GHz*, *et al.*, Report and Order and Order, 29 FCC Rcd. 761 ¶ 1 (2014).
[20] *See* 47 C.F.R. §15.256(g)(3).

licensees operating in this band in the vicinity of Google's proposed operations.[21] A notification was sent to each of these licensees, informing them of the technical parameters of the proposed experimentation.[22] No licensee objected.[23]

Comsearch also identified site-based licenses in the microwave public safety and industrial/business pool services.[24] Comsearch then performed an analysis to assess the interference into all potentially affected site-based 31 GHz stations in the microwave public safety and industrial/business pool services.[25] This analysis shows that no incumbent fixed operations should be affected by the proposed experimental operation.[26]

- *Federal operations*: The Table of Frequency Allocations reflects a federal allocation for standard frequency and time signal-satellite (space-to-earth) operations. Google is not aware of any federal standard frequency and time signal-satellites using the 31 GHz band, but is prepared to coordinate with such satellites as necessary.

Federal operations adjacent to the 31 GHz band: Google's operations will not interfere with earth exploration satellites operating in the 31.3-31.8 GHz band. These satellites carry passive sensors and are operated by the National Oceanic and Atmospheric Association, the National Aeronautics and Space Administration, and EUMETSAT. ITU-R Recommendation RS.2017[27] provides interference protection guidelines for these satellite operations. The recommendation suggests that an interference signal level should not exceed -166 dBW for more than 0.01% of the time the signal is active or 0.01% of the area covered by the signal operation. Google has conducted a comprehensive simulation of the impact of its proposed operations on Advanced Microwave Sounding Unit-A (AMSU-A) radiometer systems operating in the 31.3-31.5 GHz band. The analysis shows that by complying with an out-of-band emissions (OOBE) level of -38 dBW / 100 MHz, the received signal from Google's operations exceeds -166 dBW less than 0.01% of the time.[28] This analysis assumes Google's [REDACTED]. Google will operate consistent with these assumptions when under the authority of the requested STA, thus ensuring that Google's operations will not interfere with AMSU-A operations.

---

[21] See Exhibit D (31 GHz Frequency Coordination Report).

[22] *Id.* at 1. When Comsearch issued these notification letters, Google had contemplated requesting authority to operate at higher EIRPs than proposed in this application. As a result, the parameters of the proposed operation are more restrictive of Google than those discussed in the coordination report.

[23] *Id.*

[24] *Id.*

[25] *Id.*

[26] *Id.*

[27] ITU-R Recommendation RS.2017, *Performance and Interference Criteria for Satellite Passive Remote Sensing* (2012), *available at* https://www.itu.int/rec/R-REC-RS.2017/en.

[28] The proposed OOBE level is also consistent with the OOBE recommendations set forth in Resolution 750 of the 2007 World Radio Conference, which urges administrations to take all reasonable steps to limit OOBE to -38dBW / 100 MHz or less. *See* Final Acts, WRC-07, Res. 750 (2007), *available at* http://www.itu.int/dms_pub/itu-s/oth/02/01/S020100002C4006PDFE.PDF.

Google has also analyzed potential interference to the Advanced Technology Microwave Sounder (ATMS) sensor. The ATMS is similar in many respects to the AMSU-A radiometer systems; however, the ATMS beamwidth is 5.2 degrees instead of 3.3 degrees for AMSU-A, and the cross-track scan rate is 2.7 seconds compared to 8 seconds for the AMSU-A. Google's simulations also confirm that if Google limits its OOBE to -38 dBW / 100 MHz into the 31.3-31.5 GHz band and [REDACTED], the received power at the ATMS satellite will not exceed -166 dBW more than 0.01% of the time. Thus, no interference to the AMTS satellite is expected.

Google, moreover, is prepared to coordinate with NTIA to ensure that federal operations in the band do not experience harmful interference.

International users: Because the proposed test area is more than 39 miles from the Mexican border, no international coordination is required.[29] Moreover, operations in the southernmost part of the proposed test area will use directional antennas pointing northward (i.e., away from the Mexican border), further reducing any potential for harmful interference.

