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September 27, 2011

Via Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th St., S.W.
Washington, DC 20554

Re: IB Docket No. 11-109 and FCC File No. SAT-MOD-20101118-00239
Ex Parte

Dear Ms. Dortch:

On September 15, 2011, Garmin International, Inc. ("Garmin") submitted an ex parte filing (the "Garmin Filing") in the above-referenced proceedings that included a copy of a Powerpoint presentation Garmin had made to FCC staff.[1] LightSquared Subsidiary LLC ("LightSquared") hereby replies to certain positions taken in the Garmin Filing.[2]

Garmin's filing relates largely to a LightSquared September 6, 2011 presentation of operational and design solutions for resolving GPS interference concerns.[3] Among other things, LightSquared proposed to limit power on the ground from its terrestrial base stations, including a process for calibrating and monitoring the power level to ensure compliance. LightSquared also reviewed the results of the TWG testing and discussed the development of filters to protect precision GPS receivers.

For the reasons provided in the attachment, LightSquared urges the Commission to take action consistent with these comments.

[1] Letter from M. Anne Swanson, counsel for Garmin, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 11-109 and FCC File No. SAT-MOD-20101118-00239 (September 15, 2011).

[2] LightSquared already has addressed, in its Reply Comments submitted on August 15, 2011 in this proceeding, the other issues raised in the Garmin Filing and hereby incorporates by reference its previously-filed Reply Comments.

[3] Letter from Jeffrey Carlisle, Executive Vice President, LightSquared, to Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 11-109 and FCC File No. SAT-MOD-20101118-00239 (September 7, 2011).

Respectfully submitted,

/s/Jeffrey Carlisle
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Attachment

1. *The LightSquared (Power on the ground) proposal does nothing to address the Aviation interference issues with the lower 10 – it may make things worse.* (Garmin Filing, p. 5)

The LightSquared proposal to limit power on the ground is only one element of a comprehensive solution and not designed to address aviation receivers in flight. Instead, LightSquared's power on the ground solution is specifically designed to address mobile and portable GPS receivers operating in the vicinity of cellular antenna points such as towers and rooftop installations. Garmin's claim that limiting power on the ground could make the aviation case worse is unsubstantiated and incorrect. Garmin's speculation that LightSquared would choose to limit its power on the ground by decreasing downtilt is wholly inconsistent with optimal network operation and practice and in any event is impractical for a number of reasons. Further, all operators including LightSquared employ several methods to reduce power, of which downtilt is only one.

2. *LightSquared's power monitoring protocol has serious problems.* (Garmin Filing, pp. 7-9)

a. *Power monitoring begins at 50 meters from the base of the tower or "closest practical point."* (Garmin Filing, p. 7)

Many towers are sited such that vehicle traffic can frequently come within 50 meters of the tower and still be in the beam of the transmit antenna. (Garmin Filing, p. 7)

LightSquared proposes the 50m measurement distance because (a) 50m, being such a short distance, is often the closest practical point of measurement access and (b) it is very unlikely that base station power will exceed the proposed limit at distances of less than 50m and not also exceed the limit at distances 50-500m away (where measurements will be taken) given the pattern of the tower/rooftop antennas.

b. *Up to 5000 measurements will be collected, but no spatial sampling requirements are given.* (Garmin Filing, p. 7)

The 5,000 measurements are proposed as part of an initial test to identify potential hot spots. To the extent that any areas are identified with power levels in excess of the agreed upon levels, detailed static tests will then be performed on the area with the strongest measured signal. The 5,000 measurements in the drive around test are intended to be taken at the rate of 1 per second, which is a practical rate for such data logging platforms and was used by both Trimble and LightSquared in their independent data collection efforts last May at the Las Vegas field trials. At the above sampling rate, a collection of 5,000 samples involves about 1.5 hours of driving. This should be sufficient to identify peak power levels within the "hot spots" surrounding each base station. The *normative measurements* are not the initial tests, but the 10 static tests in the 10m x 10m area. These measurements will have a spatial averaging distance of approximately 1 meter. Such fine resolution is completely practical and addresses pedestrian and vehicular use cases.

c. *The samples could all be taken in areas where the power is relatively low due to terrain, building obscuration, etc. Areas with good line of site exposure to the tower (and hence high power) could be ignored.* (Garmin Filing, p. 7)

The test plan will focus on primary and secondary routes in the range of 50 to 500 meters from the cell site. LightSquared's drive test methodology will be consistent with existing wireless industry standards and protocols for measuring signal strength. LightSquared takes exception to Garmin's accusation that it would attempt to game the process in order to avoid adhering to the power levels to which it has committed.

