Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Request by Piper Networks, Inc.	)	ET Docket No. _____
For Waiver of Sections 15.250(c)-(d) and	)	
15.519(a) of the Commission's Rules	)	

To: Chief, Office of Engineering and Technology

REQUEST FOR WAIVER

Piper Networks, Inc. ("Piper"), pursuant to Section 1.3 of the Commission's rules, respectfully requests a waiver of Sections 15.250(c)-(d) and 15.519(a)(2) of the Commission's rules (the "Waiver").[1] The Waiver would permit Piper's installation of an ultra-wideband ("UWB") train positioning system as fixed wireless infrastructure under the handheld UWB device rules in the 3200-3700 MHz and 4243-4743 MHz bands or under the wideband device rules with additional power in the 6240-6740 MHz band.[2] More specifically, the Waiver allows the installation of Piper's UWB equipment on subway and commuter train lines in urban and outdoor areas and the creation of an enhanced transit location system ("ETLS"). The ETLS will enable the transmission of train positioning data and tracks a subway or train's location at all times down to the centimeter.

The Waiver will serve the public interest by: (1) promoting safety for railway passengers and personnel by helping to place more trains into service, helping prevent train-to-train collisions,

[1] 47 C.F.R. §§ 15.250(c)-(d), 15.519(a)(2).

[2] 47 C.F.R. §§ 15.519(a)(2) and 15.250(c)-(d), respectively.

and identifying unauthorized train movements in work zones; (2) enabling Communication Based Train Control ("CBTC") and Positive Train Control ("PTC") to be deployed on public transit and short rail train systems in a cost-effective manner; and (3) advancing the Commission's efforts to support railway system compliance with Congressional mandates to implement PTC systems.[3] Additionally, the Waiver will not undermine the purpose of Sections 15.250(c)-(d) or 15.519(a)(2), which were adopted to prevent both interference with primary services and the creation of large-scale UWB communications systems.[4]

I. BACKGROUND

A. Piper Networks

Piper is a San Diego based company specializing in proximity solutions for transit and airport authorities, warehouses and manufacturing facilities, smart cities, healthcare, and other enterprises needing real-time location awareness and data capturing. Piper has developed and will test the ETLS, a UWB train positioning technology, as part of a pilot program with various train services. This system is cheaper, easier to operate, and can be installed faster than traditional positioning systems. This makes ETLS ideal for rail and subway systems of all sizes and can be easily integrated into both new and existing transit structures. Piper's worker protection and collision avoidance solutions also help transit and freight organizations better protect and monitor rail and subway workers. Most importantly, Piper's ETLS mitigates subway and rail travel's inherent risk by addressing concerns and requirements mandated by Congress in the RSIA.

[3] *See* Railroad Safety Enhancement Act of 2008 (Pub. L. 110-432) Section 104 ("RSIA").

[4] *See Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153, First Report and Order, 17 FCC Rcd 7435 (2002) at ¶¶ 18, 199 ("UWB Order").

Piper first developed ETLS as part of an underground test, or proof of concept, on the Times Square Shuttle track in New York City in 2018 and determined that UWB could reliably measure a train's position along an underground track. Based on the initial success of this proof of concept, Piper was tasked with a second proof of concept to demonstrate the integration of UWB positioning with established CBTC signaling technology, PTC, and automated train operation also deployed exclusively underground.

On July 1, 2019, Piper will begin additional testing of the ETLS in accordance with a grant of special temporary authority from the Commission's Office of Engineering and Technology.[5] This testing will last six months and will occur partially outdoors in order to further confirm no interference from the ETLS system to other Commission licensees. If Piper's testing is successful, implementing CBTC and UWB technology by using ETLS could dramatically decrease the time and economic resources required to modernize subway and train systems around the country.

