

Date: August 5, 2016

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

File Number: 0539-EX-PL-2016

To Whom It May Concern:

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

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

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

Google's request for confidential treatment is limited to information that has been redacted from the Experimental License and Exhibits A and C. Google does not seek to withhold from public inspection information in the Experimental License and associated exhibits 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 contain confidential and proprietary information regarding the proposed tests/experiments:

Consistent with the standards set forth in Section 5.63 of the Federal Communications Commission's (Commission's) Rules, 47 C.F.R. § 5.63, Google Inc. (Google) requests authorization to conduct radio experiments in support of developing Citizens Broadband Radio Service (CBRS) technologies, using [REDACTED] experimental transmitters at up to 24 U.S. locations. The experimental authorization is sought for a period of 24 months. Google outlines

below its need for the requested authorization and the reasons why it should be granted expeditiously.

### Background

In establishing the CBRS, the Commission opened a door for wireless innovation and bandwidth abundance. Rather than allocating the 3.5 GHz band to a single use, the Commission rightly decided to allow shared use of the spectrum. Users of the spectrum might, for instance, deploy “small cell” networks that can carry heavy loads of data in high-traffic areas—such as crowded stadiums—or offer fixed wireless broadband services in rural areas. The additional spectrum that is now available in the 3.5 GHz band will also help relieve Wi-Fi congestion—improving the experience of consumers accessing the Internet over wireless broadband.

A key component to sharing in this band is the Spectrum Access System (SAS), which utilizes database technology to protect important federal government uses of spectrum. These systems will ensure that neither priority access nor general authorized access users interfere with the existing government and private users who will continue to need 3.5 GHz spectrum in a limited number of areas. SAS database systems also will allow new users to share effectively with each other. Google has been a leader in using databases to free-up available spectrum, and it is one of the companies working to develop a sharing system for the 3.5 GHz band.

The instant experimental authorization is needed to advance technologies in the 3.5 GHz band. Specifically, the experimental authorization will allow Google to continue its experimentation with propagation and [REDACTED]. As discussed further below, the parameters of the experimental authorization will protect incumbent operators from harmful interference. Indeed, there have been no reports of interference from Google’s ongoing experimental operations under call signs WH2XNF (File Nos. 0722-EX-PL-2014 and 0004-EX-ML-2015) and WI2XFG (File No. 0095-EX-PL-2016).<sup>1</sup>

Google requests authorization to operate in and adjacent to the 3550-3700 MHz band that has been opened for innovative small-cell spectrum sharing by CBRS devices. Google requests authorization to operate on frequencies down to 3400 MHz and up to 3800 MHz so that [REDACTED]. Authority to operate in this range will ensure that Google has access to sufficient spectrum for experimentation while avoiding interference to incumbent operations, including federal government operations and operations under Parts

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<sup>1</sup> Call sign WH2XNF (File Nos. 0722-EX-PL-2014 and 0004-EX-ML-2015) is associated with 3550-3700 MHz operations in Mountain View, CA, Arlington, VA, and Reston, VA. That experimental authorization is set to expire in December 2016. If this request for experimental authorization is granted, Google plans to let its authorization under WH2XNF expire and experimental operations at those three locations would continue under the new authorization.

25 and 90 of the Commission's rules.

The proposed experimentation will allow Google to perform propagation, [REDACTED] testing [REDACTED]. Data obtained from these tests will be reflected in the design of Google's commercial SAS, which is currently under development to serve users in the new CBRS band. Specifically, together with testing under call signs WH2XNF and WI2XFG, the proposed testing will assist in enabling: (1) [REDACTED]; (2) [REDACTED]; and (3) [REDACTED]. [REDACTED]. [REDACTED].

### Planned Operations

Google anticipates performing the following tests under the requested experimental authorization. As described in the next section, the proposed experimental operations in the 3.5 GHz band will be conducted without harmful interference to other authorized users.

- **Propagation Testing:** Google will use both a simple continuous wave (CW) tone and a broadband signal to understand the effects of clutter loss, differential fading, multipath, and other propagation phenomena. To test [REDACTED], Google will use a mobile receiving station [REDACTED]. Google may also position [REDACTED]. In each local test area, Google will generally operate only [REDACTED] while conducting propagation tests.
- **Testing of [REDACTED]:** Google will test [REDACTED]. In Atlanta, Austin, and Provo, Google will use [REDACTED].
- **[REDACTED] Testing:** Google will [REDACTED]. [REDACTED].
- **[REDACTED] Testing:** Google will investigate [REDACTED].

In order to perform these tests, Google seeks authorization to operate [REDACTED] experimental transmitters per test area. Specifically, Google seeks authorization for [REDACTED] eNodeBs (also referred to as access points or base stations) and [REDACTED] end user devices (EUDs) that will communicate with the eNodeBs ([REDACTED] EUDs per [REDACTED] eNodeB on average). Google will deploy this equipment [REDACTED] within the proposed areas of operation. It is unlikely that [REDACTED], or the full number of authorized devices, will ever transmit simultaneously. Rather, the full complement of test areas is needed to ensure sufficient diversity of test environments.

Google requests authorization to transmit in a variety of locations and environments that meet several characteristics, including the radio propagation environment, height and variety of clutter (buildings and foliage), existence of suitable Google infrastructure and resources to support experimentation, and existence of partners who may participate in the tests. To that end, Google requests authorization to conduct testing in up to 24 U.S. areas. The test areas will be selected from the list of locations in Exhibit B. All test areas will be subject to the same limit of [REDACTED] experimental transmitters, and none of the areas will have a radius of operations greater than 40 kilometers. See Exhibit B

for the proposed radius of operation for each of the potential test locations.

From the list in Exhibit B, Google plans to deploy initially in Atwater, California, Mountain View, California, Palo Alto, California, San Bruno, California, San Francisco, California, San Jose, California, Boulder, Colorado, Kansas City, Kansas,<sup>2</sup> Omaha, Nebraska, Raleigh, North Carolina, Provo, Utah, and Reston, Virginia.

EUDs operating under the requested authorization will be used by Google's employees and contractors. Such devices may also be used, under close supervision, by "trusted testers" selected by Google on a volunteer basis without payment. No commercial operations will be conducted under the requested authorization and all equipment will be collected at the end of the experimentation period.

### **Interference Analysis**

The 3400-3800 MHz frequency range covers multiple allocated bands and a variety of incumbent systems and services. As described below, Google will deploy and operate its equipment under this experimental authorization in a manner that will avoid interference to other authorized users.

#### *Transmit Power and Out-of-Band Emission Considerations*

Most operations under this experimental authorization will be conducted within the Part 96 Category B CBSD EIRP limit of 47 dBm per 10 MHz. Experimentation will also be conducted within the Category A CBSD EIRP limit of 30 dBm per 10 MHz. [REDACTED], Google requests authorization to operate up to a conducted power spectral density (PSD) limit of 40 dBm per 10 MHz and a radiated PSD of 57 dBm per 10 MHz. [REDACTED], Google also requests authorization to operate up to a total conducted power limit of 49 dBm [40 dBm + 10log(8)] and a maximum radiated power (EIRP) of 66 dBm. The requested maximum conducted and radiated power limits will provide flexibility to support a wide range of complementary advanced technology development and experimentation. [REDACTED].<sup>3</sup> [REDACTED]. [REDACTED].

Additionally, Google requests authority to conduct narrowband propagation testing in the 3550-3575 MHz segment using a maximum conducted power of 47 dBm and a maximum radiated power of 77 dBm (assuming the use of a high-gain, narrow beamwidth 30 dBi antenna). [REDACTED]. [REDACTED]. Google notes that extensive propagation testing has been conducted in this band under its existing experimental authorization (call sign WH2XNF) in the densely populated areas of Arlington, Virginia, and Mountain View, California, with no reports of interference. Google has chosen the 3550-3575 MHz portion as it is

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<sup>2</sup> Call sign WI2XFG (File No. 0095-EX-PL-2016) is associated with 3400-3700 MHz operations in the Kansas City area. In the present application, Google requests authority to operate up to 3800 MHz in a limited section of Kansas City, KS.

