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July 2, 2015

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Written *ex parte* presentation in IB Docket No. 12-340; IBFS File Nos. SAT-MOD-20101118-00239; SAT-MOD-20120928-00160; SAT-MOD-20120928-00161; SES-MOD-20121001-00872

Dear Ms. Dortch:

This *ex parte* letter responds to the presentation to Commission staff by the GPS Innovation Alliance on June 17-18, 2015. Those submissions have been reviewed by the undersigned along with our engineering consultants at Roberson and Associates and with LightSquared's engineering team. This review leads us first to identify several significant errors or incomplete engineering and technical points made by the GPS Alliance in its submission. Second, we highlight some noteworthy admissions or concessions of fact.

I. Engineering and Technical Errors and Incomplete Points

A. "Band Gaps" and "Duplex Spacing"

The Alliance claims on slide 3 of its first presentation that "wireless networks rely on significant spectral separation – the 'band gap' and 'duplex spacing' – to avoid self-interference through overload."

The Alliance's claim attempts to support its contention that broad swaths of spectrum near the spectrum used by GPS devices must be cleared of any significant terrestrial operations. However, "band gaps" or "duplex spacing" are *irrelevant* to receive-only devices – and irrelevant to what the Commission must consider when it examines GPS and terrestrial compatibility. Moreover, the duplex spacing/spectral separation mentioned by the Alliance is often *less* than the spacing that exists between LightSquared and the GNSS band.

Cellular handsets are two-way devices that must transmit and receive on the same antenna without suffering self-interference or overload. A duplexer allows a handset to do so by allowing reception of one band and transmission on a second band, separated from the first by the duplex spacing. This, then, is what the Alliance means when it refers to "duplex spacing." But a GPS device is not a two-way device – it is a receive-only device and does not use a duplexer. A GPS device's resilience to signals from other bands is maximized by including multiple stages of linear low noise amplifiers and receiver filters, which are not always practical in two-way devices. Thus, the Alliance errs when it compares a duplex gap used by two-way devices to avoid self-interference with methods for protecting a receive-only GPS device.

Even if one were to accept the premise of the Alliance's argument that such a comparison is appropriate, there are many examples of uplink-downlink spacing that are *closer* than that for GPS and LightSquared. In fact, the Alliance provides such an example on slide 10 of its second presentation. The Alliance shows the PCS band with an uplink from 1850-1920 MHz and its downlink from 1930-2000 MHz – a spacing between the edges of uplink and downlink of only 10 MHz.

The Third Generation Partnership Project (3GPP) sets worldwide standards for the development and implementation of wireless networks worldwide; all major cellular networks operating in the United States today abide by 3GPP standards. The 3GPP has standardized 28 different spectrum pairings for frequency division duplex networks (the types referenced by the Alliance) worldwide[1]. Of those 28 pairings, 14 have less than 23 MHz separation cited in the Alliance report as the distance between LightSquared downlinks and the edge of the GNSS band. Additionally 7 pairings have less than the 17 MHz of separation cited as the distance between the GNSS band and LightSquared's uplinks.

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1 As of 3GPP Release 12.

3GPP Band #	Uplink (UL) operating band		Downlink (DL) operating band		Duplex Spacing (MHz) Edge-to-Edge	Region	Operator	FCC Name
	UL Lower Freq (MHz)	UL Upper Freq (MHz)	DL Lower Freq (MHz)	DL Upper Freq (MHz)				
31	452.5	457.5	462.5	467.5	5	Central Latin America		
8	880	915	925	960	10	Europe, East Asia, Oceania, Japan		
26	814	849	859	894	10	USA	Sprint (ESMR)	ESMR and Cellular
28	703	748	758	803	10	Asia & Pacific		APT
N/A*	1930	2000	1850	1920	10	USA	Dish Network	PCS A-H
20	832	862	791	821	11	Asia & Pacific		
12	699	716	729	746	13	USA , Canada	T, TMO, US Cellular	Lower 700 A,B & C
25	1850	1915	1930	1995	15	USA	Sprint	PCS + G Block
17	704	716	734	746	18	USA, Canada	T & Rogers	SMH B/C
2	1850	1910	1930	1990	20	North America, South America	T, VZ, S, TMO, C Spire	PCS A-F
3	1710	1785	1805	1880	20	Europe, Asia, Oceania, Africa, Latin America		DCS
5	824	849	869	894	20	USA, Oceania, South America, East Asia, Israel, Brazil	T, VZ. US Cellular	Cellular A & B
14	788	798	758	768	20	USA, Canada	Public Safety	Upper 700 D and PS
22	3410	3490	3510	3590	20	Europe		
13	777	787	746	756	21	USA, Canada	VZ, Telus	Upper 700 C