B. ETLS

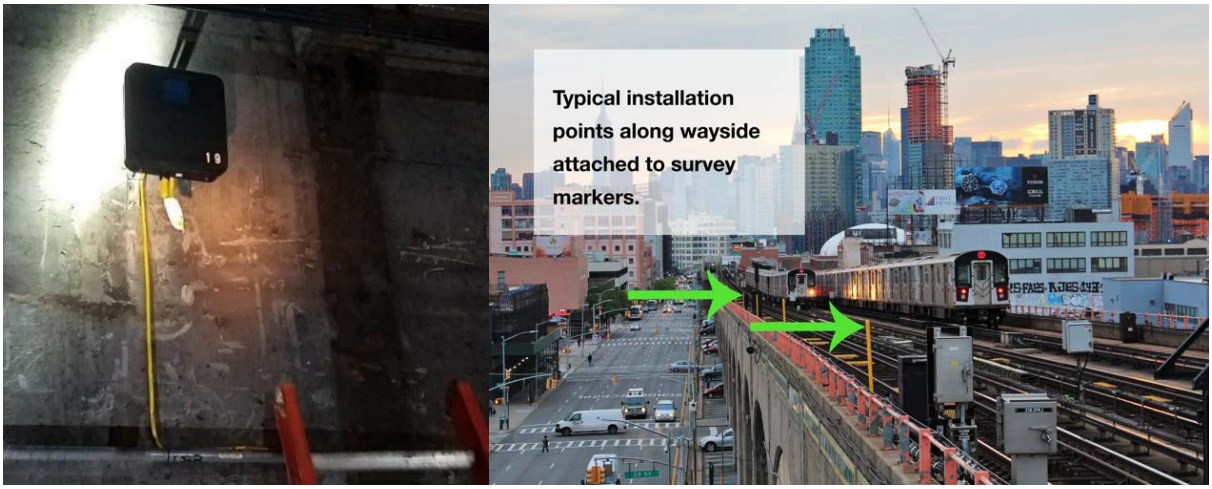
ETLS is a modular system that uses UWB radios to wirelessly transmit communications between trains, the wayside of tracks, and on-train positioning systems. ETLS consists of three component parts: tags, anchors, and tag controllers.

Tags

Tags mounted on the front and back of a train are responsible for ranging to and collecting distance information from the anchors located along the tunnel perimeter walls using a UWB radio and a directional antenna. This radio and antenna produce a radiation cone that is very narrow and positioned to direct its signal along the corridor of a train or subway's rail lines. Tags are very small in size and measure less than the size of a personal laptop computer.

[5] *See* Call Sign WO9XHG, File No. 0630-EX-ST-2019, granted April 25, 2019 ("STA Grant").

Anchors



Anchors installed in fixed positions adjacent to the tracks provide UWB ranging responses to tags and are positioned at different distance intervals along the track at the height of the train.[6] An anchor houses two UWB radios that are able to operate between the frequency ranges of 3200-3700 MHz, 4243-4743 MHz, and 6240-6740 MHz (Channels A, B, and C, respectively). Some anchors will also be positioned outside on stationary infrastructure as pictured above. Besides periodic system status signals, anchors do not emit a signal if there is no operating train with a tag in the vicinity.[7] Thus, the ETLS will comply with Section 15.519(a)(1) of the Commission's rules because any transmission will receive acknowledgment and cease transmission in far less than 10 seconds.[8] Anchors are also relatively small and comparable in size to a personal laptop computer.

[6] Anchor interval distances depend on whether a track is straight or winding. The straighter the track, the less anchors are needed to safely operate the ETLS.

[7] These periodic status signals are a safety precaution to identify if another anchor in the vicinity is malfunctioning or has been dislocated from its intended position. Status signals are similar in strength and duty cycle to signals that occur when a train is passing. The only difference is that in a status check, an anchor is transmitting to another receiving anchor instead of to a passing train's tags.

[8] *See* 47 C.F.R. § 15.519(a)(1).

Tag Controllers

The tag controller is found onboard the train and is the processing unit for ranging data to compute trilateration. Tag controllers also send and receive network data from the train to the vehicle on-board computer ("VOBC").

