Zipline International Inc.
333 Corey Way, South San Francisco, CA 94080

Zipline Application for Special Temporary Authority
Narrative

Introduction

Zipline International Inc. ("Zipline") seeks Special Temporary Authority ("STA") to evaluate the use of a vehicle-to-infrastructure ultra-wideband ("UWB") ranging system to support precision positioning for an unmanned aircraft system ("UAS") during approach, docking, and departure operations. One UWB transceiver will be mounted on an aircraft and operate no higher than 30 meters Above Ground Level ("AGL"), communicating exclusively with corresponding UWB transceivers installed at fixed Zipline infrastructure. UWB transmissions will occur only while the aircraft is within the immediate vicinity of the docking station and only for the brief periods necessary to support precision approach, docking, and departure operations. Zipline's proposed operations will be conducted under current Federal Communications Commission ("FCC" or "Commission") rules[1] except for its proposal to use the UWB device onboard an aircraft and for a non-handheld device, which is why Zipline seeks this STA.

As demonstrated in this narrative, the proposed operations incorporate multiple technical and operational safeguards to minimize the potential for harmful interference to authorized users. These safeguards include reduced out-of-band emission limits, minimum separation distances from sensitive Federal facilities, and advance coordination with Federal users. In particular, Zipline is willing to pre-coordinate testing conducted in the vicinity of identified Federal stations with the affected agencies, if requested. Zipline will also provide advance 24-hour e-mail notification before testing begins and have a Stop Buzzer point of contact authorized to immediately suspend testing in the unlikely event harmful interference is reported.

Background

Zipline is an American robotics and logistics company that designs, manufactures, and operates UAS that deliver medical supplies, healthcare goods, food, and other consumer products. Zipline is transforming the way goods move so that every human on Earth has access to exactly what they need, when they need it—no matter where they live. Zipline started by delivering blood to health and hospital systems in Rwanda in 2016 and have grown to operate in seven countries across four continents, including the United States. Zipline has flown 140 million autonomous miles and made more than 2,700,000 deliveries to customers to date.

In 2025, Zipline launched a precision delivery service designed to make instant deliveries of food, retail goods, and health products to people who live even in dense cities across the U.S. In its first year of service, Zipline launched the precision delivery system in Pea Ridge, Arkansas, and more than 20 communities in the Dallas-Fort Worth Metroplex with Walmart, and more than a dozen restaurant brands.

[1] *See* 47 CFR §§ 15.519(a), 15.521(a).

The Zipline drone does not land or dock at merchant or consumer premises. Instead, it lowers a pod on a long cable to collect or deliver the package at ground level while the aircraft hovers overhead.[2] Today, the Zipline drone and the pod both rely on Global Navigation Satellite System ("GNSS"), Inertial Measurement Unit ("IMU"), and perception for localization. In the future, Zipline plans to expand its operations into urban environments near tall buildings where GNSS will be less reliable. In order to enable robust localization and navigation in these environments, Zipline is exploring the potential of vehicle-to-infrastructure UWB ranging.

Research Objectives and Public Interest

Grant of the requested STA will serve the public interest by enabling Zipline to evaluate the use of UWB technology as a complementary positioning capability to existing GNSS/GPS and Real-Time Kinematic ("RTK") navigation systems.

The experiment will generate real-world performance data to assess whether UWB can improve the accuracy, integrity, and reliability of autonomous aircraft positioning during precision approach, docking, and departure operations, particularly in environments where GNSS/RTK performance may be degraded by signal blockage or multipath effects, such as dense urban areas and locations with significant building obstructions.

The experiment will also provide valuable engineering data regarding the coexistence of low-power UWB systems with Federal authorized spectrum users by validating Zipline's interference analysis and demonstrating the effectiveness of the proposed technical and operational safeguards.

The results of this experiment will contribute to the FCC's and the National Telecommunications and Information Administration's ("NTIA's") understanding of emerging UWB applications for autonomous aviation and help inform future spectrum policy and equipment authorization decisions involving innovative UWB technologies.