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

removed by at least 75 MHz from the nearest adjacent-band allocation. Furthermore, the possibility of interference to authorized users of the band will be mitigated by using narrow beamwidth antennas and narrowband CW transmissions, along with out-of-band emission levels that will meet or exceed (i.e., be lower than) the limits in Section 96.41(e) of the Commission's Rules, 47 C.F.R. § 96.41(e).

In summary, Google requests authorization to operate up to the following power limits:

Planned Testing	Conducted Power Limits	Radiated Power Limits
Broadband Network (3400-3800 MHz)	40 dBm per 10 MHz power spectral density  49 dBm total conducted power (assumes eight 10-MHz aggregate channels)	57 dBm per 10 MHz radiated power spectral density  66 dBm total radiated power (assumes eight 10-MHz aggregate channels)
Narrowband Propagation (3550-3575 MHz)	47 dBm	77 dBm

Below, Google explains its plans for protection of the following incumbent users in the 3400-3800 MHz frequency range.

Frequencies	Users
3400-3500 MHz	Military radar systems Amateur radio
3500-3650 MHz	Shipborne military radar systems
3600-3700 MHz	Grandfathered FSS receive-only earth stations
3650-3700 MHz	Ground-based military radar systems Part 90, Subpart Z operators
3700 MHz	FSS receive-only earth stations

#### *Protection of Military Radar Systems Below 3500 MHz*

In the 3100-3500 MHz band, the U.S. military operates radar systems on ships and at several land-based military installations around the country. To

protect such uses, Google will ensure that the signals from its experimental operations remain at or below levels that would reasonably preclude the possibility of interference. Specifically, for all test locations within the coastal exclusion zones (see Figures 1-3 below) or within 150 km of an in-land operations area, Google will use the NTIA propagation model that was used to compute the coastal exclusion zones<sup>4</sup> (hereafter referred to as the NTIA model) to predict the aggregate interference from its deployed transmitters operating at or below 3550 MHz to the closest point of the military operations area (coastal or land-based) and will limit its signal strength to at or below the ambient noise level of -174 dBm/Hz at that point, as received by an isotropic antenna. In the calculation, Google will include both fundamental emissions below 3500 MHz and out-of-band emissions from devices operating above 3500 MHz.

#### *Amateur Radio Operations in 3400-3500 MHz*

The amateur radio service has a secondary allocation in the 3300-3500 MHz band (3.4 GHz band). Based on Google's spectrum monitoring elsewhere in the U.S., amateur operation in this band appears to be infrequent and generally point-to-point. However, Google will coordinate with the amateur radio community to ensure that Google's operations do not interfere with any amateurs who may be utilizing the 3.4 GHz band. For example, Google will inform the American Radio Relay League prior to beginning operations in each area and provide contact information so they can report any suspected interference.

#### *Protection of Shipborne Military Radar Systems in 3500-3650 MHz*

In the 3500-3650 MHz band, the U.S. military operates shipborne radars in coastal areas. To protect such uses, Google will ensure that the signals from the experimental operations remain at or below levels that would reasonably preclude the possibility of interference. Alternatively, if operating such that the signals could exceed the interference threshold at the coast, Google will operate a sensor to detect military radar operations and reconfigure its devices to avoid those frequencies during the operations.

Specifically, for all test locations within the coastal exclusion zones established by the Commission<sup>5</sup> (see Figures 1-3 below), Google will use the NTIA model to predict the aggregate interference from its deployed transmitters to the closest point on the coast<sup>6</sup> and limit the signal strength to at or below the

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<sup>4</sup> The model is described on the NTIA website at

<https://www.ntia.doc.gov/report/2015/35-ghz-exclusion-zone-analyses-and-methodology>.

<sup>5</sup> See 47 C.F.R. §§ 96.15(a)(1), 96.15(a)(3), 96.15(b); see also Letter from Paige Atkins, Associate Administrator, Office of Spectrum Management, National Telecommunications and Information Administration, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 12-354, at Enclosure 1 (proposing exclusion zones to protect shipborne radars).

<sup>6</sup> In the event of unusual local geography (e.g., a hill or mountain that blocks the path to the nearest point on the coast but does not block other paths starting a short distance from that point), Google will analyze paths to a range of points on the coast and ensure that its signal does not exceed the interference threshold at any of those points.

ambient noise level of -174 dBm/Hz at that point, as received by an isotropic antenna. In the calculation, Google will include both fundamental emissions in 3500-3650 MHz and out-of-band emissions from devices operating below 3500 MHz and above 3650 MHz. If the signal level is predicted to exceed -174 dBm/Hz at the closest point on the coast, Google will deploy a sensor to detect military radar operations offshore and configure its devices to avoid the frequency at which the military is operating, and +/-5 MHz on either side. This is consistent with the operational concept of the ESC in the Part 96 rules.<sup>7</sup> Google will use a prototype ESC sensor for this purpose, which will be designed to meet the WinnForum requirements on ESC sensitivity.<sup>8</sup>

*Protection of Grandfathered FSS Receive-Only Earth Station Operations in 3600-3700 MHz*

In the 3600-3700 MHz band, FSS receive-only earth stations operate on a grandfathered basis in accordance with the FCC's rules.<sup>9</sup> The earth stations are located at 35 sites that are largely clustered along the coasts.<sup>10</sup> For all test areas subject to Grandfathered FSS Operations protection requirements (see Figures 1-3 below), Google will meet the Part 96 requirements<sup>11</sup> and will conduct its calculations using the NTIA model. In the event that Google's predictions show that the Part 96 limits may be exceeded for a particular site, Google will coordinate with the operators of the affected earth station(s).

*Protection of Ground-based Military Radar Systems in 3650-3700 MHz*

In the 3650-3700 MHz band, the U.S. military conducts research and development (R&D) activity at three land-based sites whose coordinates are listed in the FCC's rules.<sup>12</sup> To protect such uses, Google will ensure that the signals from its experimental operations remain at or below levels that would reasonably preclude the possibility of interference. Specifically, for all test locations within 150 km of the R&D sites,<sup>13</sup> Google will use the NTIA model to predict the aggregate interference from its deployed transmitters to the R&D sites and will limit its signal strength to at or below the ambient noise level of -174 dBm/Hz at that point, as received by an isotropic antenna. In the calculation, Google will include both fundamental emissions in 3500-3650 MHz and

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<sup>7</sup> See 47 C.F.R. § 96.67.

<sup>8</sup> Specifically, "[a]n ESC shall be capable of detecting an in-band incumbent radar over a maximum propagation loss from the radar of 184 dB on the coastline and given a sufficiently elevated sensor location (e.g. 25m) with a clear line-of-sight to the horizon." WINNF-15-S-0112-V1.0.0 CBRS Operational and Functional Requirements at 27, available online at <http://groups.winnforum.org/p/cm/ld/fid=85&tid=338&sid=5781>.

<sup>9</sup> See 47 C.F.R. § 2.106; Table of Frequency Allocations (Mar. 4, 2016) at footnote US107.

<sup>10</sup> The sites are listed on the Commission's website at <https://www.fcc.gov/general/35-ghz-band-protected-fixed-satellite-service-fss-earth-stations>.

<sup>11</sup> See 47 C.F.R. § 96.17.

<sup>12</sup> See 47 C.F.R. § 2.106; Table of Frequency Allocations (Mar. 4, 2016) at footnote US109.

<sup>13</sup> Consistent with the proposed power levels for its experimental operations, Google will observe a 150 km exclusion zone instead of the 80 km exclusion required by 47 C.F.R. § 96.15(b)(2).

out-of-band emissions from devices operating below 3500 MHz and above 3650 MHz. In general, Google will avoid operating in the 3650-3700 MHz band unless necessary for the purpose of the experiment, as there are many incumbents in this band segment in addition to the military radar operations.

*Protection of Part 90 Incumbents in the 3650-3700 MHz Band*

To protect existing Part 90 operations in the 3650-3700 MHz band, Google will coordinate its proposed experimental transmissions in this band with all Part 90 licensees in the Commission's ULS database that are within 25 km of a Google transmitter location. Because there are many Part 90 systems operating in this band segment, and because Google plans to coordinate with adjacent-band FSS sites, Google will generally avoid using the 3650-3700 MHz band except when necessary to meet testing objectives, [REDACTED].

