

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
)	
Theia Holdings A, Inc.)	SAT-LOA-20161115-00121
)	
Application for Authority Launch and Operate)	
a Non-Geostationary Satellite Orbit System in)	
the Fixed-Satellite Service, Mobile-Satellite)	Call Sign: S2986
Service, and Earth Exploration Service)	
)	

REPLY TO CONSOLIDATED OPPOSITION AND RESPONSE

The GPS Innovation Alliance (“GPSIA”), pursuant to Section 25.154(d)¹ of the Commission’s Rules, submits this reply (“Reply”) to the consolidated opposition and response (“Opposition”) of Theia Holdings A, Inc. (“Theia” or “Applicant”)² concerning the above-referenced application (“Application”).³ GPSIA submitted a petition to deny or defer action (“Petition”) on the Application based on the failure of Theia to demonstrate the ability to operate its proposed non-geostationary satellite orbit (“NGSO”) constellation in the Earth Exploration-

¹ See 47 C.F.R. § 25.154(d).

² See Consolidated Opposition and Response of Theia Holdings, A. Inc., IBFS File No. SAT-LOA-20161115-00121, et. al. (filed July 7, 2017) (“*Theia Opposition*”).

³ See IBFS File No. SAT-LOA-20161115-00121 (“*Application*”); see also *OneWeb Petition Accepted for Filing*, IBFS File No. SAT-LOI-20160428-00041; *Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 10.7-12.7 GHz, 14.0-14.5 GHz, 17.8-18.6 GHz, 18.8-19.3 GHz, 27.5-28.35 GHz, 28.35-29.1 GHz, and 29.5-30.0 GHz Bands*, Public Notice, 31 FCC Rcd 7666 (IB 2016).

Satellite Service (active) (“EESS (active)”) 1215-1300 MHz band without causing harmful interference to Radionavigation-Satellite Service (“RNSS”) operations in the same band.⁴

GPSIA reaffirms that Theia’s proposed synthetic aperture radar (“SAR”) instruments will create harmful interference for RNSS operations, and requests denial of the Application or deferred action until Theia amends the Application to remove the 1215-1300 MHz band.

I. Theia’s Opposition Offers No Meaningful Technical Analysis Addressing the Serious Interference Concerns Raised by GPSIA

Instead of responding to GPSIA’s interference concerns with meaningful technical analysis, Theia cites outdated ITU reports and recommendations, makes unsupported assumptions concerning the technical and operating parameters of global navigation satellite system (“GNSS”) equipment making use of RNSS signals, and overstates the “success” of the *de minimis* non-commercial active EESS (active) operations in the 1215-1300 MHz band.

A. Theia Relies Upon Outdated ITU-R Reports and Recommendations Not Relevant for Evaluating the Aggregate Interference Threat Presented by its NGSO Network

In support of the assertion that its network is compatible with GNSS operations, Theia references certain ITU-R publications concerning interference from pulsed emissions.⁵ These materials, however, do not reflect current developments and intensive on-going ITU-R work on interference issues related to SAR instruments that operate in the EESS (active) 1215-1300 MHz band. The ITU-R, and in particular Working Party 7C, have made significant progress on the development of a comprehensive methodology to evaluate interference into GNSS receivers in

⁴ See Petition to Deny or Defer of the GPS Innovation Alliance, IBFS File No. SAT-LOA-20161115-00121 (filed June 26, 2017) (“GPSIA Petition”) The U.S. Global Positioning System (“GPS”) and other RNSS systems operate in the 1215-1300 MHz band around the world as part of the Global Navigation Satellite System (“GNSS”).

⁵ See *Theia Opposition* at 9-10.

the 1215-1300 MHz band from EESS-based SAR instruments in the same band.⁶ This methodology has been under development for several years and will supplement the long-outdated Recommendation ITU-R RS.1347 (published in 1998 based on work dating back to the mid-1990s) that Theia cites.⁷

Working Party 7C's contemporary interference analysis methodology calls for an evaluation of the impact of each proposed SAR instrument.⁸ If the evaluation shows an exceedance of the RNSS protection criteria, a more detailed analysis is required.⁹ In cases where a more detailed analysis is needed, the interference issues are addressed between administrations of the intended EESS (active) sensor and administrations of all affected RNSS systems and networks, "taking into account operational parameters of the EESS (active) SAR sensor, detailed RNSS receiver characteristics, and any other relevant factors."¹⁰ Critically, this methodology also calls, in the case of every SAR instrument evaluated, for an assessment of the aggregate impact on GNSS receivers of multiple SAR instruments. This aggregate impact assessment is particularly relevant in the instant context, where Theia seeks to operate 52 EESS (active) payloads simultaneously. The impact of Theia's multiple NGSO operations must be evaluated with existing and proposed EESS (active) missions and other ground-based radar systems.¹¹