Operational Areas

Experimental operations will be conducted within two geographic test areas: the Dallas-Fort Worth metropolitan area and the San Francisco Bay Area. These locations were selected because they represent diverse operating environments in which Zipline currently develops and deploys its autonomous drone delivery system, including suburban and urban environments where UWB positioning may provide operational benefits when GNSS performance is degraded. The requested operating areas are centered on the following coordinates:

Dallas–Fort Worth Metroplex: 32°54'28.5"N, 96°53'51.7"W (NAD83)
San Francisco Bay Area: 37°59'40.5"N, 122°04'12.6"W (NAD83)

For administrative purposes, each operating area is defined by a 100-kilometer radius to accommodate multiple temporary test locations within the metropolitan area (See Appendix A Maps). However, individual flight operations will be confined to small, controlled test sites centered on a fixed station location. UWB transmissions

[2] Additional information on Zipline's delivery systems can be found at https://www.zipline.com/technology.

will occur only while the aircraft is within the immediate vicinity of the fixed test station and at altitudes from ground level to no more than 30 meters AGL as described in more detail below.

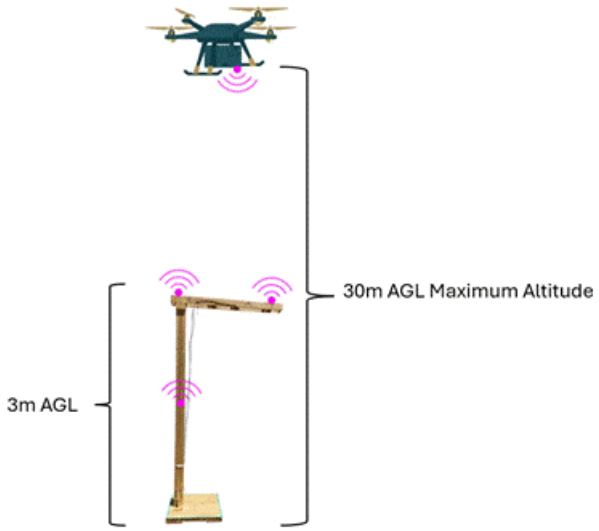
Experimental Design

For this experiment, Zipline will use a next-generation UWB ranging integrated circuit from ST Microelectronics, model number ST64UWB-A500, and from NXP, model number SR250. Their UWB feature set includes the following:

- Supported standards for UWB radio:
  - IEEE 802.15.4z-2020
  - IEEE 802.15.4ab
  - CCC, ICCE
- Antenna ports: 2 × transmit and receive ports
- Supported channels: 5, 6, 8-12 (6489.6 MHz to 8985.6 MHz)
- Modulation: BPRF, HPRF

The proposed operations will use a custom Zipline antenna. Additional technical information regarding the antenna design, configuration, and radiation pattern is provided in the accompanying Confidential Exhibit. Zipline will evaluate all supported channels to assess ranging performance, robustness against interference, and the potential risk of causing interference.

For the experiment, three transceivers will be mounted to a temporary 3m tall structure similar to the one pictured below with the patch antennas pointed directionally upward. One transceiver will be mounted to an aircraft and pointed down at the structure.



Conceptual Sketch — Not to Scale

In UWB terminology, the transceiver on the aircraft will act as the initiator of a multicast ranging session with the transceivers on the temporary structure acting as responders. One set of range measurements between the

initiator and each responder will be taken every 100ms. While the UWB ranging session is ongoing, the aircraft's maximum altitude will be limited to 30 meters AGL for the reasons discussed in the next section.

Zipline is willing to pre-coordinate the locations of its fixed testing/docking stations with any Federal users that have concerns regarding the potential for interference, if requested. The experiment can be halted immediately in the unlikely event of a complaint by landing the aircraft and turning it off. The Stop Buzzer contact is:

Gregorio Lopes, greg.lopes@flyzipline.com, (510) 707-6524

Analysis of Interference Potential

Zipline addresses interference potential in two categories: (1) emissions outside the UWB operating band into Federal systems below and adjacent to the operating band, and (2) in-band emissions into authorized services operating in the 7.7 to 8.3 GHz range. Zipline also explains how it will avoid causing harmful interference with government sites through prior coordination.