*Protection of FSS Receive-Only Earth Station Operations in the 3700-4200 MHz Band*

Numerous FSS receive-only earth stations operate in the 3700-4200 MHz band (C-band). To protect such uses, Google will meet the protection requirements for these systems as established in Part 96. Once again, Google will conduct its calculations using the NTIA model. Google will meet the in-band protection requirements in 47 C.F.R. § 96.17(a), extended to 3700-4200 MHz, since Google will be operating in-band in this segment. In the event that Google's predictions show Part 96 limits may be exceeded for a particular site, Google will coordinate with the operators of the affected earth station(s). As previously noted, Google intends to avoid operations above 3600 MHz due to the number of incumbents, unless such operations are necessary to meet the objectives of the experiments.

## Figures

The following figures show the locations of Google's planned and potential test areas relative to the locations of incumbents requiring interference protection. The following key applies to the figures:

- **Green areas:** Locations where Google plans to operate under the requested experimental authorization, if approved.
- **Blue areas:** Locations where Google may operate under the requested experimental authorization, if approved.
- **Gold-colored areas:** Protection zones for incumbent federal ground-based radar operations in the 3100-3500 MHz band.
- **Red lines:** Coastal exclusion zones for incumbent U.S. military shipborne operations in the 3500-3650 MHz band.
- **Red circles:** Exclusion zones for incumbent U.S. military R&D sites in the 3650-3700 MHz band, calculated using a 150 km exclusion distance.



- **Red dots:** Incumbent FSS earth stations in the 3600-3700 MHz band.

