NARRATIVE DESCRIPTION

Pursuant to Sections 5.54 and 5.61 of the Federal Communication Commission's ("Commission") rules,[1] Sigfox USA ("Sigfox") respectfully requests experimental special temporary authorization ("STA") for a period of six (6) months to conduct experiments using two Internet-of-Things ("IoT") devices (one of each of two types) that will operate in the 902-906 MHz and 920-924 MHz (Earth-to-space) and 400.05-400.15 MHz (space-to-Earth) frequency bands at two locations in Massachusetts.

This experimental STA is necessary for proof-of-concept demonstrations that transmissions from the IoT devices may be received by technology validation payloads onboard certain satellites, in this case the U.S.-licensed Loft Orbital Solutions, Inc. ("Loft") YAM-2 and YAM-3 satellites (the "Loft satellites").[2] The experimental operations proposed herein will constitute a critical experimental milestone to extending and enhancing existing terrestrial IoT networks. The proposed experimental operations will be limited to two experimental IoT devices in limited geographic areas for a short testing period and are otherwise compliant with existing Part 15 rules for terrestrial IoT devices. Accordingly, the potential for harmful interference caused by this experimentation is negligible, and timely grant of the requested operations would strongly serve the public interest.

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[1] *See* 47 C.F.R. §§ 5.54, 5.61.

[2] The YAM-2 and YAM-3 grants do not currently include authority to receive transmissions in the 920-924 MHz band from U.S. territory. *See Application and Amendment of Loft Orbital Solutions, Inc.,* File Nos. SAT-LOA-20190807-00072, SAT-AMD-20200527-00063, Call Sign S3052 (grant stamp Oct. 8, 2020) ("YAM-2 grant"); *see also Application of Loft Orbital Solutions, Inc.*, File No. SAT-LOA-20200907-00105, Call Sign S3072 (grant stamp May 24, 2021) ("YAM-3 grant"). Sigfox requests experimental authority herein to ensure that the IoT devices may transmit in the 920-924 MHz band to the Loft satellites once appropriate authority is granted.

I. BACKGROUND

Terrestrial IoT networks may readily serve densely populated areas which already possess significant telecommunications infrastructure. Nevertheless, such networks are limited by the footprint of the terrestrial network and are thus unable to facilitate seamless operations for remote or mobile applications. The IoT devices presented herein facilitate significant extension of those terrestrial networks by enabling ancillary satellite operations to communicate with terrestrial the IoT devices, thereby enhancing IoT services to end-users regardless of their location. Accordingly, grant of this experimental STA is fully consistent with the public interest because it will promote expansion of innovative IoT technologies to the U.S. public, including in remote and underserved locations.

II. DISCUSSION

As discussed herein, Sigfox seeks to conduct radio experiments in the U.S. with two types of IoT devices: (i) a racked-mounted, non-integrated IoT device (the "ELO-Rack"); and (ii) an integrated IoT device (the "ELO-Device"). The ELO-Rack will transmit test signals (up to 25 kHz wide) to the Loft satellites in the 902-906 MHz and 920-924 MHz frequency bands (the "900 MHz band"), with a tunable center frequency nominally centered at 902.20 MHz or 920.80 MHz, respectively, to assess the feasibility of such operations. The ELO-Device will primarily transmit in one of the foregoing band segments under the same parameters. The IoT devices will receive a downlink beacon signal transmitted by the Loft satellites in the 400.05-400.15 MHz band, with a center frequency of 400.1 MHz, which could be used to enhance the performance of terrestrial IoT devices in future applications.

The purpose of this experimental STA is to perform various technical and proof-of-concept testing, including:

- to determine the best wireless configuration for the device;
- to optimize network quality and service level; and
- provide an end-to-end assessment of link performance with potential end users.

Completion of these experiments will allow Sigfox to: (i) verify that an IoT device can receive information from a satellite by analyzing the frequency spacing of unmodulated tones composing a beacon signal; (ii) assess the feasibility of doppler-compensated ultra-narrow band Binary Phase-Shift Keying ("BPSK") signal transmission to a satellite; and (iii) verify that the doppler shift can be estimated with enough accuracy by an IoT device from a carrier signal sent by the satellite to permit the transmission of a doppler-compensated signal. Sigfox will ensure the IoT devices comply with applicable Commission requirements, including operating technical parameters regarding field strength, output power limits, use restrictions, duty cycles, and other operating restrictions.

