Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Parts 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band	)	ET Docket No. 15-26
	)	
Amendment of Part 15 of the Commission's Rules to Permit the Operation of Vehicular Radar Services in the 77-78 GHz Band	)	RM-11666
	)	
Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band	)	ET Docket No. 11-90 RM-11555
	)	
Amendment of Section 15.253 of the Commission's Rules to Permit Fixed Use of Radar in the 76-77 GHz Band	)	ET Docket No. 10-28
	)	
Amendment of the Commission's Rules to Permit Radiolocation Operations in the 78-81 GHz Band	)	WT Docket No. 11-202

COMMENTS OF TRIMBLE NAVIGATION LIMITED

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SUMMARY

Trimble Navigation Limited appreciates and supports the FCC's efforts to examine how use of the 76-81 GHz band can be expanded to support additional radar applications. To maximize and promote even greater use of the spectrum, while still protecting the applications the Commission proposes for the band, the Commission should expand its regulatory framework to allow the 76-81 GHz band to be used for additional compatible uses, consisting of three dimensional scanning, surveying, mapping, and Geographic Information System data collection applications. These applications can easily coexist with other users of the band. *First*, these applications will generally be used inside buildings, on private property, and in other geographic areas where other radar applications are not present. *Second*, the scale of the applications will be limited such that they will create only a *de minimis* risk of interference. *Finally*, even where these additional applications are near other radar operations, they will operate under the same technical parameters as they do and can fit seamlessly into the existing interference mitigation scheme.

Allowing compatible radar services access to the 76-81 GHz band will serve the public interest. Permitting such uses will promote the availability of high-resolution and more accurate 3D imaging, increasing enterprise productivity and efficiency, and expand the geographic footprint of the services that can be offered using the 76-81 GHz band. Further, greater use of the 76-81 GHz band would create cost synergies and economies of scale that ultimately will reduce costs for all band users and increase consumer safety in particular for the automotive sector.

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COMMENTS OF TRIMBLE NAVIGATION LIMITED

Trimble Navigation Limited ("Trimble") submits these comments in response to the Notice of Proposed Rulemaking and Reconsideration Order ("*NPRM*") issued by the Federal Communications Commission ("Commission" or "FCC") in the above-referenced proceedings on February 5, 2015.[1/] The *NPRM* seeks comment on proposals to expand the use of the 76-81 GHz band, by making the entire band available for vehicular radars and radars at airports for foreign object debris ("FOD") detection and the sub-band 76-77 GHz band available for other fixed radars (outside of airports) and aircraft-mounted radars used only on the ground. Trimble applauds the FCC's efforts to make the full 76-81 GHz band available for various radar

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1/ *See Amendment of Parts 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band, et al.*, Notice of Proposed Rulemaking and Reconsideration Order, ET Docket No. 15-26, *et al.*, FCC 15-16 (rel. Feb. 5, 2015) ("*NPRM*").

applications. To maximize and further unlock the full potential of this spectrum, the Commission should adopt a regulatory framework that also allows the 76-81 GHz band to be used for three dimensional ("3D") scanning, surveying, mapping, and Geographic Information System ("GIS") data collection applications. These additional high-value, limited applications will promote greater use of the band without affecting existing and proposed operations.

I. INTRODUCTION

Founded in 1978, Trimble is a leading provider of advanced positioning solutions using GPS, laser, optical, and inertial technologies. Trimble integrates such technologies with application software, wireless communications, and services to provide complete commercial solutions and to make field and mobile workers in businesses and government significantly more productive. Its integrated solutions not only allow customers to collect, manage, and analyze complex information faster and easier, but also makes them more efficient, effective, and profitable. Trimble's products are used in over 100 countries around the world, and it has offices in over 35 countries, along with a highly capable network of dealers and distribution partners. Trimble's portfolio includes over 1,000 unique patents and serves as the basis for the broadest array of offerings in the industry.