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

[29] Where Part 101 of the FCC's rules specifies a coordination distance for operations in the frequency bands above 1 GHz, it typically requires coordination within 35 miles of the Mexican border. *See*, *e.g.*, 47 C.F.R. § 101.31(b)(v); *id.* §101.1527(b); *id.* §101.1423.

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

Ka-Band Transmitter Equipment and Station Details

[REDACTED] Transmitter Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Mobile
Location	Operations not to exceed 70 km from the following geographic centerpoint: • 32° 59’ 25” N, 106° 58’ 11” W

Frequency Range	**Low (GHz)**	**High (GHz)**
[REDACTED]	27.900	28.200

Radio	Modulation	Emission Designator	Modulation Bandwidth	Maximum Power Out	Maximum EIRP
[REDACTED]	QAM	300MA2D	300 MHz	4 W	42 dBW (with 36 dBi antenna)

[REDACTED] Antenna Information

Antenna #1	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED][a]
Gain	19-27 dBi
Beam Width at Half-Power Point	0.5-3 degrees in azimuth, 10-50 degrees in elevation
Orientation in Horizontal Plane	0° to 360°
Orientation in Vertical Plane	-45° to +45° from Nadir

Antenna #2	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED][a]
Gain	27-36 dBi
Beam Width at Half-Power Point	0.1-0.5 degrees in azimuth, 10-50 degrees in elevation
Orientation in Horizontal Plane	0° to 360°
Orientation in Vertical Plane	-45° to +45° from Nadir

[a] [REDACTED]. [REDACTED].

[REDACTED] Transmitter Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Fixed
Locations	• Location 1: 32° 59’ 39” N, 106° 58’ 29” W • Location 2: 32° 56’ 27” N, 106° 55’ 15” W

Frequency Range	**Low (GHz)**	**High (GHz)**
[REDACTED]	31.000	31.300

Radio	**Modulation**	**Emission Designator**	**Modulation Bandwidth**	**Maximum Power Out**	**Maximum EIRP (with highest gain antenna)**
[REDACTED]	QAM	300MD1D	300 MHz	12 W	58.3 dBW

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	[REDACTED]
Quantity	[REDACTED]
Gain	47.5 dBi
Beam Width at Half-Power Point	0.6°
Orientation in Horizontal Plane	0°-360°
Orientation in Vertical Plane	45°-85° in elevation from horizon

2.15 GHz Transmitter Equipment and Station Details

[REDACTED] Transmitter Equipment

Equipment	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Mobile
Location #1	Operations not to exceed 40 km from the following geographic centerpoint: • 32° 59' 25” N, 106° 58' 11” W
Location #2	Operations within 160 km from the following geographic centerpoint: • 40° 25' 26" N, 116° 16' 34" W with the exception of a 40 km exclusion zone around the specified centerpoint: • 40° 50' 2" N, 115° 45' 41" W

Frequency Range	**Low (GHz)**	**High (GHz)**
[REDACTED]	2.145	2.155

Radio	**Modulation**	**Emission Designator**	**Modulation Bandwidth**	**Maximum Power Out**	**Maximum EIRP**
[REDACTED]	64QAM OFDM	10M0A2D	10 MHz	5 W	23 dBW

[REDACTED] Antenna Information

Antenna	[REDACTED]
Type	Directional
Quantity	[REDACTED]
Gain	16 dBi
Beam Width at Half-Power Point	32°
Orientation in Horizontal Plane	0°-360°
Orientation in Vertical Plane	-45° to +45° from Nadir

1.75 GHz Transmitter Equipment and Station Details

[REDACTED] Transmitter Equipment

Equipment[1]	[REDACTED]
Number of Terminals	[REDACTED]
Station Class	Mobile
Location #1	Operations not to exceed 40 km from the following geographic centerpoint: • 32° 59' 25” N, 106° 58' 11” W
Location #2	Operations within 160 km from the following geographic centerpoint: • 40° 25' 26" N, 116° 16' 34" W with the exception of a 40 km exclusion zone around the specified centerpoint: • 40° 50' 2" N, 115° 45' 41" W

Frequency Range	**Low (GHz)**	**High (GHz)**
[REDACTED]	1.745	1.755

Radio	**Modulation**	**Emission Designator**	**Modulation Bandwidth**	**Maximum Power Out**	**Maximum EIRP (with highest gain antenna)**
[REDACTED]	64QAM	10M0A2D	10 MHz	0.25 W	2 dBW

[1] Google plans to use the equipment listed in this table but may supplement it with standard, retail equipment certified by the FCC for operation in the 1745-1755 MHz band. [REDACTED].