Out-of-Band Interference

Zipline does not anticipate that this experiment will cause harmful interference to other users for the following reasons. In revising its Part 15 rules regarding UWB transmission systems, the FCC noted that NTIA Special Publication 01-43:

> *"analyzed UWB devices operating . . . at heights of 2 meters (roughly equivalent to ground level) and 30 meters (roughly equivalent to the tenth floor in a typical suburban, office building) and calculated the maximum allowable UWB EIRP,"* where *"the maximum UWB EIRP is the maximum signal level that NTIA calculated at which a UWB transmitter could operate without causing interference to the system when the UWB is allowed unrestricted outdoor operation independent of the UWB's pulsewidth, PRF, or other modulation schemes or the nature of its intended operation (e.g. radio determination or communication)."*[3]

Zipline's proposed UWB system falls squarely within the scenario described by the NTIA and FCC for non-aircraft outdoor UWB operation, indicating that these operations will not cause harmful interference to other users.

The below table summarizes selected values from Table 1 of NTIA Special Publication 01-43 for the 30-meter UWB height case,[4] the emissions limits ultimately adopted by the FCC's UWB rules,[5] and the margin between those values. The FCC Outdoor Handheld UWB EIRP limit exceeds NTIA's recommended limit for ARSR-4, ASR-9, NEXRAD, FSS, and TDWR. The FCC's justification for this is that (1) the devices at 30m height will be

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[3] Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order, 17 FCC Rcd 7435, ¶ 145 (2002) ("First Report and Order"); *see also id.* ¶ 124.

[4] NTIA Special Publication 01-43, Assessment of Compatibility between Ultrawideband Devices and Selected Federal Systems, January 2001, https://www.ntia.gov/files/ntia/publications/uwb.pdf.

[5] 47 C.F.R. § 15.519.

located indoors and therefore benefit from an additional 9-12dB of building attenuation and (2) "[t]he building itself would at least partially obstruct the 3dB beamwidth of the mainbeam and be the limiting factor along the given azimuth and not the UWB's EIRP."[6] In short, the FCC concluded that this difference was acceptable because such devices would typically operate adjacent to buildings, thereby benefiting from additional building attenuation and partial obstruction of the antenna mainbeam.

System	Frequency (MHz)	NTIA Limit EIRP (dBm/MHz) UWB Outdoors	FCC Section 15.519 Limit EIRP (dBm/MHz) UWB Outdoors	FCC Margin to NTIA Limit
DME, Interrogator	960-1215	Not Applicable		
DME, Transponder	1025-1150	-57	-75.3	+ 18.3
ATCRBS, Transponder	1030	Not Applicable		
ATCRBS, Interrogator	1090	-45	-75.3	+ 30.3
ARSR-4	1240-1370	-82	-75.3	- 6.7
SARSAT	1544-1545	-66	-75.3	+ 9.3
ASR-9	2700-2900	-66	-61.3	- 4.7
NEXRAD	2700-2900	-76	-61.3	- 14.7
Marine Radar	2900-3100	-57	-61.3	+ 4.3
FSS, 20 degrees	3700-4200	-42	-61.3	+ 19.3
FSS, 5 degrees	3700-4200	-77	-61.3	- 15.7
CW Altimeters	4200-4400	Not Applicable		
Pulsed Altimeter	4200-4400	Not Applicable		
MLS	5030-5091	Not Applicable		
TDWR	5600-5650	-63	−41.3	-21.7

Because Zipline's UWB transmitter will be mounted on an aircraft operating outdoors, Zipline does not rely solely on these assumptions. Instead, Zipline proposes a combination of technical and operational safeguards that provide protection exceeding that contemplated by the FCC's rules. Zipline proposes a three-pronged approach to eliminating the out-of-band interference potential:

1. Zipline's UWB system will avoid causing harmful interference as the proposed operations will meet an even stricter out-of-band EIRP limit than that specified by the FCC.

Frequency (MHz)	FCC 15.519 Limit EIRP in dBm	Proposed limit EIRP in dBm	Additional margin in dBm
960 - 1610	-75.3	-75.3	0
1610 - 1990	-63.3	-71.3	8
1990 - 3100	-61.3		10

[6] First Report and Order at ¶ 144.

Frequency (MHz)	FCC 15.519 Limit EIRP in dBm	Proposed limit EIRP in dBm	Additional margin in dBm
3100 - 6000	-41.3		30
6000 - 7500			
7500 - 8500		-41.3	0
8500 - 10600		-61.3	20
Above 10600	-61.3		0

2. Zipline will avoid causing harmful interference by not operating its UWB positioning system within 800 meters of ARSR-4 and NEXRAD stations or within 200 meters of all other government services listed above.[7]
3. Further, Zipline will limit antenna gain toward the horizon to approximately 5dB below peak through antenna orientation, providing an additional reduction in emissions toward distant receivers.