⁶ See Document 7C/147, Annex 8, PRELIMINARY DRAFT NEW RECOMMENDATION ITU R RS.[EESS_SAR-RNSS], Method to evaluate interference into receiving earth stations in the radionavigation-satellite service (space-to-Earth) from spaceborne synthetic aperture radar sensors in the Earth exploration-satellite (active) service in the 1 215-1 300 MHz band (April 2017) ("*ITU-R 2017 SAR Recommendations*").

⁷ See, *Id.* GPSIA expects only minor revision to the forthcoming ITU-R SAR recommendations, which are presently near final form.

⁸ See, *Id.*

⁹ See, *Id.*, Recommends 2.

¹⁰ *Id.*, Recommends 3.

¹¹ See, e.g., *Id.*, Annex 8, Tables 1-9, Note 3.

Nothing in the record suggests Theia has undertaken such an analysis, or for that matter any other useful evaluation of the interference consequences resulting from a 52 satellite SAR deployment.

B. Theia's Claims of Compatibility are Based on Unsupported and Incorrect Assumptions about GNSS Operating Parameters

Theia argues that since its customers will require a “geo-referencing” capability to utilize Theia products, interference into GNSS systems would harm its own business interests.¹² It further argues that GPSIA has “sensationalized” its claims of interference because GNSS-type receivers enjoy supposedly “massive coding gain and interference rejection.”¹³ In neither instance does Theia provide any substantive basis for its assertions.

With respect to its own spacecraft design, Theia provides no meaningful way of confirming that interference to GNSS in the 1215-1300 MHz band would harm its self-interests. Theia does not confirm whether its spacecraft will transmit in the L2 band occupying 1215-1300 MHz. Nor does it provide any other technical specification or operating parameters for its receivers. The argument that interference into GNSS systems would harm its own self-interests is a hollow claim without specifics.

Theia similarly provides no technical showing to support its claims regarding GNSS receiver coding gain and interference rejection. Instead, Theia relies on assumptions from technical studies completed nearly 20 years ago during the infancy of civilian satellite navigation use as the basis for its understanding of GNSS receiver architecture.¹⁴ Given the changes in

¹² *Theia Opposition* at 9.

¹³ *Id.* at 11.

¹⁴ ITU-R RS.1347 was published in 1998.

equipment design (*e.g.*, wideband GNSS signals and augmented high-precision navigation receivers) and radiofrequency environment in the interim decades, such assumptions are not reasonable. Notwithstanding, Theia overstates the benefits and relevance of receiver coding gain to GNSS devices operating in the presence of pulsed emissions. Specifically, because GNSS receiver tracking loops have time constants longer than radar pulses, affected receivers may nominally maintain lock during radar-related interruptions. During such interruptions, however, loop noise will grow with increasing radar pulse duty cycle (“PDC”), leading to a commensurate decrease in C/No.

C. Theia Misrepresents the “Success” of Existing SAR Missions in the 1215-1300 MHz Band

Theia continues to tout the “success” of a small number of government-affiliated, scientific SAR satellite missions in the 1215-1300 MHz band as a basis for favorable action on its NGSO application.¹⁵ However, these missions present a meaningful and ongoing interference threat to GNSS. For example, with respect to the ALOS-2 spacecraft identified by Theia as a “success” story, the pulsed emissions from the ALOS-2 SAR payload can create approximately 2.9 dB of C/N_0 degradation to an affected GNSS receiver in combination with ground based radar.¹⁶ GNSS interests engaged in several years of direct interaction with the spacecraft operator to evaluate and rectify the potential harmful interference created by this system. Such a level of interference does not represent a “success,” and the fact that Theia proposes an ALOS-2 like spaceborne SAR instrument without being privy to the arrangements that were made to limit

¹⁵ See, *e.g.*, *Theia Opposition* at 13, asserting that ALOS-2 PALSAR payload “has been operating successfully since 2014 in a mode almost identical to that planned by Theia.”

¹⁶ Based on prior testing involving a pulse duty cycle of 0.07186, chirp frequency from the ALOS-2 of 14 or 28 MHz and a GNSS receiver under test with a front-end capable of tuning the GPS L2 and GLONASS G2 signals.

interference to GNSS receivers in the 1215-1300 MHz band provides no basis for action on the authority Theia requests.

