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Federal Communications Commission
445 12th Street SW
Washington, DC 20554
United States of America

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Attention: Marlene H. Dortch, Secretary

Dear Ms. Dortch:

**Re: Written ex parte presentation in IB Docket No. 11-109; DA 16-442;
IB Docket No. 12-340 (Comments Sought on Ligado's Modification Applications);
IBFS File Nos. SES-MOD-20151231-00981; SAT-MOD-20151231-00090 and
SAT-MOD-20151231-00091**

NovAtel Inc. ("**NovAtel**"), by its counsel, submits its comments to, Ligado Networks LLC's ("**Ligado**"), (formerly New LightSquared LLC and its subsidiary, LightSquared Subsidiary LLC), Licence Modification Applications.¹

Ligado proposes a specific set of operational parameters for terrestrial wireless operations in a portion of the spectrum in the L-band segments, including base stations in the 1526-1536 MHz portion of the MSS L-band and user equipment in the 1627.5-1637.5 MHz and 1646.5-1656.5 MHz portions of the MSS uplink band. In support of this proposal, Ligado recently filed results of a test program that Roberson & Associates completed with respect to the deployment of LTE in adjacent bands affects the ability of GPS to provide accurate location information.²

NovAtel is an integrated global positioning solutions company which provides OEM Global Satellite Positioning products. NovAtel's head office is in Calgary, Alberta, Canada.

NovAtel herein provides comment on: a) the parameters and conditions that are proposed as set out in the RAA study and b) Ligado's proposed operations in the 1526-1536 MHz, 1627.5-1637.5 MHz and 1646.5-1656 MHz bands and unresolved concerns of potential harmful interference to GPS receivers and devices should Ligado operate any terrestrial mobile network in those frequencies.

¹ Comment sought on Ligado's Modification Applications, Public Notice, IB Docket Nos. 11-109 & 12-340, DA 16-442 (April 22, 2016).

² See letter from Gerard J. Waldron, counsel to Ligado, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109 et al (with attachment "Results of GPS and Adjacent Band Co-Existence Study") filed May 11, 2016 (the "RAA Study").

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Comments on the RAA Study

- NovAtel notes the RAA Study did not test DGPS, RTK or PPP modes and only tested for autonomous position, even in the High Precision category of receivers tested. The RAA Study is also devoid of any carrier phase based positioning analysis. Ligado has provided no explanations in its *ex parte* presentation or in the RAA Study for this lack of review.
- NovAtel notes an apparent error in the RAA Study. The RAA Study purports to have tested a NovAtel Smart6 Receiver.³ From the test results presented, NovAtel suspects that the RAA Study did in fact utilize a NovAtel SMART6L for its purposes, but the apparent error in the RAA Study is troubling and raises issues as to Ligado's apparent knowledge of NovAtel equipment and its intended use.
- NovAtel also states the RAA Study makes an erroneous assumption with respect to the utilization of its OEM equipment in the market. The RAA Study suggests that the NovAtel SMART6 (or more properly NovAtel SMART6L) is "intended" for agriculture and maritime applications⁴ and likely not to be used within the proposed Ligado network. NovAtel is an OEM and it sells receivers to a number of system integrators that utilize the product in a number of varied applications. To assume use of the receivers is limited to agriculture and maritime applications is not accurate, nor supported by publicly-available information on the NovAtel website. NovAtel will add that as far as it is aware no one from Ligado or Robertson & Associates contacted them to confirm how the SMART6 or SMART6L may be utilized, nor if these products were representative of all NovAtel product.
- NovAtel is particularly concerned that Ligado has moved away from what it understood to be an agreed upon standard that interference tolerance should be limited to a received interference signal power level that causes no more than 1-dB degradation in the received C/No level.⁵ NovAtel disagrees with the conclusion in the RAA Study that there is no meaningful correlation between a 1-dB change and GPS performance. The GPS L1 C/A signal is very weak and has a number of structural vulnerabilities where low level interference can cause disruption to pseudorange and carrier phase. NovAtel's customers expect excellent tracking performance. High interference levels directly reduce the receiver's tracking loop robustness and directly increase the chances of loss of lock, in addition to impeding initial acquisition and subsequent reacquisition. NovAtel submits any interference must not exceed 1-dB degradation in received C/No. The intention should be to prove that fielded receivers will not be adversely affected by Ligado's use of the spectrum, which is what the 1-dB C/No degradation metric ensures. The level of positioning accuracy required by the multitude of applications deploying GNSS receivers varies, and is highly dependent on the operational environment. The testing presented in the RAA Study does not address high accuracy positioning (i.e. at the centimetre level), or positioning in challenging environments typical of urban areas, with high multipath and frequent GNSS signal blockages from buildings and other structures.