[REDACTED] Antenna Information

Antenna #1	[REDACTED]
Type	Dipole (Nearly Omnidirectional)
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 #2	[REDACTED]
Type	Dipole (Nearly Omnidirectional)
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 #3	[REDACTED]
Type	Directional
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 #4	[REDACTED]
Type	Directional
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°

EXHIBIT C – 28 GHZ FREQUENCY COORDINATION REPORT

Experimental Operation

Spaceport America, NM

Frequency Coordination Report – 28 GHz

Prepared on Behalf of
Google Inc.

July 20, 2015

COMSEARCH®
A CommScope Company

Table of Contents

1. Summary of Results

In support of experimental operations at 28 GHz[1], Comsearch performed a frequency search considering all existing and proposed incumbent licenses within an appropriate coordination distance of the experimental system. The search results identified licensees in the common carrier fixed point-to-point microwave service, local television transmission service (LTTS) and local multipoint distribution service (LMDS). Prior notification letters were sent to the licensees and a summary of the notification data is provided in section four of this report.

No objections were received from any of the incumbent 28 GHz licensees. Our notification to the LMDS incumbents was performed under the assumption that the experimental station would be operating on a secondary basis to LMDS Block A operations and a point of contact at Google has been provided in case any concerns may arise in the future.

2. Coordination Data

This section presents the data pertinent to the experimental system in Spaceport America, New Mexico. This data was circulated to all incumbent licensees in the shared 28 GHz frequency ranges.

Summary of Proposed Experimental Operations

Applicant	Google Inc.
Operation	Air-to-ground
Location	Within 100 km of 32.9903° N, 106.9697° W (Spaceport America, NM)
Center Frequency	28,050 MHz
Emission Bandwidth	300 MHz
Antenna	Fan Beam, 36 dBi
EIRP	72 dBm
Antenna Height/Altitude	3657 m to 7620 m AMSL

[1] The experimental system will operate in the 27.9 – 28.2 GHz portion of the 28 GHz / LMDS band.

3. 28 GHz Common Carrier and LTTS Coordination

In accordance with FCC Rules and Regulations, the 28 GHz experimental system in Spaceport America, New Mexico was prior-coordinated by Comsearch. A notification letter for this system was sent to the following 28 GHz common carrier fixed microwave licensee. This licensee is authorized to operate temporary fixed operations from 27.5 to 29.5 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
Verizon	Continental US

A notification letter and datasheet for the experimental system were also sent to the following 28 GHz local television transmission licensee. This licensee is authorized to operate temporary fixed operations from 27.5 to 29.5 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
Information Super Station, LLC	Continental US

No objections were received from the common carrier or local television transmission service incumbents.

4. 28 GHz LMDS Coordination

A Notification letter was sent to the following 28 GHz LMDS licensees. The proposed experimental system will operate on frequencies that overlap Block A of the LMDS service. The total frequency allocation for Block A of the LMDS spectrum appears below.

Block A: 27.500-28.350 GHz
29.100-29.250 GHz
31.075-31.225 GHz

Licensee	Market	Market Name
Nextlink/XO	BTA008	Albuquerque, NM
2 Lightspeed	BTA013	Amarillo, TX
PVT NetWorks	BTA068	Carlsbad, NM
AT&T	BTA087	Clovis, NM
Nextlink/XO	BTA110	Denver, CO
Nextlink/XO	BTA128	El Paso, TX
AT&T	BTA264	Lubbock, TX
EchoStar	BTA347	Phoenix, AZ
AT&T	BTA386	Roswell, NM
Central Texas Communications	BTA400	San Angelo, TX
Nextlink/XO	BTA447	Tucson, AZ

No objections were received from the LMDS incumbents.

