



PUBLIC REDACTED VERSION

November 15, 2016

Via ELS

Douglas Young
Electronics Engineer
Federal Communications Commission
Experimental Licensing Branch
445 Twelfth Street SW
Washington, DC 20554

Re: Request for Information - File No. 0539-EX-PL-2016

Dear Mr. Young:

We appreciate the questions raised by the Satellite Division of the Commission's International Bureau regarding Google Inc. (Google) operations under the application for an Experimental Radio Service License (Experimental License), File No. 0539-EX-PL-2016, which was filed with the Office of Engineering and Technology on August 5, 2016, and which has been successfully coordinated through NTIA. In Attachment A, Google addresses each of the specific questions asked by the Satellite Division in the document transmitted to Google on November 9, 2016, as well as the other concerns identified by the Satellite Division. In addition, we have the following general observations relating to those concerns.

Previously Granted Experimental Licenses

The proposed operations under the requested Experimental License pose no greater threat of interference to fixed-satellite service (FSS) operations than other experimental licenses issued recently by the Commission, including the following:

- General Dynamics SATCOM Technologies is experimenting under call sign WC2XPH throughout the 3700-4200 MHz band in Maiden, NC, using an effective radiated power (ERP) up to 288 watts CW (File No. 0107-EX-RR-2013, issued June 1, 2013).
- The Boeing Company is experimenting under call sign WF2XBZ in the 3625-4200 MHz band in Los Angeles, CA, using an ERP of up to 14,297 watts CW (File No. 0175-EX-RR-2015, issued July 3, 2015).

- AT&T has been issued authority under call sign KM2XBI to operate fixed and mobile throughout the entire continental United States and across the 3700-4200 MHz band with an ERP of up to 100 watts (mobile) and 1,200 watts (fixed) per 10 MHz (File No. 0057-EX-ML-2016, issued June 13, 2016).
- BAE Systems Technology Solutions & Services, Inc., is experimenting under call sign WG2XFW throughout the 3700-4200 MHz band in California, MD, using an ERP of up to 1,280,000 watts per 2.64 MHz (equivalent to 4,800,000 watts per 10 MHz) (File No. 0317-EX-RR-2016, issued September 1, 2016).

Some of these experimental licenses (for example, the Boeing license in Los Angeles, and AT&T's nationwide license) cover some of the same geographical areas in which Google is requesting to operate. And the proposed operations in Google's request overlap less FSS spectrum than any of the referenced licenses. Specifically, Google requests to operate co-frequency with FSS only over the 3600-3800 MHz range, which is 200 MHz of overlapping spectrum, whereas the referenced experimental licenses cover 500-575 MHz of overlapping spectrum.

Furthermore, Google requests a maximum ERP of 305 watts per 10 MHz in that portion of spectrum that overlaps FSS operations, while some of the previously granted licenses allow emissions at far greater power. AT&T's nationwide license, for instance, authorizes an ERP from fixed devices that is four times greater than Google's request. BAE's license allows an ERP that is more than *four thousand* times greater than Google's request; when scaled to power in a 10 MHz bandwidth, BAE's authorized power is nearly *16 thousand* times greater than Google's request.

The previously approved experimental licenses were granted subject to one of two reasonable conditions for protecting FSS earth stations:¹ operations must be prior-coordinated with all affected licensees to avoid interference (General Dynamics and AT&T), or they are subject to immediate shutdown if any interference occurs to FSS earth stations (Boeing and BAE). There is no basis to impose more stringent requirements on Google's proposed uses, which represent no more, and often less, of an interference threat than any of the referenced licenses. Google is confident that the conditions the FCC has placed on these prior licenses are sufficient to protect FSS operations, and can do the same when applied to Google's requested Experimental License.

¹ Although the Boeing license requires separation from grandfathered earth stations as defined in Part 90, subpart Z (Boeing), the authorized point of operation is within the 150 km coordination distance of several grandfathered FSS earth stations near Los Angeles. The condition therefore appears to refer to coordination rather than exclusion.

Additional Interference Protections for FSS

In addition to being well within the range of non-interfering activity set by the Commission's previous license grants, Google's requested Experimental License includes considerations that provide FSS licensees additional assurances against interference. As noted in the application, Google will generally use frequencies below 3600 MHz to avoid interference to incumbents above 3600 MHz, including FSS earth stations. In those situations where frequencies above 3600 MHz will be used, Google will coordinate with all possibly affected earth stations. Also as noted in the application, Google will calculate the aggregate interference into all FSS earth stations, and for any calculation that shows aggregate interference exceeding the Part 96 interference threshold for FSS earth stations, Google will adjust its operational parameters (for example, power output per node, or total number of nodes) to bring the aggregate interference below Part 96 criteria. If power levels cannot be adjusted to meet the Part 96 criteria, then Google will coordinate directly with the operator of the affected earth station prior to beginning transmissions in that area.