Figure 1: Nationwide view of planned and potential test areas

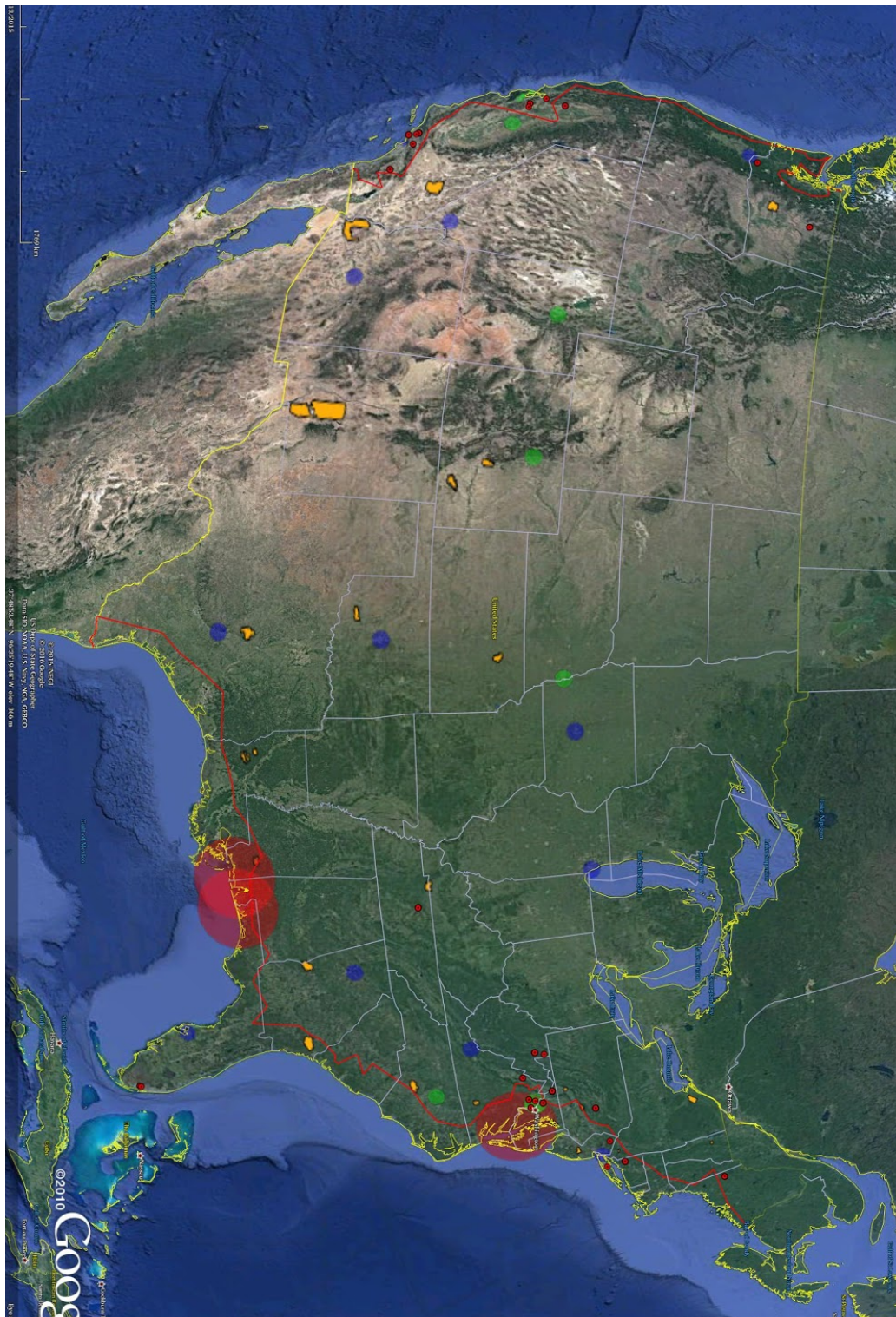




Figure 2: Close-up of San Francisco Bay area

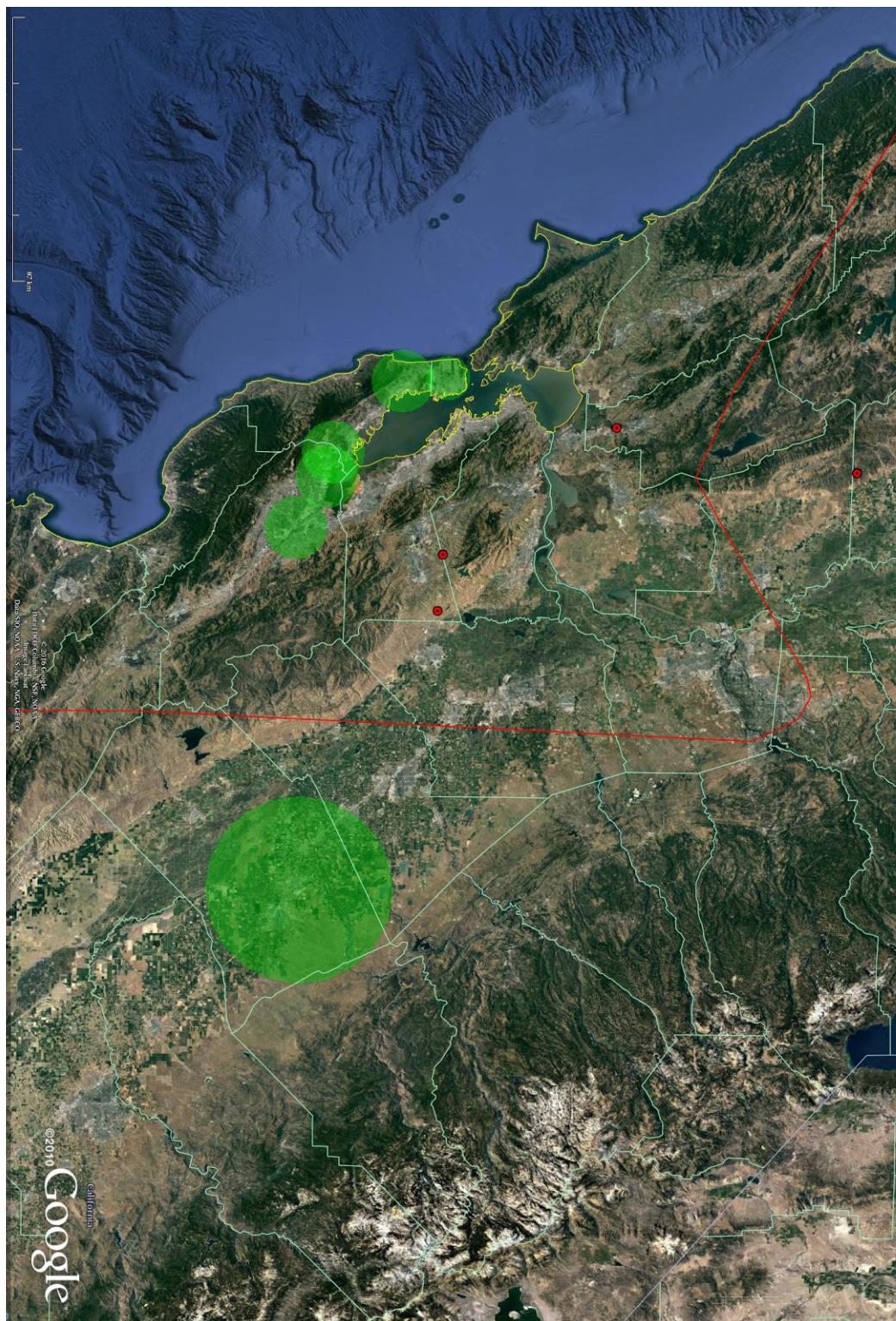
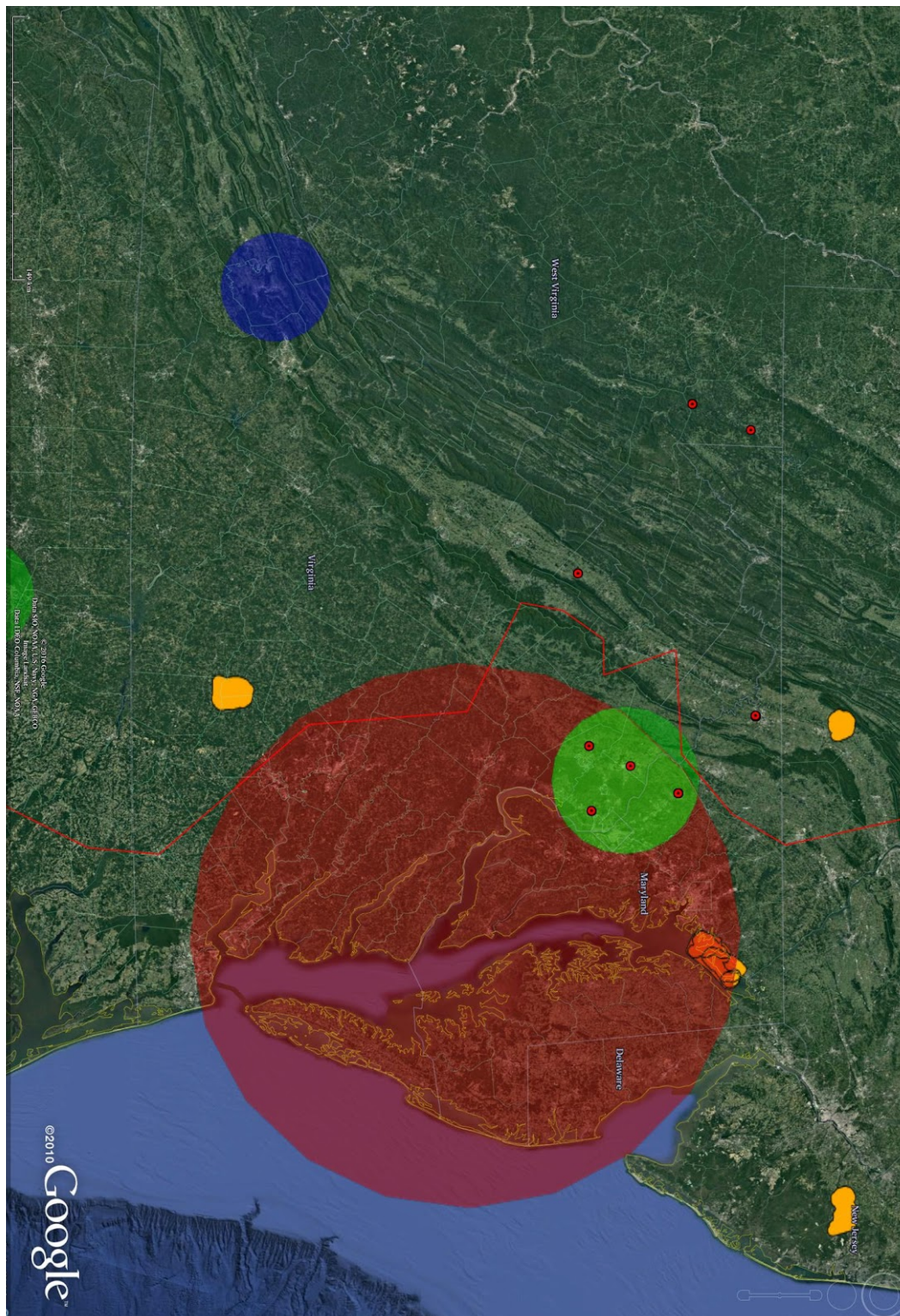




Figure 3: Close-up of Reston, VA area



**Conclusion**

The proposed experimental operations will advance radio technologies associated with the new CBRS service and be conducted without harmful interference to other authorized users. For the foregoing reasons, Google requests approval of this application.

**Exhibit C - Technical Information:**

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

Applicant Name: Google Inc.  
Applicant FRN: 0016069502

**Legal Contact Details**

<b>Name of Contact</b>	Stephanie Selmer
<b>Contact Details</b>	Associate Corporate Counsel 25 Massachusetts Avenue NW, Ninth Floor Washington, DC 20001

**Technical Contact Details**

<b>Name of Contact</b>	Dr. Andrew Clegg
<b>Contact Details</b>	1875 Explorer Street, Tenth Floor Reston, VA 20190 Phone: (202) 370-5644 Email: aclegg@google.com

**Transmitter Equipment and Station Details***Radio Information*

<b>Equipment</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Area of Operation</b>	Operations vary from 7 km to 40 km from the geographic centerpoint of each test area. See Exhibit B for the specific areas of operation.

<b>Frequency</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	3800	3400

*Amplifier Information*

<b>Equipment</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Area of Operation</b>	Operations vary from 7 km to 40 km from the geographic centerpoint of each test area. See Exhibit B for the specific areas of operation.

*Antenna Details*

<b>Antennas</b>	[REDACTED]
<b>Type</b>	Both directional and omnidirectional antennas will be used.
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	30 dBi max; -4 dBi min
<b>Beam Width at Half-Power Point</b>	Various (5° to 360° Horizontal; 5° to 180° Vertical)
<b>Orientation in Horizontal Plane</b>	Various (0° to 360°)
<b>Orientation in Vertical Plane</b>	10° to -30°

Radio	Modulation	Emission Designator	Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	50 W <sup>14</sup>	EIRP = 47 dBW (50 kW) <sup>14</sup>  ERP = 44.9 dBW (31 kW) <sup>14</sup>  (with 30 dBi antenna)
[REDACTED]	Digital	10M0W7D 20M0W7D 40M0W7D 60M0W7D 80M0W7D	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	<b>For 10 W conducted:</b> EIRP = 27 dBW (500 W); ERP = 24.9 dBW (305 W)  <b>For 20 W conducted:</b> EIRP = 30 dBW (1000 W); ERP = 27.9 dBW (611 W)
[REDACTED]	Digital	10M0F9W 20M0F9W 40M0F9W 60M0F9W 80M0F9W	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	
[REDACTED]	Digital	10M0G7D 20M0G7D 40M0G7D 60M0G7D 80M0G7D	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	
[REDACTED]	Digital	10M0GXW 20M0GXW 40M0GXW 60M0GXW 80M0GXW	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	

<sup>14</sup> High power operation limited to [REDACTED] in the 3550-3575 MHz band segment.