Trimble already provides customers with innovative applications that increase productivity in the scanning, surveying, mapping, and GIS data collection industries. For instance, it offers a mobile mapping application that allows users to collect geospatial data rapidly and cost-effectively convert that data into high-resolution models, which can be used for planning, designing, building and maintaining infrastructure.[2/] Trimble's Indoor Mobile Mapping Solution similarly allows users to capture spatial data indoors and provides spherical

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[2/] *See* Trimble, *Land Mobile Mapping & Survey* (2011), *available at* http://www.trimble.com/imaging/pdf/Trimble_Land_Mobile.pdf.

video, enabling the creation of accurate, real-life representations of interior spaces.[3/] In addition, Trimble provides, as an augmentation to terrestrial photogrammetric systems, surveying applications that enable surveyors to take panoramas of sites and accurately generate data.[4/] It has also developed applications that allow GIS professionals to capture images in the field and create complete databases of those images.

However, these applications and others can be improved if they are augmented using radar technology.[5/] Among other benefits, images and data gained through the use of radar may be fused with photogrammetric data to more reliably produce high-resolution and more accurate 3D imaging, particularly if the entire 76-81 GHz band is available. Unlike traditional photographic imagery, radar provides instantaneous depth and scale in the frame. Advanced remote feature extraction and mapping will also be possible, increasing productivity and safety for GIS workers. As demonstrated below, these additional applications are entirely consistent with the existing and anticipated uses of the band as well as the Commission's goal of making more intense use of the spectrum. Accordingly, Trimble is pleased to have the opportunity to submit these comments and urges the Commission to modify its proposed rules to accommodate 3D scanning, surveying, mapping, and GIS data collection radar applications in the full 76-81 GHz band.

3/ *See* Applanix, *TIMMS™: Fast, Accurate & Cost-Effective Indoor Mapping* (2013), *available at* http://www.applanix.com/media/downloads/products/brochures/TimmsBrochure_web.pdf.

4/ *See* Trimble, *Trimble V10 Imaging Rover; User Applications* (2014), *available at* http://trl.trimble.com/docushare/dsweb/Get/Document-687844/022516-012B_TrimbleV10_BRO_0914_LR.pdf.

5/ This proceeding provides a unique opportunity to deploy radar technologies for these applications. While there are bands below 76 GHz that are generally available for radar operations, none provide the bandwidth that the 76-81 GHz band would provide. The wide bandwidth potentially available in that spectrum is critical to the ability to provide high-resolution imaging. Technology has not yet been developed that would permit the implementation of radar for these applications above 81 GHz.

II. THE FCC SHOULD ALLOW COMPATIBLE RADAR APPLICATIONS IN THE 76-81 GHz BAND

The FCC explains that the 76-77 GHz band is currently designated for use under Part 15 of the rules on an unlicensed basis for long-range vehicular radars ("LRR").[6/] FOD detection radar use – a fixed radar service – is also permitted at airports in the 76-77 GHz band under Part 15 of the FCC's rules on an unlicensed basis and in the 78-81 GHz band under Part 90 of the rules on a licensed basis.[7/] Level probing radars ("LPRs"), including tank LPRs ("TLPRs"), are permitted to operate in the 77-81 GHz band on an unlicensed basis under Part 15 of the rules.[8/] Moreover, the Radio Astronomy Service ("RAS") has a mix of primary and secondary allocations that span the 76-81 GHz band, and the FCC allows Amateur radio use within the full 76-81 GHz band.[9/]

In response to several petitions seeking additional use of the 76-81 GHz band, the FCC now proposes to make the 76-81 GHz band available for all vehicular radars.[10/] Specifically, it proposes to permit licensed use of the band for all vehicular radars by rule under Part 95 and migrating existing Part 15 76-77 GHz vehicular radar services there.[11/] Similarly, the Commission proposes to consolidate FOD detection radar operations that are currently permitted under Part 15 in the 76-81 GHz band under Part 95.[12/] The FCC notes that vehicular radar use in the newly available 77-81 GHz band will be compatible with FOD detection radars and LPR

6/ *See NPRM* ¶ 6.

7/ *See id.* ¶¶ 14-15.

8/ *See id.* ¶ 23.

9/ *See id.* ¶¶ 21-22.

10/ *See id.* ¶¶ 28-32.

11/ *See id.* ¶¶ 37-42.

12/ *See id.* ¶¶ 45-49.

devices (as well as RAS and Amateur operations) in that range and *vice versa*.[13/] Finally, the Commission proposes rules to permit fixed infrastructure radar applications outside of airport settings and seeks comment on expanding the use of the 76-77 GHz band for aircraft-mounted radars used only on the ground.[14/]

While Trimble supports the Commission's proposals, the band can and should support additional compatible applications like 3D scanning, surveying, mapping, and GIS data collection. As Trimble demonstrates below, the additional uses Trimble proposes will not degrade either existing or proposed uses of the band. To the contrary, the public interest would be best served by the Commission making the most intense use of the band possible, while preserving a workable interference environment.