³ RAA Study, Appendix D: High Precision Devices in Open Sky Conditions, pages 66-72.

⁴ RAA Study, Page 12.

⁵ RAA Study, page 4.

- NovAtel will point out that there appears to be no testing of other GPS + L-band receivers. There are many other receivers used for airborne purposes, survey or mobile mappers that require L-band correction data. The RAA Study appears to be devoid of any testing on the effect of Ligado's operations on other receivers that operate in the GPS + L-bands.
- Further, NovAtel would submit that not every GPS application will use the same measurements. The RAA Study assumes one level of positioning and accuracy is sufficient for every application when that is clearly not the case. Different applications, such as survey and measurement will require much greater positioning accuracy.
- NovAtel notes that the RAA Study did not look at GNSS systems operated by organizations outside of the United States, such as GALILEO or GLONASS or Beidou. NovAtel is aware of other users in the United States that utilize GALILEO, GLONASS and/or Beidou. In order to assess the risk of interference, NovAtel strongly suggests other systems should have been considered in the testing protocol.
- NovAtel queries the RAA Study wherein it is suggested that interference concerns could be limited by using a filtered or narrow band antenna. There is no explanation as to a program to retrofit narrowband antennas to the many existing GPS wideband receivers, how such a program will be implemented, nor who will be responsible for the expense of same. The assumption only by retrofitting existing GPS receivers with filtered antenna leads to compatibility with Ligado's intended operations ignores the practical effect of how such a program could be realized.
- The RAA report is also devoid of any high multipath environment testing. NovAtel submits that such multipath environment testing is critical for precision with wideband receivers. Indeed, wideband receivers operating in the GPS L1 band are a requirement for high multi-path environments. There is no analysis in the RAA Study to determine the effect of narrowing or filtering in the band and the effect on multipath performance. NovAtel notes that all of the testing in the RAA Study appears to have been carried out in "best case" conditions with no real world testing in a high multipath environment.
- Finally, NovAtel notes the RAA Study did not test GPS signal acquisition while LTE signals were present. The RAA Study is limited to testing the maintenance of the signal with adjacent LTE signals. There is no analysis of the effect of interference when GPS receivers are initialized and seek to acquire a GPS signal while LTE signals are present or what would happen if the GPS signal was lost and the receiver had to reacquire the GPS signal in the presence of LTE. Acquisition and reacquisition of a GPS signal place higher demands on a GPS receiver.

Comments on Potential Harmful Interference to GPS Receivers⁶

- NovAtel notes that Ligado has not indicated whether the intent is to use multi-band signals in the proposed 1526-1536 MHz band as well as 1670-1680 MHz⁷ in order to

⁶ NovAtel acknowledges the Commission's definition of "harmful interference" at 47 C.F.R § 2.1 (c).

communicate from the base stations to the LTE devices. If there are multi-band signals present in the intended band no apparent studies have been carried out on the effects of inter-modulation within that frequency range and potential interference to the GPS L1, L2 and L5 bands (as well as the bands of other GNSS systems). Ligado has not provided any information with respect to co-location of base stations operating at 1526-1536 MHz and 1670-1680 MHz and inter-modulation mitigation or any parameters that must be implemented to separate the proximity of the base stations to mitigate interference.

- There is no indication as to how base stations are intended to be dispersed in Ligado's operations.
- NovAtel adds that utilizing 1526-1536 MHz as a downlink will have serious impact on the MSS L Band signals operating in this area (i.e. Inmarsat operations 1526–1559 MHz). Many of NovAtel OEM products are highly sensitive by design to process Inmarsat signals in the MSS L-band and note that Ligado has provided no explanation or intended mitigation for interference in that frequency range.

NovAtel submits that the foregoing concerns with respect to potential harmful interference to GPS receivers have not yet been addressed by Ligado and represent a legitimate and ongoing concern should Ligado operate a terrestrial mobile network in the referenced MSS L-band frequencies.

Pursuant to section 1.1206(b)(2) of the Commissions' Rules, an electronic copy of this letter is being filed in the above-referenced proceedings.

Yours very truly,

McCarthy Tétrault LLP



Timothy St. J. Ellam, QC

TSE/crr

⁷ Comment Sought to Update the Record on Ligado's Request That the Commission Initiate a Rulemaking to Allocate the 1675-1690 MHz Band for Terrestrial Mobile use Shared With Federal use, Public Notice, RM-11681 (April 22, 2016).