					(1833 W) <b>For 80 W conducted:</b> EIRP = 36 dBW (4000 W); ERP = 33.9 dBW (2444 W)  (all with 17 dBi antenna)
[REDACTED]	Digital	2M00P0N	2 MHz	4 W	EIRP = 22 dBW (160 W)
[REDACTED]	Digital	5M00Q7N 10M0Q7N 20M0Q7N	5 MHz 10 MHz 20 MHz	4 W	ERP = 19.9 dBW (98 W)  (with 16 dBi antenna)

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

Exhibits A and C were submitted to the Commission in support of the Experimental License. The exhibits were filed with the Office of Engineering and Technology on August 5, 2016. For additional information, please see File No. 0539-EX-PL-2016.

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

The information requested to be kept confidential has significant commercial value. The exhibits supporting the Experimental License discuss tests/experiments that include trade secret information. The Commission has clarified that confidential treatment should be afforded to trade secrets.<sup>15</sup> Google's tests/experiments and proprietary wireless applications using particular radio frequency equipment represent a "secret commercially valuable plan" within the meaning of a trade secret as recognized by the Commission.

<sup>15</sup> *Examination of Current Policy Concerning the Treatment of Confidential Information Submitted to the Commission*, Report and Order, GC Docket No. 96-55, at para. 3, (released Aug. 4, 1998) (defining "trade secrets" for purpose of Commission rules on confidential treatment).

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

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

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

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

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

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

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

The information contained in the confidential exhibits is not available to the public, and will only be disclosed to third parties pursuant to the restrictive safeguards described above.

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

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

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



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

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

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

Consistent with 47 C.F.R. § 0.459(d)(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,



Stephanie Selmer

## EXHIBIT A - NARRATIVE STATEMENT

Consistent with the standards set forth in Section 5.63 of the Federal Communications Commission's (Commission's) Rules, 47 C.F.R. § 5.63, Google Inc. (Google) requests authorization to conduct radio experiments in support of developing Citizens Broadband Radio Service (CBRS) technologies, using [REDACTED] experimental transmitters at up to 24 U.S. locations. The experimental authorization is sought for a period of 24 months. Google outlines below its need for the requested authorization and the reasons why it should be granted expeditiously.

### Background

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A key component to sharing in this band is the Spectrum Access System (SAS), which utilizes database technology to protect important federal government uses of spectrum. These systems will ensure that neither priority access nor general authorized access users interfere with the existing government and private users who will continue to need 3.5 GHz spectrum in a limited number of areas. SAS database systems also will allow new users to share effectively with each other. Google has been a leader in using databases to free-up available spectrum, and it is one of the companies working to develop a sharing system for the 3.5 GHz band.

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<sup>1</sup> Call sign WH2XNF (File Nos. 0722-EX-PL-2014 and 0004-EX-ML-2015) is associated with 3550-3700 MHz operations in Mountain View, CA, Arlington, VA, and Reston, VA. That experimental authorization is set to expire in December 2016. If this request for experimental authorization is granted, Google plans to let its authorization under WH2XNF expire and experimental operations at those three locations would continue under the new authorization.

including federal government operations and operations under Parts 25 and 90 of the Commission's rules.

The proposed experimentation will allow Google to perform propagation, [REDACTED] testing [REDACTED]. Data obtained from these tests will be reflected in the design of Google's commercial SAS, which is currently under development to serve users in the new CBRS band. Specifically, together with testing under call signs WH2XNF and WI2XFG, the proposed testing will assist in enabling: (1) [REDACTED]; (2) [REDACTED]; and (3) [REDACTED]. [REDACTED]. [REDACTED].

### Planned Operations

Google anticipates performing the following tests under the requested experimental authorization. As described in the next section, the proposed experimental operations in the 3.5 GHz band will be conducted without harmful interference to other authorized users.

- **Propagation Testing:** Google will use both a simple continuous wave (CW) tone and a broadband signal to understand the effects of clutter loss, differential fading, multipath, and other propagation phenomena. To test [REDACTED], Google will use a mobile receiving station [REDACTED]. Google may also position [REDACTED]. In each local test area, Google will generally operate only [REDACTED] while conducting propagation tests.
- **Testing of [REDACTED]:** Google will test [REDACTED]. In Atlanta, Austin, and Provo, Google will use [REDACTED].
- **[REDACTED] Testing:** Google will [REDACTED]. [REDACTED].
- **[REDACTED] Testing:** Google will investigate [REDACTED].

In order to perform these tests, Google seeks authorization to operate [REDACTED] experimental transmitters per test area. Specifically, Google seeks authorization for [REDACTED] eNodeBs (also referred to as access points or base stations) and [REDACTED] end user devices (EUDs) that will communicate with the eNodeBs ([REDACTED] EUDs per [REDACTED] eNodeB on average). Google will deploy this equipment [REDACTED] within the proposed areas of operation. It is unlikely that [REDACTED], or the full number of authorized devices, will ever transmit simultaneously. Rather, the full complement of test areas is needed to ensure sufficient diversity of test environments.

Google requests authorization to transmit in a variety of locations and environments that meet several characteristics, including the radio propagation environment, height and variety of clutter (buildings and foliage), existence of suitable Google infrastructure and resources to support experimentation, and existence of partners who may participate in the tests. To that end, Google requests authorization to conduct testing in up to 24 U.S. areas. The test areas will be selected from the list of locations in Exhibit B. All test areas will be subject to the same limit of [REDACTED] experimental transmitters, and none of the areas will have a radius of operations greater than 40 kilometers. See Exhibit B for the proposed radius of operation for each of the potential test locations.

From the list in Exhibit B, Google plans to deploy initially in Atwater, California, Mountain

View, California, Palo Alto, California, San Bruno, California, San Francisco, California, San Jose, California, Boulder, Colorado, Kansas City, Kansas,<sup>2</sup> Omaha, Nebraska, Raleigh, North Carolina, Provo, Utah, and Reston, Virginia.

EUDs operating under the requested authorization will be used by Google's employees and contractors. Such devices may also be used, under close supervision, by "trusted testers" selected by Google on a volunteer basis without payment. No commercial operations will be conducted under the requested authorization and all equipment will be collected at the end of the experimentation period.

### **Interference Analysis**

The 3400-3800 MHz frequency range covers multiple allocated bands and a variety of incumbent systems and services. As described below, Google will deploy and operate its equipment under this experimental authorization in a manner that will avoid interference to other authorized users.

#### *Transmit Power and Out-of-Band Emission Considerations*

Most operations under this experimental authorization will be conducted within the Part 96 Category B CBSD EIRP limit of 47 dBm per 10 MHz. Experimentation will also be conducted within the Category A CBSD EIRP limit of 30 dBm per 10 MHz. [REDACTED], Google requests authorization to operate up to a conducted power spectral density (PSD) limit of 40 dBm per 10 MHz and a radiated PSD of 57 dBm per 10 MHz. [REDACTED], Google also requests authorization to operate up to a total conducted power limit of 49 dBm [40 dBm + 10log(8)] and a maximum radiated power (EIRP) of 66 dBm. The requested maximum conducted and radiated power limits will provide flexibility to support a wide range of complementary advanced technology development and experimentation. [REDACTED].<sup>3</sup> [REDACTED]. [REDACTED].

Additionally, Google requests authority to conduct narrowband propagation testing in the 3550-3575 MHz segment using a maximum conducted power of 47 dBm and a maximum radiated power of 77 dBm (assuming the use of a high-gain, narrow beamwidth 30 dBi antenna). [REDACTED]. [REDACTED]. Google notes that extensive propagation testing has been conducted in this band under its existing experimental authorization (call sign WH2XNF) in the densely populated areas of Arlington, Virginia, and Mountain View, California, with no reports of interference. Google has chosen the 3550-3575 MHz portion as it is removed by at least 75 MHz from the nearest adjacent-band allocation. Furthermore, the possibility of interference to authorized users of the band will be mitigated by using narrow beamwidth antennas and narrowband CW transmissions, along with out-of-band emission levels that will meet or exceed (i.e., be lower than) the limits in Section 96.41(e) of the Commission's Rules, 47 C.F.R. § 96.41(e).