Moreover, although the standard for harmful interference into RNSS is 1 dB of C/N_0 degradation, this does not mean that the entire 1 dB budget is allocated to pulsed interferers such as SARs. In fact, the maximum degradation permitted by pulsed sources is 0.2 dB, which is exceeded in Theia's proposed operating modes.¹⁷

D. Avoiding Overlap between SAR Sweeps Does Not Resolve Theia's Interference Problems

Theia argues that its "satellites will operate in sun-synchronous orbits,...creating limited regions where there is a possibility of two Theia radar-equipped satellites illuminating the same place at the same time."¹⁸ While GPSIA welcomes the additional narrative clarification regarding Theia's proposed orbital parameter, simply avoiding overlap between Theia SAR emissions does not solve the interference concerns raised by GPSIA. A single Theia satellite can and will create harmful interference, and the aggregate effects of a Theia SAR emission in combination with ground-based radar and/or other SAR emissions can create debilitating harmful interference that exceeds several dB depending on certain variables, including the SAR duty cycle, proximity of the radar, etc...

¹⁷ See ITU-R 2017 SAR Recommendations Document 7C/147, Annex 8, Tables 1-9.

¹⁸ *Theia Opposition* at 15.

II. Theia's Obligation to Protect Higher Priority Users is Non-Interference, Not Coordination

Theia makes repeated references to “coordinating” its approximately 60 satellites.¹⁹ As a secondary service, coordination is an interference avoidance mechanism not available to Theia. Instead, Theia’s obligation is to demonstrate that its proposed operations will not cause harmful interference to any system in a primary service – such as all GNSS systems in the 1215-1300 MHz RNSS band -- that is operating in accordance with its authorization.

Allocation of a given frequency band to a particular service on a primary basis entitles operators to protection against harmful interference from stations of “secondary” services. Further, secondary services cannot claim protection from harmful interference caused by a primary service. Co-primary status means that the services share a frequency band on an equal basis, that facilities will be protected based on the order in which the license applications are coordinated and authorized, and that the services have equal rights of protection against harmful interference from stations of secondary services.²⁰

With respect to the instant request, GNSS, including the GPS L2 signal, enjoys co-primary service status in the 1215-1260 MHz band with certain other federal services in the United States Table of Allocations²¹ EESS (active) is nominally co-primary with RNSS for federal systems, but is also subject to Footnote 5.332 to the International Allocation Table, which states that “[i]n the band 1215-1260 MHz, active spaceborne sensors in the Earth exploration-

¹⁹ Theia makes repeated reference to “coordination” between its proposed network in the 1215-1300 MHz band and other spectrum users in its Opposition; *see, e.g., Theia Opposition* at 14, asserting that “coordination [of its proposed constellation] is straightforward and essentially analogous to the coordination of communications links that occur every day among satellite operators.”

²⁰ *See* 47 C.F.R. §§ 2.104(d) and 25.105(c).

²¹ *See* 47 C.F.R. § 2.106.

satellite and space research services shall not cause harmful interference to, claim protection from, or otherwise impose constraints on operation or development of the radiolocation service, the radionavigation-satellite service and other services allocated on a primary basis.”²² In the U.S. Table of Frequency Allocations, non-federal EESS (active) systems such as Theia’s proposed SAR feature are secondary operations across the entire 1215-1300 MHz band. As such, Theia must demonstrate that its operations will protect all co-primary services from interference.²³ Accordingly, Theia’s obligation is to demonstrate protection through non-interference; it is not entitled to participate in a coordination among equals.

III. Conclusion

Based on the foregoing, the Commission should either deny Theia’s Application or defer action until Theia amends the Application and removes the proposal for SAR emissions in the 1215-1300 MHz band.

Respectfully submitted,

/s/_____

Mark N. Lewellen
GPS INNOVATION ALLIANCE

Dated: July 14, 2017

²² See, *Id.*, n. 5.332.

²³ The de minimis active EESS SAR systems operating in the 1215-1300 MHz band are government systems enjoying co-primary status in the United States but not elsewhere.

CERTIFICATE OF SERVICE

I, M. Renee Britt, hereby certify that on this 14th day of July 2017, I caused a true and correct copy of the foregoing GPS Innovation Alliance Reply to Consolidated Opposition and Response to be served via electronic mail and U.S. First Class mail, to the following:

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