An advantage to the process that LightSquared has proposed is that it can be replicated by any interested third party if they should ever believe that LightSquared is not fully meeting its commitment.

d. *LightSquared proposes to sample "up to 500m from the base of the tower."* (Garmin Filing. p. 8)

Garmin does not explain why it considers this distance to be problematic. LightSquared selected this measure because it is the distance in which the strongest on-the-ground power levels are most likely to be observed. If one were to arbitrarily increase the radius, it would merely increase the drive test and analytical complexity without any resulting change in the utility of the data.

e. *The procedure for verifying the point of highest power is extremely vague.* (Garmin Filing, p. 9)

LightSquared disagrees that the proposed procedure is vague but it is prepared to consider reasonable refinements in the field test procedure.

i. *10 measurements are taken within a 10m by 10m square, then measurements averaged in dBs.* (Garmin Filing, p. 9)

The intent here is to find the "local mean" as defined in propagation literature [1], [2] and not to base a go/no-go decision exclusively on the sporadic peaks of multipath peaks which have coherence distance of a fraction of a wavelength (20 cm) at L-band.

ii. *Averaging dBs is not accurate when there is a large variation in measurement values.* (Garmin Filing, p. 9)

The literature [1, p. 155] shows that spatial averaging over 20-40 wavelengths or 4 - 8 m is the common practice when trying to measure the local mean (the lognormal fading, also referred to as he slow

fading, component), separated from the fast, Rayleigh fading fluctuations caused by movement or multipath.

Averaging power or dBs is the right way to perform this averaging as the slow fading component is normally distributed about the local mean when the mean value is expressed in dBs.

iii. *The local minimum power in the square could be sampled 10 times to give a false low reading.* (Garmin Filing, p. 9)

LightSquared's testing will ensure that the 10 spatial sampling points will be approximately uniformly distributed.

3. *LightSquared's "Corrective Action" plan is insufficient; adjusting downtilt of transmit antenna changes the entire power environment of coverage area; because of this, other areas may be over the power limit, perhaps in a neighboring cell; adjusting downtilt could significantly change the power aloft, affecting Aviation GPS receivers; reducing base station transmit power is the most effective corrective action* (Garmin, p. 10)

Garmin appears to be prejudging the means by which LightSquared will adjust and control power on the ground. In some cases, LightSquared may reduce base station EIRP, especially at sites having a low antenna height.

4. *LightSquared's Lower 10 MHz Proposal Raises Significant Concerns for GLN Devices.* (Garmin Filing, pp. 14-23)

a. *The Lower 10MHz Proposal Interferes with the Installed User Base of GLN Devices.* (Garmin Filing, p. 16)

The TWG tests show only two General Location/Navigation ("GLN") devices experienced a 1dB reduction in C/No at the on-the-ground power levels proposed by LightSquared and neither of those devices suffered apparent performance degradation. Therefore, we believe the proposed limit are a practical and balanced compatibility solution for legacy devices. If desired, additional immunity can be added to upcoming GLN GPS devices at the discretion of the GPS receiver manufacturers.

b. *Real world testing in Las Vegas shows devices will experience power levels of -33 dBm and -25 dBm frequently at significant distances from the tower. That is independent of which propagation model is used.* (Garmin Filing, pp. 16-19)

LightSquared does not dispute that such power levels were observed in the Las Vegas trials. LightSquared's present power-on-the-ground commitment, applied to the Las Vegas base station deployments, would very likely involve some powering down of some base stations. The end result will be that those power levels seen in Las Vegas will be eliminated, which Garmin should welcome.

c. *The TWG tests on Lower 10 MHz were insufficient to prove that harmful interference will not occur.* (Garmin Filing, p. 20)

> Garmin led the sub-team that designed and supervised the tests, which included testing of operation on the lower 10 MHz. The GLN sub team tested every device for the Lower 10 MHz and the test suite selected the 1 dB change in C/N_0 which Garmin has said should be the only measure of harmful interference. Thus, Garmin has not provided any justification for why it believes this testing was insufficient. Moreover, three months have passed since the conclusion of the tests, time that Garmin could have used to do any further testing that it might have considered useful or necessary.