How the Positioning Works

The interaction between anchors mounted on the walls of the tunnel and tags installed on the train facilitates the geolocation of a specific train. As a train moves through the tunnel or along the tracks, distance is measured between anchors and tags using a calculation based on the time-of-arrival of a low-power radio pulse of EIRP -41.3 dBm (a slightly increased power level of -35.3 dBm is required to operate on Channel C in the 6240-6740 MHz range). The tag controllers then use the ranging data, the known positions of the anchors, and a mathematical model of the track to compute the train's location. This information is passed to the VOBC where it is processed with data from other on-board sensors to provide positioning information to the CBTC system.

II. REQUEST FOR WAIVER

The Commission may grant a waiver of its rules if good cause is shown.[9] More specifically, the Commission "may exercise its discretion to waive a rule where particular facts would make strict compliance inconsistent with the public interest."[10] There is established precedent for waiver of the Commission's rules in specific cases if the Commission determines that grant of the waiver would serve the public interest without undermining the policy that the

[9] 47 C.F.R. § 1.3.

[10] *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990), citing *WAIT Radio v. FCC*, 418 F.2d 1153, 1159 (D.C. Cir. 1969).

rule is intended to promote.[11] Additionally, the Commission must explain why deviation from the rule better serves the public interest and explain the circumstances under which the waiver is granted to prevent discriminatory application and put future parties on notice regarding its application.[12]

Grant of the Waiver to Piper would serve the public interest while not undermining the purpose of the rules. First, it would directly enhance rail safety, which has long been a key objective of both Congress and the Commission. Additionally, Piper's technology is specifically adapted to reduce the likelihood of interference while adhering to UWB rules, but for the Waiver's requests. As explained above, the main purpose of the rules prohibiting fixed installation of UWB equipment was to prevent the construction of largescale UWB communications systems.[13] The Waiver does not alter the Commission's ability to determine which channel(s) are safest to use so that Piper's technology does not interfere with the services of other licensees. There is also no intent to install Piper's UWB devices in any locations except the wayside of rail systems. Thus, Piper's proposed ETLS cannot be used as a large-scale UWB communications system.

A. Grant of Waiver of Section 15.519(a)(2) to Permit Piper's Proposed Use of Channel 1 or Channel 3 is in the Public Interest.

Piper is currently testing its UWB equipment on three different channels in the frequency ranges of 3200-3700 MHz, 4243-4743 MHz, and 6240-6740 MHz. While testing will occur on multiple channels, only one channel is required for use in a permanent ETLS when it is built. This decreases the possibility of a grant of the waiver resulting in interference to licensees in the C-

[11] *See WAIT Radio*, 418 F.2d at 1157.

[12] *Northeast Cellular Tel.*, 897 F.2d at 1166.

[13] UWB Order, ¶ 18.

Band. To date, testing has determined that the 3200-3700 MHz band ("Channel A") offers the strongest signal propagation. The 4243-4743 MHz band ("Channel B") also offers strong propagation characteristics, although not as strong as those in Channel A. In the event the Commission does not waive Section 15.519(a)(2) for either Channel A or Channel B, Piper respectfully requests the Commission waive Sections 15.250(c)-(d) for the 6240-6740 MHz band ("Channel C"). Channel C is the weakest channel to use for the ETLS, but it can be effective if operating at authorized power levels above what is currently permitted by the Commission's wideband rules.[14]

Access to Channel A or Channel B is sought to operate the ETLS. While Channel A offers superior propagation characteristics best suited to ETLS, Piper respectfully requests access to Channel B as well. Both channels only require a waiver of Section 15.519(a)(2) to operate under UWB rules for handheld devices using fixed infrastructure, and Piper's technology produces a very low power emission that will be confined to the wayside of tracks and subway tunnels.

Piper's UWB devices do not undermine the Section 15.519(a) requirement that UWB devices be handheld.[15] These devices are equivalent or smaller in size to a personal laptop computer,[16] and they are also smaller in cubic inches than the train-mounted units or wayside anchors described in Metrom Rail LLC's ("Metrom") pending waiver request.[17] While tags or anchors will be affixed to a train, tunnel wall, or short structure outside, they will function

[14] *See* 47 C.F.R. § 15.250(c)(1).