5. Contact Information

For questions or information regarding the 28 GHz Frequency Coordination Report, please contact:

Contact person:	Joanna Lynch
Title:	Manager, Spectrum & Data Solutions
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5711
Fax:	703-726-5599
Email:	jlynch@comsearch.com
Web site:	www.comsearch.com

EXHIBIT D – 31 GHZ FREQUENCY COORDINATION REPORT

Experimental Operation

Spaceport America, NM

Frequency Coordination Report – 31 GHz

Prepared on Behalf of
Google Inc.

July 20, 2015

COMSEARCH®
A CommScope Company

Table of Contents

1. Summary of Results

In support of experimental operations at 31 GHz[1], Comsearch performed a frequency search considering all existing and proposed incumbent licenses within an appropriate coordination distance of the experimental system. The search results identified area licenses in the common carrier fixed point-to-point microwave service, local television transmission service (LTTS), and local multipoint distribution service (LMDS). The search also identified site-based licenses in the microwave public safety and industrial/business pool services.

Prior notification letters were sent to the area-based licensees and a summary of the notification data is provided in section two of this report. No objections were received from any of the incumbent 31 GHz licensees. The Google experimental system will be operating on a secondary basis to incumbent operations, and a point of contact at Google has been provided in case any concerns arise during operation.

In addition to the above coordination effort, an analysis was performed to assess the interference into all potentially affected site-based 31 GHz stations in the microwave public safety and industrial/business pool services. This analysis shows that no incumbent fixed operations should be affected by the proposed experimental operation.