* The PCS H block has not yet been standardized by 3GPP and thus has no Band Class number

Remarkably, in arguing for significant spectral separation, the Alliance neglects to mention that the Department of Defense ("DOD") does not warrant performance of the GPS system should manufacturers choose to build receivers that look far outside the GNSS band. DOD's Standard Positioning Service Performance Standard ("SPSPS") defines the level of performance the satellite constellation provides to GPS users. This level of performance is conditioned on certain assumptions regarding GPS receivers, including the use of a receiver that uses a "sharp-cutoff filter bandwidth," first at 24 MHz and later at 20.46 and 30.69 MHz, centered at the L1 frequency.[2]

While this is not a receiver standard that is mandatory for GPS manufacturers, DOD stated that this is part of the "Minimum Usage Assumptions" that "are necessary attributes to achieve the SPS performance described."[3] So when the Alliance argues that its members' receivers can only work with substantial spectral separation from other services, it ignores that the operator of the GPS constellation has warranted performance only assuming receivers use sharp-cutoff filters for specific bandwidths, and thus are resilient enough to filter out adjacent band signals.

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2 *See* U.S. Department of Defense, Global Positioning System SPS PS (4th Edition, Sept 2008) at 13, *available at* http://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf.

3 *Id.* at 7.

B. Power of Terrestrial Service

On slide 4 of its first presentation, the Alliance provides data on handsets used for terrestrial services, arguing that the significant disparity between handset power and the power of GNSS reception requires significant spectral separation – more than would normally be required for separation of transmit and receive bands for a cellular network – "yet frequency spacing relative to MSS ATC is smaller." The Alliance fails to mention that *today's MSS devices operate with up to 1500 times more power* than would handsets used for terrestrial service, and do so without causing any reported interference or overload with GPS devices. The Alliance fails to explain how it then follows that GPS somehow requires *more* spectral separation should far less powerful handsets be added to the band.

C. Aerospace Study

On slide 6 of its first presentation, the Alliance provides a graph from an Aerospace study, arguing that it shows that GPS devices are more resilient to adjacent band power than other consumer devices.

This graph shows that the best performing of three GPS devices was a Garmin GPS receiver. While the Alliance does not explain the reason for varying levels of resiliency, this result is consistent with the results seen in the testing performed by the Technical Working Group ("TWG") in 2011: many devices across all categories showed high levels of resilience and thus compatibility with terrestrial use of L-band. Thus, it is obvious that the capabilities and components exist for the GPS industry to build receivers that are resilient to overload, compatible with terrestrial use of L-band, and that industry best practices in this regard should be widely adopted. Such best practices are routinely used by manufacturers of cellular handsets, which, as a class, demonstrated very high levels of resiliency in TWG testing.

It is important to note that the Alliance states on slide 8 that masks effectively establishing standards for GNSS receivers should be "forward looking and not based on the lowest common denominator of all GNSS receivers." The Alliance should provide more detail regarding what objective device criteria would be appropriate for determining the lower limit for such a mask.

D. Interference-Induced Errors

On slide 7 of its first presentation, the Alliance states that interference-induced errors have a greater impact on navigation than on communications. While this distinction is generally accurate, the Alliance does not state how it is relevant to this proceeding. This distinction does, however, underscore the fact that *if* GNSS devices are particularly vulnerable to interference, then high levels of resiliency should be a primary consideration in responsible receiver design –

which the previous slides in the Alliance's presentation and the TWG test results clearly show is achievable.

Indeed, while communications devices may be able to tolerate interference better, they also operate in a very challenging environment themselves. Cellular devices utilize very narrow band gaps and perform today in numerous safety-of-life situations – *and have been designed accordingly.* The Alliance's effort to distinguish "receive-only" GNSS devices as particularly vulnerable to interference belies the fact that, with respect to adjacent-band operations, the tools to prevent this lie in the hands of GNSS receiver designers themselves.

E. GPS Innovation

On slide 8 of its first presentation, the Alliance states that "GNSS receivers should be evaluated under criteria comparable to other mass market devices, and prior innovations should not be penalized with new, overly restrictive performance criteria." The Alliance does not provide any explanation of what other criteria might apply, but presumably it is concerned that GPS devices might be subjected to more stringent evaluation. Given the Alliance's entire second presentation is about the importance of GPS, and GPS has been incorporated into every smartphone operating on commercial spectrum in the U.S. market, it is odd that the Alliance should then argue for *less* stringent evaluation than might apply to devices used for critical applications or broadly used for licensed services.