[15] *See* 47 C.F.R. § 15.519(a).

[16] *See* 47 C.F.R. § 15.503(m). The Commission makes a comparison to a "lap top computer" in its definition of "Hand held."

[17] *Request by Metrom Rail, LLC For Waiver of Sections 15.519(a) and 15.519(c) of the Commission's Rules,* Docket No. OET-18-284, Request for Waiver, pg. 12 (filed Sept. 4, 2018).

essentially the same as handheld devices because of their size.[18] Additionally, transmissions between train-mounted tags and wayside-mounted anchors will operate on a peer-to-peer basis. The anchors (the only devices that remain fixed in the ETLS) function when a train is operating and passing by their immediate vicinity. They do not emit a signal when (i) there are no trains moving nearby or (ii) if a train is nearby but is halted and not in operation – except to provide periodic system status signals as mentioned above. Thus, the anchors fully comply with Section 15.519(a)(1) of the Commission's rules.[19]

The installation of Piper's anchors to either a train or fixed structure indoors or outside also does not undermine Section 15.519(a) and its intent. This rule was meant to deter the creation and use of large scale communications infrastructure that would emit signals and interfere with primary services.[20] First, the signals emitted by Piper's UWB devices are very low power and operate at an EIRP of -41.3 dBm with a duty cycle of 0.6%.[21] This power level conforms to the current UWB handheld rules and mitigates against the possibility of interference. Second, the ETLS is confined to and only used in transportation systems such as subways and commuter rail lines. There is no need for fixed infrastructure outside of these limited transportation corridors, which, even in an urban areas, are insulated by man-made and natural structures.[22] Third, most of the signals emitted

[18] Much smaller devices have also been developed that can be worn by rail workers to warn them if a train is approaching.

[19] 47 C.F.R. § 15.519(a)(1).

[20] UWB Order at ¶ 18.

[21] 47 C.F.R. § 15.519(c). *See also Request by iRobot Corporation for Waiver of Section 15.250(c) of the Commission's Rules*, Request for Waiver, ET Docket 15-30, note 5 (filed Jan. 22, 2015). iRobot's technology had an operating duty cycle similar to Piper's.

[22] *See* n. 21 for an example of the Commission waiving Section 15.250(c) because of the insular effect of these structures.

by ETLS and its fixed infrastructure are focused directionally down a track in a narrow beamwidth.[23] Anchors will also only be installed as high as the height of a train. This means there will be little to no "bleed over" effect of any signals into other space outside of a specific train corridor and its wayside.

Piper will ensure its UWB devices can operate on multiple channels, although ETLS only requires one channel to function effectively. Piper is not requesting a waiver of the Commission's authorized power levels for UWB devices to operate on Channel A and Channel B.[24] This dramatically decreases any risk of interference to other frequency users. Piper's ETLS is a solution to the nation's growing transportation safety and traffic problems that is inexpensive, replicable, and reliable. Failing to grant the Waiver would be contrary to the public interest and unduly burdensome given Piper's innovative ability to adhere to UWB power levels while enabling a service that contributes to the safety of life and property.

B. Grant of a Waiver of Sections 15.250(c)-(d) to Permit Piper's Proposed Use of Channel 5 is in the Public Interest.

In the alternative, Piper requests access to Channel C to operate the ETLS if the Commission does not grant the Waiver for either Channel A or Channel B. Section 15.250(c) of the Commission's rules prohibits "fixed outdoor infrastructure" when using wideband spectrum while Section 15.250(d) limits EIRP power levels to -41.3 dBm in the 5925-7250 MHz frequency

[23] The size of this beamwidth is many degrees smaller than Metrom's and is found in Piper's STA Grant; *See also Amtrak Request for Waiver, ET Docket No. 16-415*, Letter from Julius P. Knapp, Chief, Office of Engineering and Technology, 32 FCC Rcd 4592, 4594-95 (Jun. 1, 2017) (allowing broadband radios to be mounted on a moving train that would communicate with trackside pole-mounted transmitters because transmissions would be within the track right of way and directionally focused).