Grandfathered earth stations operating in the 3600-3700 MHz band segment will be fully protected using the same method described above. Part 96 already takes into account the existence of these grandfathered earth stations, and has established rules for avoiding interference to them.² Google will follow these rules. There is no difference between the interference avoidance expected as the Citizens Broadband Radio Service (CBRS) develops, and the interference avoidance Google will implement under its Experimental License—except that the scale of Google's proposed testing will be vastly smaller. In fact, it is Google's goal [REDACTED].

With regard to transmit power, the Satellite Division notes that Google is requesting power levels that are greater than those allowed under Part 96. This is correct, as [REDACTED], and Google would like to conduct limited experiments with [REDACTED]. The requested power level at the 24 local sites defined in the application is some four times less than the power that AT&T is authorized to transmit throughout the continental U.S. under its nationwide experimental licence.

As described in Attachment A, moreover, Google does not plan to operate all units at the highest power. In fact, Google plans to experiment mostly within the Category B CBSD power limits, and also to conduct experiments within the Category A limits. The nature of the Commission's experimental license application (FCC Form 442) requires the submission of the absolute greatest power to be transmitted and the absolute maximum number of units to be deployed. But Google generally will not be operating at those maximum levels.

² See 47 C.F.R. § 96.17.

The Satellite Division has expressed concern over the 31 kW ERP CW emissions that are proposed under Google's Experimental License application, and recommends that such transmissions remain below 3600 MHz to avoid interference to FSS earth stations. Google agrees, and the pending application therefore requests authorization for these high-power emissions only in the 3550-3575 MHz portion of the band. As stated in the application:

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).

Test Plans

The experimental license application form requires specifying the maximum power level, the maximum number of units to be deployed, the listing of all sites at which experimentation may be conducted, the largest bandwidth that will be employed, and the maximum frequency range over which signals may be transmitted. The totality of this information creates a worst-case scenario for assessing potential interference. In actual operations, several mitigating factors will reduce the likelihood of harmful interference, including the following:

- It is likely that experimentation will occur only in a small fraction of the requested 24 local sites at any one time.
- Most experimentation will involve significantly fewer [REDACTED] specified in the license application.
- Most experimentation will remain below 3600 MHz, as discussed above.

For these reasons, the number of situations in which interference could occur will be much fewer than suggested by the requested operational parameters (which, as explained, are themselves below Part 96 requirements or subject to direct coordination with FSS operators).

Request for Confidential Treatment

Google requests confidential treatment of the material underlined in this response and in Attachment A, for the length of the experiment and thereafter in order to protect its evolving business and technology strategies. The information Google seeks to keep confidential includes information regarding proprietary wireless applications, and therefore represents a trade secret as recognized by the Commission.

Moreover, Google has limited the number of people involved in the tests/experiments, and required all third parties involved in the testing process to execute robust nondisclosure agreements. Consistent with 47 C.F.R. § 0.459(d)(l), Google requests notification if release of confidential information is requested pursuant to the Freedom of Information Act or otherwise.

Please contact me should you have any questions regarding this response.

Sincerely yours,

A handwritten signature in blue ink, appearing to read 'Step Selmer', is positioned above the printed name.

Stephanie Selmer
Associate Counsel
Google Inc.

ATTACHMENT A
Responses to Specific Satellite Division Questions

Satellite Division Question:

The experimental application requests fixed station operations only, yet in the exhibit it states that "Google will use a mobile receiving station [REDACTED]"

- *Will all the EUD units be fixed when transmitting?*
- *Or will there be EUD units transmitting while in motion?*
- *What is the maximum antenna height above ground level for EUD stations envision?*
- *What are the antenna gains, beamwidths, associated EIRPs and associated emissions for point to multipoint?*

Google Response:

The "mobile receiving station" refers to a receiving station used for propagation measurements, not to CBSD operations. Such receiving stations are not EUD units. Rather, they will be measuring the received power from the transmitted CW propagation tone signal, which will be transmitted at a fixed location. The receiving stations have no EIRP and cannot cause interference because they are receiving only, not transmitting.

Satellite Division Questions:

Detail antenna gains and beamwidth were not provided for specific testing only a range of value where provide but Google could not determine which values belong with specific testing.

- *What is the maximum antenna height above ground level for each base station envision?*
- *What are the antenna gains, beamwidths, associated EIRPs and associated emissions for point to multipoint?*
- *Will their antenna be down tilted? If yes, what is the tilt angle?*

The exhibit mention deployment of [REDACTED].

- *What is the maximum antenna height above ground level for each base station envision?*
- *What are the antenna gains, beamwidths, associated EIRPs and associated emissions for [REDACTED]?*

- *What is the maximum number of [REDACTED] deployment for each location envision?*

Google Response:

Consistent with the request for experimental authorization, Google will be using a variety of traditional and advanced beamforming antennas spanning the range of requested gains and beamwidths. Generally speaking, EUDs will use [REDACTED], while the access points may use [REDACTED]. The CW propagation testing will employ [REDACTED]. The EIRPs will be [REDACTED]. For the majority of the broadband deployments, Google will remain within the 47 dBm limit for Category B CBSDs.