In summary, Google requests authorization to operate up to the following power limits:

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<sup>2</sup> Call sign WI2XFG (File No. 0095-EX-PL-2016) is associated with 3400-3700 MHz operations in the Kansas City area. In the present application, Google requests authority to operate up to 3800 MHz in a limited section of Kansas City, KS.

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

Planned Testing	Conducted Power Limits	Radiated Power Limits
Broadband Network (3400-3800 MHz)	40 dBm per 10 MHz power spectral density  49 dBm total conducted power (assumes eight 10-MHz aggregate channels)	57 dBm per 10 MHz radiated power spectral density  66 dBm total radiated power (assumes eight 10-MHz aggregate channels)
Narrowband Propagation (3550-3575 MHz)	47 dBm	77 dBm

Below, Google explains its plans for protection of the following incumbent users in the 3400-3800 MHz frequency range.

Frequencies	Users
3400-3500 MHz	Military radar systems Amateur radio
3500-3650 MHz	Shipborne military radar systems
3600-3700 MHz	Grandfathered FSS receive-only earth stations
3650-3700 MHz	Ground-based military radar systems Part 90, Subpart Z operators
3700 MHz	FSS receive-only earth stations

#### *Protection of Military Radar Systems Below 3500 MHz*

In the 3100-3500 MHz band, the U.S. military operates radar systems on ships and at several land-based military installations around the country. To protect such uses, Google will ensure that the signals from its experimental operations remain at or below levels that would reasonably preclude the possibility of interference. Specifically, for all test locations within the coastal exclusion zones (see Figures 1-3 below) or within 150 km of an in-land operations area, Google will use the NTIA propagation model that was used to compute the coastal exclusion zones<sup>4</sup> (hereafter referred to as the NTIA model) to predict the aggregate interference from its deployed transmitters operating at or below 3550 MHz to the closest point of the military operations area (coastal or land-based) and will limit its signal strength to at or below the ambient noise level of -174 dBm/Hz at that point, as received by an isotropic antenna. In the

<sup>4</sup> The model is described on the NTIA website at <https://www.ntia.doc.gov/report/2015/35-ghz-exclusion-zone-analyses-and-methodology>.

calculation, Google will include both fundamental emissions below 3500 MHz and out-of-band emissions from devices operating above 3500 MHz.

*Amateur Radio Operations in 3400-3500 MHz*

The amateur radio service has a secondary allocation in the 3300-3500 MHz band (3.4 GHz band). Based on Google's spectrum monitoring elsewhere in the U.S., amateur operation in this band appears to be infrequent and generally point-to-point. However, Google will coordinate with the amateur radio community to ensure that Google's operations do not interfere with any amateurs who may be utilizing the 3.4 GHz band. For example, Google will inform the American Radio Relay League prior to beginning operations in each area and provide contact information so they can report any suspected interference.

*Protection of Shipborne Military Radar Systems in 3500-3650 MHz*

In the 3500-3650 MHz band, the U.S. military operates shipborne radars in coastal areas. To protect such uses, Google will ensure that the signals from the experimental operations remain at or below levels that would reasonably preclude the possibility of interference. Alternatively, if operating such that the signals could exceed the interference threshold at the coast, Google will operate a sensor to detect military radar operations and reconfigure its devices to avoid those frequencies during the operations.

Specifically, for all test locations within the coastal exclusion zones established by the Commission<sup>5</sup> (see Figures 1-3 below), Google will use the NTIA model to predict the aggregate interference from its deployed transmitters to the closest point on the coast<sup>6</sup> and limit the signal strength to at or below the ambient noise level of -174 dBm/Hz at that point, as received by an isotropic antenna. In the calculation, Google will include both fundamental emissions in 3500-3650 MHz and out-of-band emissions from devices operating below 3500 MHz and above 3650 MHz. If the signal level is predicted to exceed -174 dBm/Hz at the closest point on the coast, Google will deploy a sensor to detect military radar operations offshore and configure its devices to avoid the frequency at which the military is operating, and +/-5 MHz on either side. This is consistent with the operational concept of the ESC in the Part 96 rules.<sup>7</sup> Google will use a prototype ESC sensor for this purpose, which will be designed to meet the WinnForum requirements on ESC sensitivity.<sup>8</sup>

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<sup>5</sup> See 47 C.F.R. §§ 96.15(a)(1), 96.15(a)(3), 96.15(b); see also Letter from Paige Atkins, Associate Administrator, Office of Spectrum Management, National Telecommunications and Information Administration, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 12-354, at Enclosure 1 (proposing exclusion zones to protect shipborne radars).

<sup>6</sup> In the event of unusual local geography (e.g., a hill or mountain that blocks the path to the nearest point on the coast but does not block other paths starting a short distance from that point), Google will analyze paths to a range of points on the coast and ensure that its signal does not exceed the interference threshold at any of those points.

<sup>7</sup> See 47 C.F.R. § 96.67.

<sup>8</sup> Specifically, "[a]n ESC shall be capable of detecting an in-band incumbent radar over a maximum propagation loss from the radar of 184 dB on the coastline and given a sufficiently elevated sensor location (e.g. 25m) with a clear line-of-sight to the horizon." WINNF-15-S-0112-V1.0.0 CBRS Operational and Functional Requirements at 27, available online at <http://groups.winnforum.org/p/cm/ld/fid=85&tid=338&sid=5781>.

*Protection of Grandfathered FSS Receive-Only Earth Station Operations in 3600-3700 MHz*

In the 3600-3700 MHz band, FSS receive-only earth stations operate on a grandfathered basis in accordance with the FCC's rules.<sup>9</sup> The earth stations are located at 35 sites that are largely clustered along the coasts.<sup>10</sup> For all test areas subject to Grandfathered FSS Operations protection requirements (see Figures 1-3 below), Google will meet the Part 96 requirements<sup>11</sup> and will conduct its calculations using the NTIA model. In the event that Google's predictions show that the Part 96 limits may be exceeded for a particular site, Google will coordinate with the operators of the affected earth station(s).

*Protection of Ground-based Military Radar Systems in 3650-3700 MHz*

In the 3650-3700 MHz band, the U.S. military conducts research and development (R&D) activity at three land-based sites whose coordinates are listed in the FCC's rules.<sup>12</sup> To protect such uses, Google will ensure that the signals from its experimental operations remain at or below levels that would reasonably preclude the possibility of interference. Specifically, for all test locations within 150 km of the R&D sites,<sup>13</sup> Google will use the NTIA model to predict the aggregate interference from its deployed transmitters to the R&D sites and will limit its signal strength to at or below the ambient noise level of -174 dBm/Hz at that point, as received by an isotropic antenna. In the calculation, Google will include both fundamental emissions in 3500-3650 MHz and out-of-band emissions from devices operating below 3500 MHz and above 3650 MHz. In general, Google will avoid operating in the 3650-3700 MHz band unless necessary for the purpose of the experiment, as there are many incumbents in this band segment in addition to the military radar operations.

*Protection of Part 90 Incumbents in the 3650-3700 MHz Band*

To protect existing Part 90 operations in the 3650-3700 MHz band, Google will coordinate its proposed experimental transmissions in this band with all Part 90 licensees in the Commission's ULS database that are within 25 km of a Google transmitter location. Because there are many Part 90 systems operating in this band segment, and because Google plans to coordinate with adjacent-band FSS sites, Google will generally avoid using the 3650-3700 MHz band except when necessary to meet testing objectives, [REDACTED].

*Protection of FSS Receive-Only Earth Station Operations in the 3700-4200 MHz Band*

Numerous FSS receive-only earth stations operate in the 3700-4200 MHz band (C-band). To protect such uses, Google will meet the protection requirements for these systems as established in Part 96. Once again, Google will conduct its calculations using the NTIA model. Google will meet the in-band protection requirements in 47 C.F.R. § 96.17(a), extended to 3700-4200 MHz, since Google will be operating in-band in this segment. In the event that

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<sup>9</sup> See 47 C.F.R. § 2.106; Table of Frequency Allocations (Mar. 4, 2016) at footnote US107.