A. Allowing Additional Applications in the 76-81 GHz Band is Technologically Feasible and Consistent with FCC Precedent.

The FCC has historically favored expanding use of the 76-81 GHz band for newly proposed applications so long as those applications are compatible with existing operations. For instance, in initially permitting LRRs in the 76-77 GHz band, the FCC was optimistic that "there will be non-vehicle radar systems which can successfully operate in these bands without causing interference."[15/] In permitting LPRs in the 75-85 GHz band, the FCC emphasized that expanded

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13/ *See id.* ¶ 35.

14/ *See id.* ¶¶ 50-55, 56-61.

15/ *Amendment of Parts 2, 15, and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz for New Radio Applications*, First Report and Order and Second Notice of Proposed Rule Making, 11 FCC Rcd. 4481, ¶ 20 (1995); *see also Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band; Amendment of Section 15.253 of the Commission's Rules to Permit Fixed Use of Radar in the 76-77 GHz Band*, Notice of Proposed Rulemaking, 26 FCC Rcd. 8107, ¶ 17 (2011) (proposing to allow the use of fixed radar systems at any location even though, up to that point, interested parties had only requested use of the band for fixed radars at airports for monitoring terrestrial vehicle movements). While the Commission ultimately limited FOD radars to airports, it noted that "no parties have come forward to support fixed radar applications beyond airport locations in this band." *Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band; Amendment of*

use of the band would benefit the public without causing harmful interference to authorized services.[16/]

The Commission has typically used two criteria to determine if new applications in the 76-81 GHz band are compatible with existing operations. First, it evaluates whether the new application will be located geographically near existing uses. Second, it determines whether the application can be operated under technical parameters similar to already-authorized operations. For example, in approving the use of FOD detection radars at airport locations in the 76-77 GHz band, the FCC reasoned that "[a]irport runways, taxiways and other non-public areas at airports are generally not near public roadways, and fixed radars at airports should not illuminate public roadways in the vicinity" and that fixed FOD detection radars could operate under similar technical parameters as vehicular radars in the band.[17/]

Similarly, the FCC approved the deployment of LPRs in the 76-81 GHz band because they would be at fixed locations with antennas that point downward and thus would be unlikely to cause interference to others. In the context of TLPRs, which were initially allowed in the 77-81 GHz band before the Commission allowed LPRs more generally in the entire 75-85 GHz band, the Commission explained that the risk of interference would be minimized since those TLPRs would be mounted in storage tanks at fixed locations away from other users; installed by trained professionals; and undergo compliance test procedures to ensure that the device, storage

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Section 15.253 of the Commission's Rules to Permit Fixed Use of Radar in the 76-77 GHz Band, Report and Order, 27 FCC Rcd. 7880, ¶ 26 (2012) ("*2012 Order on FOD Radars in 76-77 GHz*").

16/ *See Amendment of Part 15 of the Commission's Rules to Establish Regulations for Tank Level Probing Radars in the Frequency Band 77-81 GHz, et al.*, Report and Order and Order, 29 FCC Rcd. 761, ¶ 2 (2014) ("*2014 Order on LPRs*").

17/ *See 2012 Order on FOD Radars in 76-77 GHz* ¶ 26 (finding that "vehicular radars should be able to share the band with fixed radars operating at the same levels" since "there are no conclusive test results indicating that there would be incompatibility issues between the two types of radars").

tank, and installation all meet the FCC's emissions requirements.[18/] The FCC likewise determined that LPRs more broadly could co-exist successfully with vehicular radars because they would be installed in downward-looking positions at fixed locations and because the extreme propagation losses of radio signals at these frequencies would mitigate any potential harmful interference beyond a very short distance from the LPR device.[19/] The FCC also found that LPRs could co-exist with FOD detection radars because LPRs would most likely not operate in the same geographic location and, even if they did, the potential for harmful interference would be "extremely unlikely" given the substantial free-space propagation losses and the extremely narrow beamwidths of the FOD radars.[20/]