d. *Developing adequate filtering for the lower 10 MHz will still take years to implement and incorporate into products.* (Garmin Filing, p. 21)

> Most legacy cellular and GLN filter technologies already reject the Lower 10 MHz even at relatively high LightSquared power levels (well beyond those which would be encountered by any device). Manufacturers may choose to undertake further rejection which, if broadly adopted, may add no cost or very little given the intense competition that characterizes the component supply marketplace. The record contains statements by one major cellular GPS technology supplier, Qualcomm, quoting new BAW technologies as viable and may at most add 5¢ to a high volume device bill of materials. In some cases upgrading compatibility margin may involve only a part-for-part substitution that requires little or no other circuit or layout modifications. While one must acknowledge the design and production pipeline timeframes as a time factor, such interchangeable component modifications are routinely and widely done so as to avoid sole source suppliers and secure more competitive pricing or performance in consumer electronics. Certainly this type of action could also be undertaken if a manufacturer felt that it was necessary in order to improve the performance of a specific product.
> At least one GPS receiver supplier has told LightSquared that it has engaged its component suppliers and now sees a lead time of only a few months to change production, presumably since it views the improved resilience as a competitive differentiator. To address improved resilience across a broad range of receiver categories, LightSquared continues to develop the market using its in-house and outside technical resources to advance the art and sharpen awareness of component filter suppliers, all of which benefits Garmin and others. Indeed these are actions that any responsible manufacturer could have undertaken as soon as they learned of LightSquared's plan for a terrestrial network, or at the very least, when LightSquared filed its proposed mitigation plan with the FCC.

e. *The handset issue has not been studied sufficiently.* (Garmin Filing, p. 22)

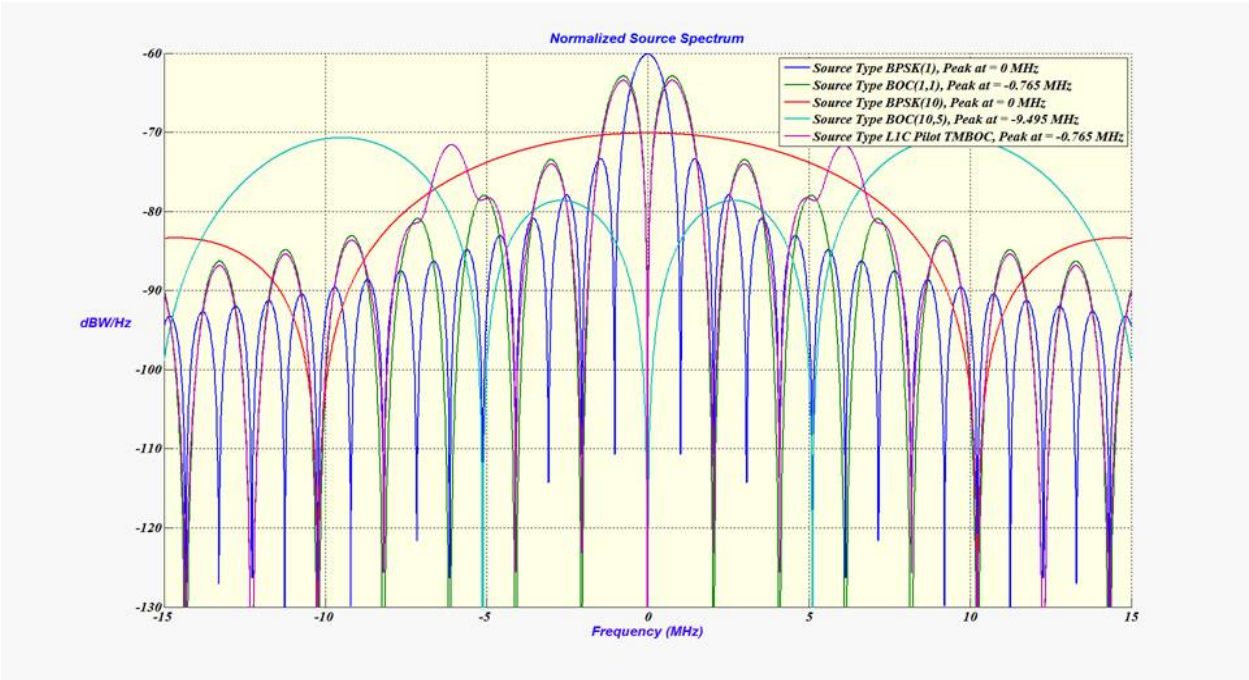
> The potential impact of LightSquared user devices was tested and analyzed by the Cellular sub-group. Those tests showed no degradation to cellular devices, which