<sup>10</sup> The sites are listed on the Commission's website at <https://www.fcc.gov/general/35-ghz-band-protected-fixed-satellite-service-fss-earth-stations>.

<sup>11</sup> See 47 C.F.R. § 96.17.

<sup>12</sup> See 47 C.F.R. § 2.106; Table of Frequency Allocations (Mar. 4, 2016) at footnote US109.

<sup>13</sup> Consistent with the proposed power levels for its experimental operations, Google will observe a 150 km exclusion zone instead of the 80 km exclusion required by 47 C.F.R. § 96.15(b)(2).

Google's predictions show Part 96 limits may be exceeded for a particular site, Google will coordinate with the operators of the affected earth station(s). As previously noted, Google intends to avoid operations above 3600 MHz due to the number of incumbents, unless such operations are necessary to meet the objectives of the experiments.

### Figures

The following figures show the locations of Google's planned and potential test areas relative to the locations of incumbents requiring interference protection. The following key applies to the figures:

- **Green areas:** Locations where Google plans to operate under the requested experimental authorization, if approved.
- **Blue areas:** Locations where Google may operate under the requested experimental authorization, if approved.
- **Gold-colored areas:** Protection zones for incumbent federal ground-based radar operations in the 3100-3500 MHz band.
- **Red lines:** Coastal exclusion zones for incumbent U.S. military shipborne operations in the 3500-3650 MHz band.
- **Red circles:** Exclusion zones for incumbent U.S. military R&D sites in the 3650-3700 MHz band, calculated using a 150 km exclusion distance.
- **Red dots:** Incumbent FSS earth stations in the 3600-3700 MHz band.



Figure 1: Nationwide view of planned and potential test areas





Figure 2: Close-up of San Francisco Bay area

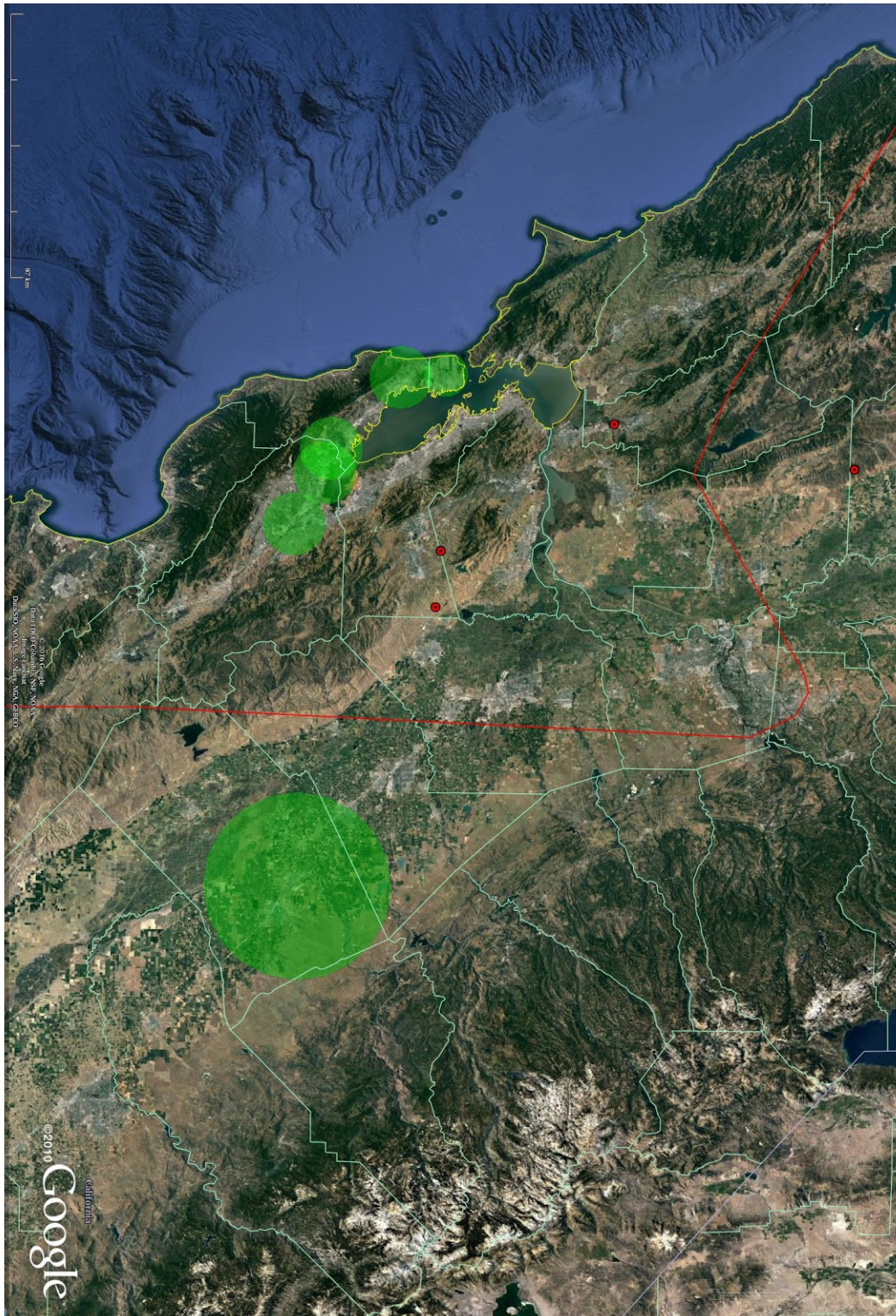
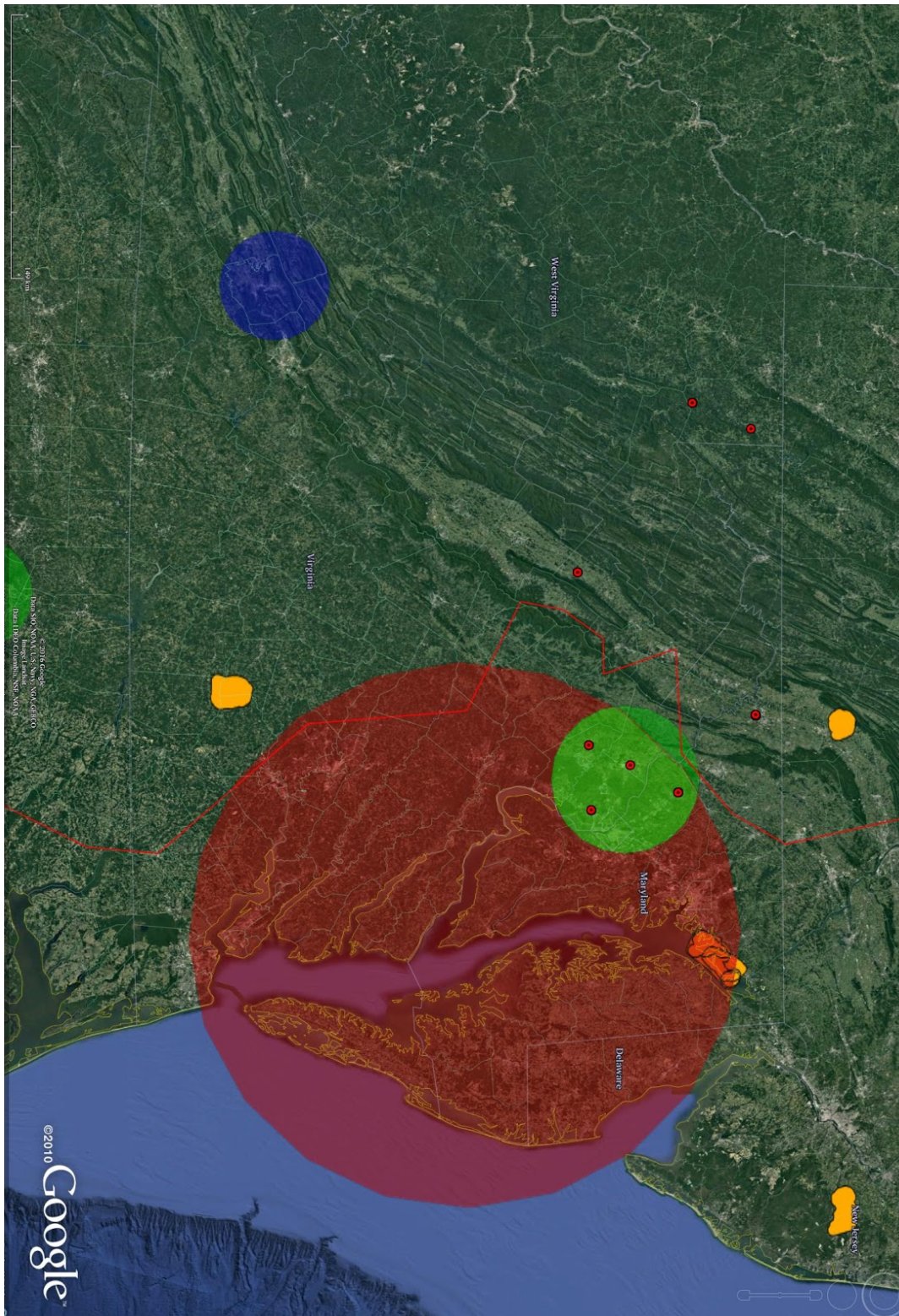