Google does not have a detailed network plan at this time. Generally speaking, however, units will be located [REDACTED]. Google hopes to deploy many [REDACTED]. Some [REDACTED]. In both [REDACTED] cases, downtilt will be employed to illuminate the area of interest.

Most of the emissions for broadband experimentation [REDACTED], with bandwidths ranging from 10 to 80 MHz. The propagation measurements will be conducted using a CW tone. Google may also transmit radar waveforms in limited circumstances to experiment with Environmental Sensing Capability.

Google notes that regardless of antenna height, beamwidth, gain, EIRP, signal type, and number of units, Google will ensure that aggregate EIRP at FSS earth stations does not exceed the interference criteria established in Part 96, or Google will coordinate directly with all affected earth station operators.

Finally, the maximum number of [REDACTED] deployments in any given location is limited by the maximum number of eNodeBs requested in the application. As noted, however, this number ([REDACTED]) represents an absolute maximum. Typical deployments will be less, and the number of active deployments at any given time will be a small fraction of the requested 24 local sites.

Satellite Division Question:

Does the experimental transmitter use filtering and if so what is the filter roll-off (in dB per decade)?

Google Response:

Although Google plans to use a wide variety of experimental equipment, the transmitters to be tested [REDACTED]. [REDACTED].

Satellite Division Questions:

What is the power level between 3700 - 3701 MHz and 3701 - 3702 MHz?

What is the power level between 3625 - 3626 MHz and 3626 - 3627 MHz?

Google Response:

Google's application requests a maximum EIRP of 27 dBW per 10 MHz, which corresponds to 17 dBW per MHz. Note that most of the experimentation will fall at or below the Category B CBSD limit of 17 dBW per 10 MHz, or 7 dBW per MHz.

Satellite Division Question:

What mitigation technique will the transmitter use to avoid interference?

Google Response:

As noted in the application, [REDACTED]. [REDACTED].

Responses to Additional Division Concerns

In addition to its specific questions, the Satellite Division's document raises the following issues, to which Google also responds:

Issue:

For co-located FSS earth station with experimental transmitter, the out-of-band emission levels from the experimental may need to exceed the limits in Section 96.41(e). There may be a need to use distance separation, guard bands, antenna direction restrictions and reduce the output EIRP to mitigate potential interference to license earth stations.

Google Response:

As noted, Google plans to calculate aggregate interference from all of its deployments into FSS earth stations, and will use suitable measures to keep predicted interference below Part 96 protection criteria. Otherwise, Google will coordinate directly with the operators of all possibly affected FSS earth stations.

Issue:

Be aware that a lot of the FSS earth stations are managed by the National Spectrum Managers Association (NSMA) frequency coordinator and Google will be required to notify them by e-mail. The notice must include the contact information of the stop buzzer personnel, testing parameters, day and times of each testing. Although Google has requested confidentiality/proprietary status, additional information will be required to be provided to incumbents license operators/managers in order to assess the potential interference impact to their network and to ensure the proper mitigation and protection are implemented to safeguard their daily network operations. NSMA contact information can be found in the website:

http://wireless.fcc.gov/services/index.htm?job=licensing_1&id=microwave

Google Response:

Consistent with the request for experimental authorization, Google has proposed to coordinate with FSS operators through appropriate channels and methods, such as those recommended by NSMA.

Issue:

We also want to bring attention to Google's proposed use of the NTIA model to determine if the FSS earth station will be impacted; using this model may not be appropriate for FSS operations. Based on the NTIA website (<https://www.ntia.doc.gov/report/2015/35-ghz-exclusion-zone-analyses-and-methodology>), the NTIA model was designed "...to protect federal radar operations (ship and land based) from aggregate interference in the band 3550-3650 MHz" and it was not intended to be used for protection of FSS earth stations. FSS earth stations have very sensitive receivers to detect weak signals from geostationary orbit satellite networks which are 35,786 km away (this distance does not consider slant angle distance). ITU has a PDF protection limit used by some countries that protect FSS earth station.

Google Response:

Google recognizes that FSS earth stations receive weak signals and have stringent protection criteria. However, the protection criteria are separate from the propagation model used to ensure compliance with those criteria. The propagation of signals from commercial devices in the 3.5 GHz band will be the same—and thus the propagation model should be the same—regardless of what incumbent operations are being protected.

While Google would be able to use an alternative propagation model if required by the FCC as a condition of granting the requested experimental authorization, Google

believes the NTIA model is suitable in this context. The NTIA model is being standardized in the Wireless Innovation Forum as the model that all SASs will use to protect incumbent operations, including FSS earth stations. The satellite industry, through SIA, participates in the Wireless Innovation Forum standards process. This work has been presented to the FCC's Wireless Bureau and Office of Engineering and Technology. Thus, Google has proposed to use the NTIA model, in conjunction with the interference criteria for FSS earth stations as specified in Part 96, to meet its obligation to avoid interference with FSS operations.