For similar reasons, the applications that Trimble has developed will be compatible with existing and other proposed radar uses of the band. *First*, the applications that Trimble envisions will not generally be used in geographic areas where vehicular radars, airport FOD detection radars, LPRs, or others are present. To the contrary, those applications will primarily be used for mapping and surveying purposes inside buildings, on private property, or other locations beyond roadways, airports, and other fixed radar locations such as storage tanks. Such use is expected to occur off of highways and out of range of vehicular radars, airport FOD detection radars, LPRs, and other operations. As explained further below, even where the proposed applications are used near vehicular or other radars, the probability of an individual user (*e.g.*, surveyor) causing interference to such radars will be relatively low. Moreover, no matter where they are deployed, the proposed applications will be employed by trained professionals to ensure that they function

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18/ *See Amendment of Part 15 of the Commission's Rules to Establish Regulations for Tank Level Probing Radars in the Frequency Band 77-81 GHz, et al.*, Notice of Proposed Rulemaking and Order, 25 FCC Rcd. 601, ¶ 36 (2010) ("*2010 NPRM and Order on TLPRs*").

19/ *See 2014 Order on LPRs* ¶ 29.

20/ *See id.*

as intended and in compliance with the FCC's rules, and the propagation losses of radio signals at these frequencies will further reduce the risk of interference.

Second, the scale of the applications that Trimble proposes creates only a minimal risk of interference. Trimble recognizes that even compatible technologies may increase the risk of interference. However, that risk does not exist here because, compared to already anticipated uses, the additional proposed uses would be *de minimis.* For instance, while millions of vehicles are expected to be produced that will use radar applications in the 76-81 GHz band,[21/] the applications that Trimble proposes are expected to be utilized by tens of thousands of specialized users on an intermittent and geographically dispersed basis. Thus, to the extent that those applications operate near vehicular or other radars, the presence of those operations would, as a practical matter, be negligible relative to, for example, the number of vehicles in proximity to one another.

Finally, the technologies in the applications that Trimble proposes will be nearly identical to those used in vehicular radar applications, and thus will be technically compatible with vehicular radars as well as airport FOD detection radars, LPRs, RAS, and Amateur operations.[22/] Because of this technical compatibility, the additional proposed use should have no discernable impact on existing or proposed operations. The anticipated applications are designed to perform similar tasks and can operate under the same power levels and other technical parameters applicable to vehicular and other radars. Indeed, the ERP of Trimble's sensors will actually be

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21/ *See, e.g.*, Traffic Safe, *Automotive Radar Sensor Shipments Reach 1 Million Milestone* (Aug. 22, 2014), *available at* http://trafficsafe.org/index.php/automotive-radar-sensor-shipments-reach-1-million-milestone-8193/.

22/ The FCC has recognized that vehicular radars are compatible with airport FOD detection radars, LPRs, RAS, and Amateur operations. *See NPRM* ¶¶ 34-36. It follows that if Trimble's applications are compatible with vehicular radars, they will also be compatible with airport FOD detection radars, LPRs, RAS, and Amateur operations.

lower than that of vehicular radars. Vehicular radars typically scan environments horizontally in order to identify objects for collision avoidance. Because the applications that Trimble proposes will be used for, among other things, 3D mapping, they will incorporate *both* horizontal and vertical scanning capabilities. These capabilities, in turn, require the use of phased array antenna that can steer the beam both vertically and horizontally. Even though the EIRP for the beam will be similar to the beam used in vehicular radars, the ERP will actually be lower because the beam steering will cover a larger area over a longer period of time.

Similarly, those applications will fit seamlessly into the current interference mitigation scheme for radars. Today's vehicular radars operate a passive co-existence and interference mitigation scheme that utilizes frequency modulated continuous wave ("FMCW") technologies that transmit and receive frequency sweeps, not just radar pulses, to determine the presence of objects.[23/] The applications that Trimble proposes will use identical interference mitigation techniques.[24/]

B. The Public Interest Will Be Served if Other Compatible Uses are Permitted.

Not only will deployment of additional applications in the 76-81 GHz band be compatible with other uses in the band, it will also serve the public interest in several ways. Allowing other compatible radar services access to the 76-81 GHz band will enable greater use of the frequencies in ways that benefit the public. As noted above, these applications will

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23/ *See, e.g.*, Freescale, Automotive Radar Millimeter-Wave Technology, http://www.freescale.com/webapp/sps/site/overview.jsp?code=AUTRMWT (last visited Mar. 31, 2015); radartutorial.eu, Vehicular Radar, http://www.radartutorial.eu/02.basics/Automotive%20Radar.en.html (last visited Mar. 31, 2015).