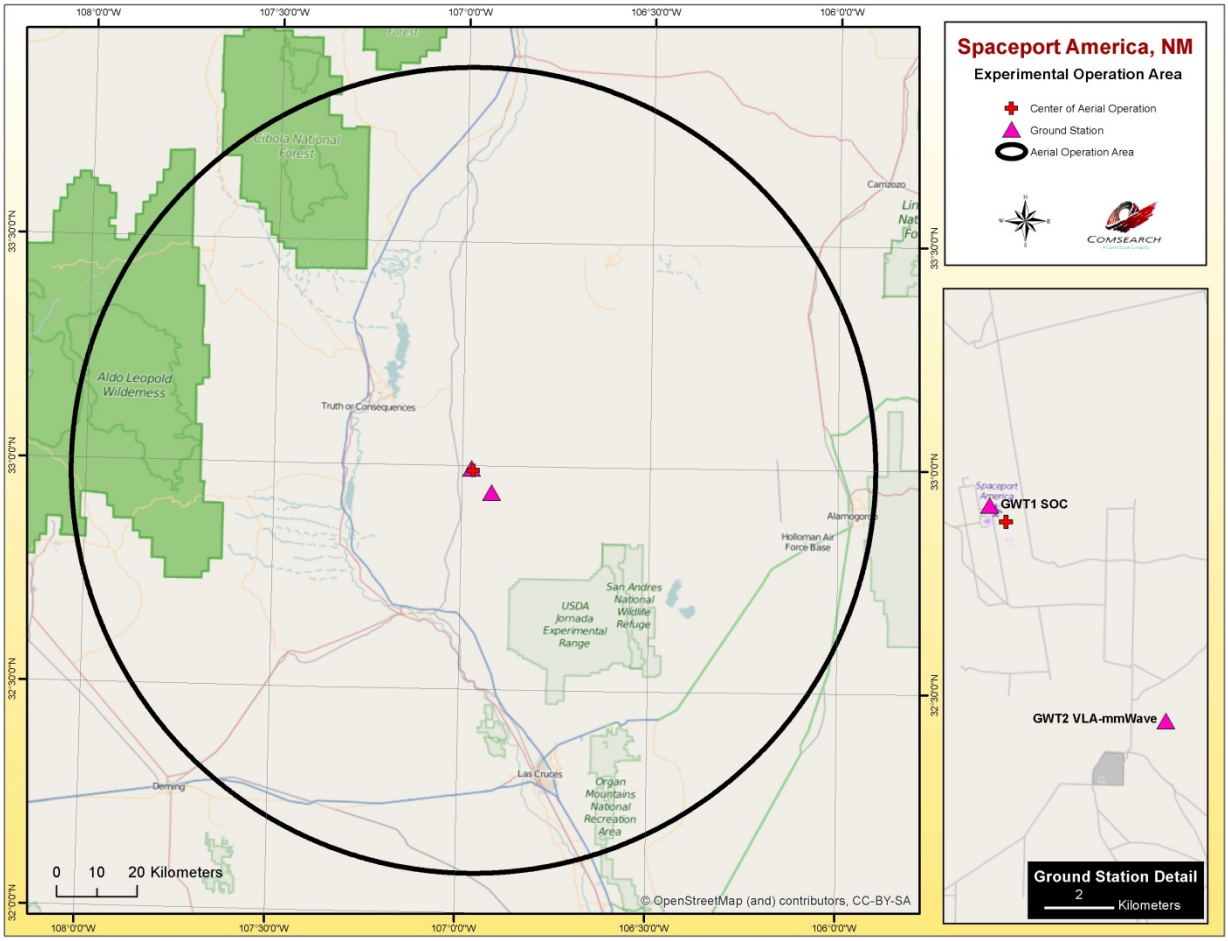
2. Coordination Data

The coordination data for the proposed experimental operation in Spaceport America, New Mexico is shown below. This data was circulated to all potentially affected incumbent area licensees.

Summary of Proposed Experimental Operations

Applicant	Google Inc.
Operation	Ground Station
Location	GWT1 SOC: 32.994274° N, 106.974744° W GWT2 VLA-mmWave: 32.940839° N, 106.920744° W
Center Frequency	31,150 MHz
Emission Bandwidth	300 MHz
Antenna	1 m Parabolic, 47.5 dBi 2.4 m Parabolic, 55.5 dBi
EIRP	1 m: 67.5 - 93.5 dBm 2.4 m: 75.5 - 101.5 dBm
Antenna Height/Altitude	1.8 m AGL

[1] The experimental system will operate in the 31.0 – 31.3 GHz portion of the 31 GHz / LMDS band.


Spaceport America, NM
Experimental Operation Area
Center of Aerial Operation
Ground Station
Aerial Operation Area
GWT1 SOC
GWT2 VLA-mmWave
Ground Station Detail
2
Kilometers
0 10 20 Kilometers
Aldo Leopold Wilderness
Truth or Consequences
Holloman Air Force Base
USDA Jornada Experimental Range
San Andres National Wildlife Refuge
Las Cruces
Deming
Organ Mountains National Recreation Area
Carrizozo
© OpenStreetMap (and) contributors, CC-BY-SA
108°0'0"W
107°30'0"W
107°0'0"W
106°30'0"W
106°0'0"W
33°30'0"N
33°0'0"N
32°30'0"N
32°0'0"N

3. Coordination with Common Carrier and LTTS

In accordance with FCC Rules and Regulations, the 31 GHz experimental system in Spaceport America, New Mexico was prior-coordinated by Comsearch. Notification letters for this system were sent to the following 31 GHz common carrier fixed microwave licensees. These licensees are authorized to operate temporary fixed operations from 31.0 to 31.3 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
AT&T	Continental US
NSM Surveillance	Nationwide
Remote Facilities Consulting Services, Inc.	Continental US
Verizon	Continental US

A notification letter and datasheet for the experimental system were also sent to the following local television transmission licensee. This licensee is authorized to operate temporary fixed operations from 31.0 to 31.3 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
Information Super Station, LLC	Continental US

No objections were received from the common carrier or local television transmission service incumbents.

4. Coordination with LMDS

A notification letter was sent to the following 31 GHz LMDS licensees. The proposed experimental system will operate on frequencies that overlap Blocks A and B of the LMDS service. The total frequency allocation for each block of the LMDS spectrum appears below.

Block A: 27.500-28.350 GHz
29.100-29.250 GHz
31.075-31.225 GHz

Block B: 31.000-31.075 GHz
31.225-31.300 GHz

Licensee	Market	Market Name
2 Lightspeed	BTA008	Albuquerque, NM
Nextlink/XO	BTA008	Albuquerque, NM
AT&T	BTA068	Carlsbad, NM
PVT NetWorks	BTA068	Carlsbad, NM
AT&T	BTA087	Clovis, NM
2 Lightspeed	BTA128	El Paso, TX
Nextlink/XO	BTA128	El Paso, TX
EchoStar	BTA347	Phoenix, AZ
AT&T	BTA386	Roswell, NM

No objections were received from the LMDS incumbents.