use similar front end pre-selectors as the GLN devices, at less than 1 meter range. Garmin's claim that tests could not be conducted because LightSquared user devices are not yet in production cannot be given credence; fully satisfactory tests can be performed using instrumentation that simulates uplink LTE signal similar. Indeed, many of the other TWG sub-teams chose to perform such tests as part of their comprehensive test plans. Garmin provides no credible justification for why the GLN team, which it led and had several employees as members, chose not to do so.

f. *The lower 10 MHz raises concerns for Modernized GPS Signals; GPS signals, which are increasingly being utilized by GLN devices, occupy the entire RNSS spectrum, requiring wideband front end designs. It is not clear that these modernized signals are compatible with the lower 10MHz proposal. Filter design for lower 10MHz (is) much more difficult when the entire RNSS band must be protected.* (Garmin Filing, p. 23)

The GPS L1 Modernized signal frequency spectra are shown below for quick reference. Note that the greatest difference in wideband signals at the L1 is the new M code, which will have a main lobe approximately 10 MHz below the L1 center frequency. The M code will have up to 20 dB higher power when necessary on a regional basis for enhanced reliability, including possible interference. Two civil signals in the new L1C signal structure main lobes fall between 0-6 MHz of center frequency thus, have most of their power within the bandwidth of the M code or the soon to be obsolete P code. Regarding capture of the full extent of the upper and lower side lobes to enhance precision or reject multipath, we note that the new satellite spectra all fall within a 31 MHz (currently migrating from 24 MHz) transmitter bandwidth that is centered at 1575.42 MHz. These factors define the key GPS passband phase and amplitude responses for purposes of specifying transition band rejection filters to establish or enhance compatible operation. Similar transmission and channel parameters exist for other GNSS systems.

Though they lie outside the L1 most relevant here, new, state-of-the-art receivers will also achieve greater accuracy, multipath mitigation and reliability as they migrate their receiver architectures to multiband and multi-constellation operation, that include new open, unencrypted civil L2C signals which for Precision receivers significantly improves tracking at lower C/No than current receivers. Along with other receivers, Precision receivers will also have access to a new L5 frequency signal set. Based on the above facts and trends, we therefore reject a view that the Lower 10 MHz terrestrial downlink will somehow limit continuation of GPS or GNSS evolution.



Several references were made to modernized signals and other GNSS such as Galileo and GLONASS. First, there are no fielded Galileo receivers available to test interference susceptibility as that European constellation is several years away from operation. Thus there is ample time to prepare commercial products for lower 10 MHz compatibility.

To our best belief, there are also no GLONASS-only receivers fielded in the US, certainly in any commercial context. GLONASS operates at a higher sub-band of the RNSS L1 between 1590-1610 MHz, therefore has greater frequency separation with respect to the LightSquared lower 10 MHz downlink carrier frequency and thus will be less affected than GPS which is centered at 1575.42 MHz. Consideration has to be paid to maintain compatibility for the uplink LightSquared frequency at 1627.5 MHz, but that offers more separation than many L Band MSS transmitters operating adjacent to GLONASS and operate at frequencies below and thus less separated than the LightSquared uplink frequencies. Some MSS uplink portables such as Iridium have transmit power levels that emit 13 dB above LightSquared's terrestrial uplink.

Filter simulations for dual mode GPS and GLONASS receivers show based on simulation initial feasibility using either BAW technology in addition to existing filter technologies. While somewhat more challenging than designing for narrowband GPS alone, these filters are not "more difficult" if reasonable cost and electrical performance criteria and suitable front end architectural solutions (cascaded filters and high-linearity LNAs for instance) are applied. Solid state filters offer good solutions since they can be packaged in combined, integrated way sharing an IC with other filter blocks, usually a few square mm in board size. These filter products are well fielded in consumer and cellular devices today to

isolate receivers from other common multiple transmitters residing in the same portable or mobile device.

References

[1] J. D. Parsons, The Mobile Radio Propagation Channel, John Wiley & Sons, 2001, ISBN 0-471-98857-X.

[2] T. S. Rappaport, Wireless Communications Principles and Practice, Prentice-Hall Inc., 2002, ISBN 0-13-042232-0.