24/ In order to further reduce interference to FMCW radars, a random coding scheme, such as random frequency hopping mechanisms used by Bluetooth technologies employed in the 2.4 GHz band, could be overlayed to the waveform used in 3D scanning, surveying, mapping, and GIS data collection applications. *See generally* maxim integrated, *An Introduction to Spread-Spectrum Communications* (Feb. 18, 2003), *available at* http://www.maximintegrated.com/en/app-notes/index.mvp/id/1890 (discussing spread spectrum methods that include frequency hopping).

generally be employed in geographic areas where vehicular, airport FOD detection radars, and LPRs are not present, thereby expanding the geographic footprint of the services that can be offered using the 76-81 GHz band. If the 76-81 GHz band is dedicated for compatible radiolocation operations, the public interest favors the broadest geographic use.

Moreover, greater access to the 76-81 GHz band would create cost synergies that will benefit all users – including the automotive industry. Increased applications will create greater demand for chipsets, decreasing prices and permitting economies of scale that will enable radar technology to be available even in the most inexpensive vehicles and promoting consumer safety. Manufacturers can leverage the technological design work and other efforts already undertaken by the automotive industry to cost-effectively develop their compatible applications. Use of these existing technologies for additional applications will result in cost savings to businesses that use these products and services while at the same time increasing their efficiency and productivity.

III. THE PROPOSED RULES MUST BE MODIFIED TO PROVIDE NEEDED CLARITY

Two of the proposed rules address eligibility to use the 76-81 GHz band. It appears, however, that those rules are not consistent and neither explicitly permits the use of 3D scanning, surveying, mapping, and GIS data collection applications. Section 95.401(h) of the proposed rules provides that "[t]he 76-81 GHz Radar Service applications include, but are not limited to, vehicular radars and aircraft-mounted radars used for collision avoidance and other safety applications, as well as fixed radars used for foreign object debris detection at airports and for other purposes."[25/] That wording (which includes the "but are not limited to" savings clause) would arguably permit the type of applications that Trimble envisions. In contrast, Section

25/ *NPRM* at Appendix B at 4.

95.1601 the FCC's proposed rules permits only specified types of radars in the 76-81 GHz band.[26/]

This inconsistency should be reconciled to create a clear framework, which will support additional investment in the 76-81 GHz band. The Commission should eliminate the doubt that proposed rule Section 95.401 would create by specifying the additional eligibility that Trimble proposes. Accordingly, the Commission should modify both proposed rules by making clear that 3D scanning, surveying, mapping, and GIS data collection radar operations are permitted.

The Commission should *not* simply invite waivers of the rule to cover additional proposed uses. This approach would, contrary to the public interest, discourage use of the band. Requests for waivers are burdensome and administratively inefficient for the FCC to process. Indeed, even though the FCC released an Order allowing parties to seek waivers to manufacture, certify, and market TLPRs in the 77-81 GHz band, few parties submitted such waiver requests.[27/] In contrast, upfront rules that allow for additional, limited compatible radiolocation services in the 76-81 GHz band will create greater certainty and promote investment and innovation. As the FCC recognized in expanding use of the 75-85 GHz band for LPRs more generally, a broader set of rules will allow for more diverse applications and consistent requirements that allow manufacturers to take advantage of economies of scale.[28/] There is no reason for the FCC to limit radiolocation services in these frequencies to the applications listed, particularly if other compatible applications can be deployed without causing harmful interference to others.

26/ *See id.* at Appendix B at 7.

27/ *See 2010 NPRM and Order on TLPRs* ¶ 25.

28/ *See 2014 Order on LPRs* ¶ 13.

IV. CONCLUSION

Trimble appreciates the FCC's efforts to examine use of the 76-81 GHz band and expanding its use for radar applications. The FCC's proposals can be expanded to make more complete use of the band without affecting existing and proposed users. In particular, because the Commission can permit the use of 3D scanning, surveying, mapping, and GIS data collection applications to be deployed in the spectrum without causing harmful interference to existing or proposed operations, the Commission should allow those applications as well. Trimble looks forward to working with the Commission to further explore these possibilities.

Respectfully submitted,

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