5. Interference Analysis with Site-Based Licenses

Comsearch performed interference calculations to determine the potential for interference from Google's proposed ground-based transmitters into site-licensed 31 GHz microwave public safety and industrial/business incumbent receivers.

As input to the interference study, Comsearch retrieved data for potentially affected 31.0 - 31.3 GHz microwave public safety and industrial/business pool systems from the FCC ULS database in June 2015. The systems selected for the analysis include 25 duplex fixed links (50 receivers) in ULS as well as point-radius licenses west of 96 degrees longitude. The distance limit imposed by this geographic selection is more than sufficient to ensure that harmful interference with systems to the east would not occur.

The potential interference from the proposed Google ground stations into the 31 GHz band receivers is along fixed terrestrial point-to-point paths. Standard direct interference calculations were used to predict the interference level from each ground station into each receiver in the selected data.

For line-of-sight propagation, the interference level at the input to a 31 GHz band receiver is calculated as:

$$I = EIRP - FSL - ABS + G_r(\delta) - L_{fixed}$$

Where:

EIRP	=	The EIRP of the interfering transmitter (dBm)
FSL	=	The free-space path loss from interfering transmitter to the receiver (dB)
ABS	=	The oxygen and water vapor absorption loss for the path from interfering transmitter to receiver (dB)
G_r	=	The receiver antenna gain (dBi) as a function of the off-axis angle
δ	=	The receiver antenna off-axis angle (deg)
L_{fixed}	=	The receiver common and receive-side fixed losses (dB)

Absorption losses were calculated according to the methods of Annex 2 of Recommendation ITU-R P.676-10. The temperature, atmospheric pressure, and water vapor density parameters that are required as inputs to the P.676 algorithms were determined at each receiver location using the methods of Recommendation ITU-R P.835-5 and the associated ITU data banks.

Specific attenuation values (dB/km) for oxygen and water vapor absorption were calculated for each 31 GHz band receiver in the data set based on the location and antenna height.

For the ground-based analysis, the total absorption loss on each terrestrial path was calculated according to the recommendation as the total (water vapor plus oxygen) specific attenuation for the receiver location times the length of the interference path.

Consistent with FCC rules Section 101.105 and TIA TSB10-F, interference low enough to degrade the performance of a 31 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:

$$N = -114 + 10 * log_{10}(BW) + NF\ (dBm)$$

Where:

BW	=	The receiver bandwidth in MHz
NF	=	The receiver noise figure (dB)

The receiver bandwidth is estimated to be the same as the transmitter emission bandwidth indicated on the license. The receiver noise figure is estimated to be 3 dB.

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:

$$I_{max} = -114 + 10 * log_{10}(BW) + NF - 6\ (dBm)$$

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

$$I_{max} = -114 + 10 * log_{10}(BW) - 3\ (dBm)$$

For each receiver, the predicted interference level under the assumption of line-of-sight propagation was compared to the 1 dB threshold degradation objective to determine whether harmful interference could occur. Where necessary, terrain profiles were constructed for interference paths using 1/3 arc-second terrain data and over-the-horizon (OH) losses were calculated. The additional losses on paths blocked by terrain then were included to reduce the predicted interference levels.

Interference Analysis Results

Analysis results for the proposed ground-based testing in each area are listed in the tables below. Interference calculation values for the reported cases are identified by the call sign, receiver site name, and transmitter site name. The tables are split into two vertical sections; thus, each case is displayed on two rows.

The interference level was calculated into each 31 GHz band receiver in the selected data. The 10 worst cases are displayed in
Table 1.

The analysis showed that the interference into all receivers meets the 1 dB TD objective and thus these cases are resolved.