Figure 3: Close-up of Reston, VA area



### **Conclusion**

The proposed experimental operations will advance radio technologies associated with the new CBRS service and be conducted without harmful interference to other authorized users. For the foregoing reasons, Google requests approval of this application.

## EXHIBIT B - LIST OF POTENTIAL TEST LOCATIONS

Google requests authorization to operate in the following geographic areas:

City	Geographic Centerpoint	Radius of Operations
<b>ARIZONA</b>		
Phoenix	33° 26' 54" N, 112° 4' 27" W	30 km
<b>CALIFORNIA</b>		
Atwater	37° 22' 14" N, 120° 34' 29" W	30 km
Los Angeles	33° 59' 43" N, 118° 28' 35" W	10 km
Mountain View	37° 25' 16" N, 122° 4' 14" W	10 km
Palo Alto	37° 26' 12" N, 122° 9' 38" W	10 km
San Bruno	37° 37' 42" N, 122° 25' 36" W	10 km
San Francisco	37° 45' 26" N, 122° 26' 32" W	7 km
San Jose	37° 20' 14" N, 121° 52' 58" W	10 km
<b>COLORADO</b>		
Boulder	40° 0' 27" N, 105° 15' 43" W	30 km
<b>FLORIDA</b>		
Tampa	27° 56' 59" N, 82° 27' 26" W	30 km
<b>GEORGIA</b>		
Atlanta	33° 54' 42" N, 84° 21' 26" W	30 km
<b>ILLINOIS</b>		
Chicago	41° 52' 41" N, 87° 37' 48" W	30 km
<b>IOWA</b>		
Des Moines	41° 35' 36" N, 93° 39' 51" W	30 km
<b>KANSAS</b>		
Kansas City	39° 7' 34" N, 94° 49' 34" W	5 km
<b>NEBRASKA</b>		
Omaha	41° 15' 28" N, 95° 56' 8" W	30 km
<b>NEVADA</b>		
Las Vegas	36° 11' 12" N, 115° 8' 23" W	30 km
<b>NEW YORK</b>		
New York	40° 45' 0" N, 73° 59' 37" W	30 km
<b>NORTH CAROLINA</b>		

Raleigh	35° 47' 44" N, 78° 30' 55" W	30 km
<b>OKLAHOMA</b>		
Oklahoma City	35° 28' 8" N, 97° 30' 53" W	30 km
<b>OREGON</b>		
Portland	45° 31' 26" N, 122° 40' 10" W	30 km
<b>TEXAS</b>		
Austin	30° 13' 0" N, 97° 45' 4" W	30 km
<b>UTAH</b>		
Provo	40° 14' 29" N, 111° 42' 44" W	30 km
<b>VIRGINIA</b>		
Blacksburg	37° 13' 40" N, 80° 25' 20" W	30 km
Reston	38° 57' 31" N, 77° 21' 33" W	40 km

**EXHIBIT C - TECHNICAL INFORMATION**

Applicant Name: Google Inc.  
Applicant FRN: 0016069502

**Legal Contact Details**

<b>Name of Contact</b>	Stephanie Selmer
<b>Contact Details</b>	Associate Corporate Counsel 25 Massachusetts Avenue NW, Ninth Floor Washington, DC 20001

**Technical Contact Details**

<b>Name of Contact</b>	Dr. Andrew Clegg
<b>Contact Details</b>	1875 Explorer Street, Tenth Floor Reston, VA 20190 Phone: (202) 370-5644 Email: aclegg@google.com

**Transmitter Equipment and Station Details***Radio Information*

<b>Equipment</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Area of Operation</b>	Operations vary from 7 km to 40 km from the geographic centerpoint of each test area. See Exhibit B for the specific areas of operation.

<b>Frequency</b>	<b>High (MHz)</b>	<b>Low (MHz)</b>
[REDACTED]	3800	3400

*Amplifier Information*

<b>Equipment</b>	[REDACTED]
<b>Quantity</b>	[REDACTED]
<b>Area of Operation</b>	Operations vary from 7 km to 40 km from the geographic centerpoint of each test area. See

	Exhibit B for the specific areas of operation.
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*Antenna Details*

<b>Antennas</b>	[REDACTED]
<b>Type</b>	Both directional and omnidirectional antennas will be used.
<b>Quantity</b>	[REDACTED]
<b>Gain</b>	30 dBi max; -4 dBi min
<b>Beam Width at Half-Power Point</b>	Various (5° to 360° Horizontal; 5° to 180° Vertical)
<b>Orientation in Horizontal Plane</b>	Various (0° to 360°)
<b>Orientation in Vertical Plane</b>	10° to -30°

Radio	Modulation	Emission Designator	Bandwidth	Maximum Power Out	Maximum EIRP/ERP
[REDACTED]	Continuous waveform	10H0N0N	10 Hz	50 W <sup>1</sup>	EIRP = 47 dBW (50 kW) <sup>1</sup>  ERP = 44.9 dBW (31 kW) <sup>1</sup>  (with 30 dBi antenna)
[REDACTED]	Digital	10M0W7D 20M0W7D 40M0W7D 60M0W7D 80M0W7D	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	<b>For 10 W conducted:</b> EIRP = 27 dBW (500 W); ERP = 24.9 dBW (305 W)  <b>For 20 W conducted:</b>
[REDACTED]	Digital	10M0F9W 20M0F9W 40M0F9W 60M0F9W 80M0F9W	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	

<sup>1</sup> High power operation limited to [REDACTED] in the 3550-3575 MHz band segment.



[REDACTED]	Digital	10M0G7D 20M0G7D 40M0G7D 60M0G7D 80M0G7D	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	EIRP = 30 dBW (1000 W); ERP = 27.9 dBW (611 W)
[REDACTED]	Digital	10M0GXW 20M0GXW 40M0GXW 60M0GXW 80M0GXW	10 MHz 20 MHz 40 MHz 60 MHz 80 MHz	10 W 20 W 40 W 60 W 80 W	<p><b>For 40 W conducted:</b> EIRP = 33 dBW (2000 W); ERP = 30.9 dBW (1222 W)</p> <p><b>For 60 W conducted:</b> EIRP = 34.8 dBW (3000 W); ERP = 32.6 dBW (1833 W)</p> <p><b>For 80 W conducted:</b> EIRP = 36 dBW (4000 W); ERP = 33.9 dBW (2444 W)</p> <p>(all with 17 dBi antenna)</p>
[REDACTED]	Digital	2M00P0N	2 MHz	4 W	EIRP = 22 dBW (160 W)
[REDACTED]	Digital	5M00Q7N 10M0Q7N 20M0Q7N	5 MHz 10 MHz 20 MHz	4 W	ERP = 19.9 dBW (98 W)

					(with 16 dBi antenna)
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