In sum, Zipline's proposed operations are unlikely to cause harmful interference as Zipline will be operating under even stricter limits than NTIA recommended. The resulting margin between Zipline's UWB system and the NTIA-recommended limits is summarized in the table below.

System	Zipline Margin to NTIA Recommendation
DME, Interrogator	Not Applicable
DME, Transponder	+ 23.3
ATCRBS, Transponder	Not Applicable
ATCRBS, Interrogator	+ 35.3
ARSR-4	+ 10.3
SARSAT	+ 14.3
ASR-9	+ 10.3
NEXRAD	+ 12.3
Marine Radar	+ 19.3
FSS, 20 degrees	+ 34.3
FSS, 5 degrees	+ 11.3
CW Altimeters	Not Applicable
Pulsed Altimeter	Not Applicable
MLS	Not Applicable
TDWR	+13.3

[7] Zipline will operate under these distances except as expressly coordinated with the relevant federal or local officials for purposes of the proposed interference-risk evaluation.

In-Band Interference

Zipline's proposed UWB positioning system presents a low risk of harmful in-band interference because it operates at the existing Part 15.519 emission limits[8] and uses conservative free-space assumptions. The system will transmit at an average EIRP limited to -41.3 dBm/MHz in the 6-10 GHz range, with operation confined to 7.7-8.3 GHz and centered at 7987.2 MHz. Zipline does not seek any waiver of those emission limits.

Zipline will limit the potential for in-band interference by using the same free-space path loss framework that the FCC found to be an acceptable method of mitigating interference potential in granting Tesla's waiver for use of UWB devices earlier in 2026.

> *For example, the received interference power spectral density (PSD) at an Earth station with 0 dBi gain toward the horizon, caused by a Tesla positioning system operating at 7987.2 MHz with a maximum PSD of -41.3 dBm/MHz, at a distance of 800 meters, will be -149 dBm/MHz, assuming free space path loss. Similarly, for fixed links, the received interference PSD at a fixed directional antenna with 10 dBi gain towards the ground, due to a Tesla positioning system operating at 7987.2 MHz with a maximum PSD of -41.3 dBm/MHz, at a distance of 800 meters, will be -139 dBm/MHz, assuming free space path loss. For comparison, the thermal noise power density at room temperature is -114 dBm/MHz. Therefore, the maximum unwanted power from a Tesla positioning system transmitted into an Earth station receiver located 800 meters distant or greater will be at least 35 dB below the thermal noise floor. Similarly, a fixed receiver 800 meters away would receive a maximum unwanted power of 21 dB below the thermal noise floor from a Tesla positioning system transmitter. This is based on a very conservative assumption of free space path loss and no accounting for clutter.*[9]

The Tesla framework is already conservative because it assumes no clutter, no building attenuation, and no other environmental losses. In Tesla's example, the resulting received interference power is already 35dB below the thermal noise floor for an Earth station and 21dB below the thermal noise floor for a fixed directional receiver at 800 meters. Zipline does not rely on unquantified clutter to support its interference case.

The Tesla waiver provides a useful conservative free-space path loss framework for assessing low-power UWB operation in the 7.7 to 8.3 GHz band, but Zipline recognizes that its proposed test geometry differs from Tesla's ground-pad use case. Zipline therefore uses the same conservative free-space framework as a starting point and adds the following operational constraints tailored to its proposed aerial/near-ground UWB operation, which will be limited to near-ground operations of no more than 30 meters AGL.

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[8] 47 C.F.R. § 15.519.

[9] Tesla, Inc.'s Request for Waiver of Sections 15.519(a) and 15.519(a)(2) of the Commission's Rules, *Order*, ET Docket No. 25-101, DA 25-168, ¶ 13, n. 36 (2026).

1. Zipline will increase separation distances for sensitive sites discussed in the Tesla waiver;[10] a four-fold increase in separation distance provides approximately 12dB of additional free-space margin.
2. Zipline will limit antenna gain toward the horizon to approximately 5dB below peak through antenna orientation, providing an additional reduction in emissions toward distant receivers.