Moreover, the Alliance does not explain how reasonable filtering or other protection of GPS devices – in other words, simply making them more resilient to interference and overload – penalizes any specific kind of innovation or prevents it from working. The lack of adequate adjacent band resilience, in itself, cannot be called an "innovation" unless it has led to a tangible improvement in some other performance metric. In the wireless industry, chipmakers and device manufacturers produce groundbreaking new devices every day, and do so at an increasing pace. They do so, however, while considering the services authorized in the radiofrequency environment in which they operate. The Alliance's members should operate in the same way.

F. A 1 dB Increase in the Noise Floor is Not Harmful Interference

Also on slide 8 of the Alliance presentation, the Alliance asserts that an increase of 1 dB in the noise floor is the "definition of harmful interference." The Alliance cites no Commission source for this, but instead simply asserts it. The Alliance's assertion that 1dB "is the accepted interference standard worldwide" is simply false. A 1 dB increase in the noise floor was recommended by the International Telecommunication Union as the allowable increase in the noise floor for *co-channel interference*, meaning interference from other GPS systems which are in-band and thus cannot be filtered out. The recommendation is silent on power limits for adjacent bands or thresholds for device overload. Notably, the document does not recommend that the 1 dB rise should apply universally to all GPS devices – just the devices utilizing assisted GPS *(i.e.,* cellular) addressed by the recommendation. In any event, even if the recommendation had any broader applicability, it has never been adopted by any relevant standards body (such as 3GPP).

The reason this measurement has not been so adopted is because it is a poor proxy for showing actual, harmful interference. When a GPS device maps its location from satellites broadcasting the GPS signal, the GPS device performs a set of calculations to determine location, but does so within a range of error that accounts for a number variables such as the positions of the satellites, atmospheric conditions, and so on. Background radio noise experienced today by the GPS device is one of these variables, but a very small one — in fact, all of these other routine variables are typically 70 times greater than a signal to noise induced error.

This means that, in everyday use, small changes in signal-to-background radio noise are irrelevant to the user of the device. Every single day GPS devices routinely experience changes in the ratio of signal to noise of 1 dB, and many times greater than 1dB. No harm can be shown because these fluctuations are insignificant to the correct operation of the device. GPS receivers are designed to operate in environments and under conditions where there are many potential sources of error, yet nevertheless correct for these errors and report position correctly. A 1 dB increase in the noise floor thus could not reasonably be said to "endanger" the functioning of a GPS device, which is the definition of "harmful interference" for GPS devices.[4]

Rather than use a flawed proxy, the Commission must instead evaluate harmful interference according to whether the functioning of the GPS device is endangered, meaning that there would be a user-perceptible impact on the position reported by the device. LightSquared has advised the Department of Transportation and the Volpe Center at its workshops and in several letters that such a measurement would be far more useful to the Commission in assessing the compatibility of GPS and terrestrial uses of the L-band, and hopes that, with the help of the GPS industry, testing conducted by Roberson & Associates can assess harmful interference using such a measurement.

II. GPS Alliance Admissions or Concessions

First, the Alliance states on page 8 of the slide deck that its members are using and intend to use GNSS signals. Yet Section 25.131 of the Commission's rules states:

> (j)(1) Except as set forth in paragraph (j)(2) of this section, receive-only earth stations operating with non-U.S. licensed space stations shall file an FCC Form 312 requesting a license or modification to operate such station.

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4 *See* 47 C.F.R. § 2.1(c); International Telecommunication Union Radio Regulations 1.169.

> (2) Operators of receive-only earth stations used to receive transmissions from non-U.S.-licensed space stations on the Permitted Space Station List need not file for licenses, provided that the space station operator and earth station operator comply with all applicable rules in this chapter and with the applicable conditions in the Permitted Space Station List.

We are not aware of any Form 312 request for GLONASS pursuant to subsection (j)(1), and GLONASS is not on the Permitted Space Station List. As such, it is contrary to the Commission's rule for a person to provide location services today in the United States based on a foreign satellite signal such as GNSS without obtaining a license. If a member company in the Alliance or some other entity were to seek such a license it should have to agree at least to follow an industry established protocol for receivers that secured the public policy goal of maximizing the economic value of all the L-Band spectrum, which means accommodating both satellite and terrestrial signals.

Second, the Alliance states that its receivers are "required" to comply with a "mask," which is a mathematical description of signals that must be filtered. Further, the Alliance asserts that this "mask" should be "forward looking," meaning that it ought to contemplate advanced filtering and software innovations. These statements are noteworthy, because in effect the Alliance is correctly asserting that the industry should have receiver standards that are openly fashioned. In this regard, the GPS industry should follow the model of 3GPP or IEEE and create an open forum where entities such as LightSquared and other terrestrial users of spectrum in the L-Band could participate with the Alliance to craft those protocols and reach such compromises on the network transmission side as are reasonable. LightSquared is eager to engage in that process immediately.

Please direct any questions to the undersigned.

Respectfully submitted,

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Counsel to LightSquared

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