[24] 47 C.F.R. § 15.519(c).

range.[25] These rule sections seek to avoid interference to existing authorized services, including cellular, PCS, and GPS systems employed in E-911 applications, by preventing the creation of large scale or wide area communications systems and networks.[26] In addition to requiring a waiver of the wideband fixed infrastructure rule similar to that required for Channel A and Channel B, operating on Channel C also requires a waiver of the power limits to increase EIRP by 6 dBm.

A waiver of Section 15.250(c) should be granted in Channel C for the same reasons Section 15.519(a)(2) should be waived for Channel A and Channel B.[27] There is also precedent for waiving the fixed infrastructure prohibition with respect to Channel C. In iRobot Corporation's ("iRobot") waiver, the Commission granted use of fixed infrastructure in Channel C for the use of a robot lawn mower to reduce lawn mowing related deaths and injuries.[28] Similar to iRobot's UWB antennas, Piper's ETLS will use directional antennas that only transmit horizontally and at the height of a train.[29] Similarly, the Commission granted 32 Technologies LLC a waiver allowing use of fixed infrastructure to track pet collars within a containment zone.[30] Both of these waiver grants relied, in part, on the rationale that the fixed wideband infrastructure would be limited and

[25] 47 C.F.R. § 15.250(c)-(d).

[26] *See* UWB Order at ¶¶ 18, 199.

[27] *See supra* Section II. A.

[28] *See iRobot Corporation Request for Waiver of Section 15.250 of the Commission's Rules,* Order, 30 FCC Rcd 8377, ¶ 1 (OET 2015) ("iRobot Waiver").

[29] *Id*. at ¶ 8.

[30] *See 32 Technologies LLC Request for Waiver of Part 15 of the Commission's Rules Applicable to Wideband System,* Order, 33 FCC Rcd 11662 (Nov. 30, 2018).

narrowly confined.[31] The ETLS's UWB signals will be restricted to a local area that is often underground, making the ETLS similarly confined and its devices sufficiently limited in number.

Piper also requires a higher power level for Channel C use than is currently permitted under Section 15.250(d). If operating on Channel C, the ETLS requires an additional EIRP of 6 dBm to operate at a power level of -35.3 dBm. The signals created in Channel C have a lower propagation strength than those in Channel A and Channel B. Nevertheless, this additional power requirement is a relatively modest increase. Because the frequency range of the ETLS is 6240-6740 MHz for this particular channel, there is relatively low risk that the ETLS will interfere with any other users. Piper recognizes that in the 6-7 GHz band there are point-to-point and satellite users (Fixed Wireless, auxiliary broadcasting and CARS). These users, however, will not experience interference from the ETLS because its anchors and tags will be either confined to a tunnel or in low proximity to the ground if fixed outside. As explained above, anchors and tags will also only communicate intermittently with trains that are in operation.

Application of Sections 15.250(c)-(d) in this instance would be both unduly burdensome and contrary to the public interest given the Commission's prior grants of waivers and the minimal increase in power required to operate on Channel C. Furthermore, if the Commission does not grant the Waiver for Channel A or Channel B, Piper is left with no reasonable alternative but to operate on Channel C. For these reasons, waiving Sections 15.250(c)-(d) to implement ETLS serves the public interest.

III. CONCLUSION

For the foregoing reasons, grant of the Waiver would serve the public interest. Piper's proposed operation of the ETLS will provide an innovative, low cost, and easily installable option

[31] *Id*. at ¶ 5; *See* iRobot Waiver at ¶ 8.

for rail systems to more reliably follow and control rail passenger transportation. The ETLS will also reduce operating costs by increasing the potential number of trains that can operate simultaneously while also increasing safety for passengers and employees alike. Piper respectfully asks the Commission to expeditiously grant the Waiver to facilitate deployment of the ETLS on rail systems in the United States.

Respectfully Submitted,

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