Accordingly, the interference analysis for Zipline's proposed operations is conservative in two respects: it begins with the same free-space framework used in Tesla's waiver, and it adds quantified margin totaling 20dB through increased separation distance and reduced horizon-facing *antenna* gain rather than relying on unquantified clutter. Under those assumptions, Zipline's proposed UWB operation presents a low risk of harmful in-band interference to authorized services.

Special Sites of Interest

Zipline plans to coordinate closely with federal and local officials for flight tests in the vicinity of the following government systems to evaluate the interference potential of its UWB device (See Appendix A Maps).

System	Frequency (MHz)	Zipline Proposed Keepout Radius (m)	City, State	Lat, Lon
DME, Transponder	1025-1150	200	Colleyville, TX	32°53'22.0"N 97°10'46.0"W
ATCRBS Interrogator & ASR-9	1090	200	Sachse, TX	32°59'24.00"N 96°34'41.00"W
ARSR-4	1240-1370	800	Mill Valley, CA	37°55'26.4"N 122°35'51.8"W
NEXRAD	2700-2900	800	Burleson, TX	32°34'22.8"N 97°18'11.3"W
TDWR	5600-5650	200	Lewisville, TX	33°03'53.99"N 96°55'05.00"W

Conclusion

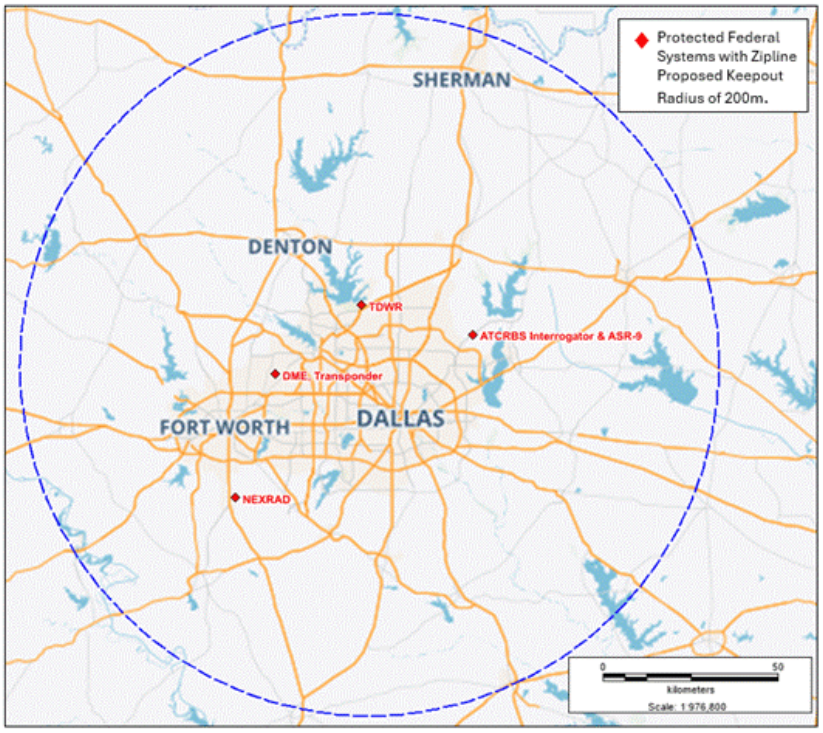
For the reasons discussed above, Zipline respectfully requests that the FCC grant the requested STA. The proposed experiment is limited in duration, geographic scope, altitude, and operating conditions, and complies with the applicable Part 15 UWB technical requirements except for the limited operation of a non-handheld UWB device onboard an aircraft.

As demonstrated by the engineering analysis and operational safeguards described in this narrative, Zipline concludes that the proposed operations are unlikely to cause harmful interference to Federal authorized spectrum users. Accordingly, grant of the requested STA will enable the evaluation of an innovative UWB application while continuing to protect incumbent services.

[10] *Id.*

Appendix A

Dallas–Fort Worth Metroplex Experimental STA Area
Radius Center: 32°54'28.5"N, 96°53'51.7"W (NAD83)



San Francisco Bay Experimental STA Area
Radius Center: 37°59'40.5"N, 122°04'12.6"W (NAD83)