Receiver Call Sign	Transmitter Call Sign	Receiver Site Name	Transmitter Site Name	Receiver Frequency (GHz)	Receiver Carrier Level (dBm)	Ground Station	Distance Site 1 to Ground Station (km)	Azimuth Site 1 to Ground Station (deg)	Receiver Antenna Off-Axis Angle (deg)	Receiver Antenna Gain (dBi)
WPJD930		PALM SPRINGS		31.0125, 31.0375, 31.0625, 31.0875, 31.1125, 31.1625, 31.1875, 31.2375, 31.2625		GWT1 - SOC	892.0392636	93.21399369	93.21	38.2
WNTV245		PALM SPRINGS		31.0125, 31.0375, 31.0625, 31.0875, 31.1625, 31.1875, 31.2125		GWT1 - SOC	892.3016026	93.2470972	93.25	38.2
WPJD930		PALM SPRINGS		31.0125, 31.0375, 31.0625, 31.0875, 31.1125, 31.1625, 31.1875, 31.2375, 31.2625		GWT2 - VLA	897.9217581	93.54151316	93.54	38.2
WNTV245		PALM SPRINGS		31.0125, 31.0375, 31.0625, 31.0875, 31.1625, 31.1875, 31.2125		GWT2 - VLA	898.1871818	93.57429211	93.57	38.2
WPOP440	WPOP445	CITY HALL	SUNSET RD	31275	-40.5	GWT1 - SOC	817.3877639	112.3440785	2.69	20.7
WPOP421	WPOP420	FLAMINGO SCH	TRAFFIC OFC	31175	-30.3	GWT1 - SOC	818.0453246	112.6899107	2.77	20.7
WPOP440	WPOP445	CITY HALL	SUNSET RD	31275	-40.5	GWT2 - VLA	824.5792719	112.5527065	2.48	20.8
WPOP421	WPOP420	FLAMINGO SCH	TRAFFIC OFC	31175	-30.3	GWT2 - VLA	825.2543398	112.8953922	2.97	20.7
WPOP440	WPOP444	CITY HALL	RUSSELL RD	31225	-43.2	GWT1 - SOC	817.3877639	112.3440785	4.46	18.8
WPOP440	WPOP444	CITY HALL	RUSSELL RD	31225	-43.2	GWT2 - VLA	824.5792719	112.5527065	4.67	18.5

Receiver Call Sign	Transmitter Call Sign	Receiver Site Name	Transmitter Site Name	Free Space Loss (dB)	Absorption Loss (dB)	Imax for 1 dB Threshold Degradation (dBm)	Margin for 1 dB Threshold Degradation (dB)	Resolution
WPJD930		PALM SPRINGS		181.3	67.8	-105.2	4.2	Clears 1 dB TD Objective
WNTV245		PALM SPRINGS		181.3	67.8	-105.2	4.2	Clears 1 dB TD Objective
WPJD930		PALM SPRINGS		181.4	68.2	-105.2	4.7	Clears 1 dB TD Objective
WNTV245		PALM SPRINGS		181.4	68.3	-105.2	4.7	Clears 1 dB TD Objective
WPOP440	WPOP445	CITY HALL	SUNSET RD	180.6	62.9	-102.0	19.3	Clears 1 dB TD Objective
WPOP421	WPOP420	FLAMINGO SCH	TRAFFIC OFC	180.6	63.0	-102.0	19.4	Clears 1 dB TD Objective
WPOP440	WPOP445	CITY HALL	SUNSET RD	180.6	63.5	-102.0	19.9	Clears 1 dB TD Objective
WPOP421	WPOP420	FLAMINGO SCH	TRAFFIC OFC	180.7	63.5	-102.0	20.1	Clears 1 dB TD Objective
WPOP440	WPOP444	CITY HALL	RUSSELL RD	180.6	62.9	-102.0	21.3	Clears 1 dB TD Objective
WPOP440	WPOP444	CITY HALL	RUSSELL RD	180.6	63.5	-102.0	22.2	Clears 1 dB TD Objective

Table 1: Spaceport America Ground Station into 31 GHz Site-Based Licenses

6. Contact Information

For questions or information regarding the 31 GHz Frequency Coordination Report, please contact:

Contact person:	Joanna Lynch
Title:	Manager, Spectrum & Data Solutions
Company:	Comsearch
Address:	19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone:	703-726-5711
Fax:	703-726-5599
Email:	jlynch@comsearch.com
Web site:	www.comsearch.com

EXHIBIT E – [REDACTED]

[REDACTED]

EXHIBIT F – [REDACTED]

[REDACTED]