A. Sigfox IoT Devices

The ELO-Rack developed by Sigfox will consist of a configurable electronics rack and box housing two antennas for reception and transmission.[3] The ELO-Rack will facilitate the assessment and management of the transmission elements such as output power, frequency, payload, and doppler parameters. One ELO-Rack will be used for testing at a facility in Massachusetts following grant of experimental STA authority. Among other things, operation of the ELO-Rack device will help Sigfox assess link performance differences between the 902-906 MHz and 920-924 MHz bands.

[3] *See* Attachment A, Figure 1.

The ELO-Device developed by Sigfox contains integrated electronics and a transmit-receive antenna in the same box.[4] Sigfox intends to primarily operate the ELO-Device in either the 902-906 MHz or 920-924 MHz bands, considering the outcome of ELO-Rack tests.

Each of these IoT devices will transmit modulated carriers. Each modulated carrier will have its phase modulated between two states (modulation defined as BPSK) and will simultaneously have its frequency drifted during the transmission to compensate for the doppler effect between the IoT device and the satellite. Each modulated carrier will occupy a total maximum bandwidth of 25 kHz during the transmission.

Pursuant to the Commission's Table of Frequency Allocations ("Table of Allocations"), Part 15 devices are authorized to operate in the 900 MHz band. The IoT devices in this experiment operate consistent with rules governing 900 MHz IoT devices.[5] Moreover, the IoT devices in this experiment will only operate on an opportunistic basis when a Loft satellite is overhead. Accordingly, the proposed experimentation is consistent with the Commission's experimental rules and will not cause harmful interference to other authorized systems or services.[6]

Both IoT devices will receive 50 kHz downlink beacon transmissions from the Loft satellites with a center frequency of 400.1 MHz.[7] This downlink will provide precise frequency and accurate time information to enhance the performance of terrestrial IoT devices. The beacon

[4] *See id.*, Figure 2.

[5] *See generally*, Part 15. Allowable output power is 1W. *See* 47 C.F.R. § 15.247(b). ELO-Rack device output power is 1W and ELO-Device maximum output power is 0.25W. Thus, the output power of the devices is compliant with the Commission's rules. The devices will also appropriately reduce the radiofrequency power outside their operating frequency band. *See id.* § 15.247(d).

[6] *See* 47 C.F.R. § 5.84.

[7] 47 C.F.R. § 2.106, n.5.261.

signal will be a set of non-modulated "tones" at reference frequencies or by a modulated signal containing accurate time information with a bandwidth of up to 50 kHz. The signals will also indicate service information such as a status of the satellite configuration.

At all times, Sigfox will adhere to the requirements under the Commission's rules to operate on an unprotected, non-interference basis during the term of the experimental STA.[8]

B. YAM-2 and YAM-3 Satellites

The YAM-2 and YAM-3 satellites are approved by the Commission under a Part 25 authorization and included on the Commission's approved space station list.[9] To the extent applicable, Sigfox hereby incorporates by reference all relevant information pertaining to the technical and operational characteristics of the Loft satellites. Furthermore, the IoT devices will transmit to the Loft satellites on each proposed frequency band only after the Commission has granted appropriate authority for the Loft satellites to receive in each band.

C. Testing Locations

The devices will only transmit on a purely opportunistic basis when the Loft satellites are overhead. The test transmissions will be operated solely by Sigfox conducted from the following fixed location[s]:

ELO-Rack
10 Canterbury Hill Road
Topsfield, MA 01983
N42°39'7"; W70°55'54"

[8] If Sigfox learns its experimental operations are causing interference into existing spectrum users, it will immediately cease transmissions and will not resume transmissions until it establishes that harmful interference will not be caused to any authorized radio service. *See* 47 C.F.R. § 5.84; *see also* 47 C.F.R. § 15.5(b).

[9] *See* YAM-2 grant; *see also* YAM-3 grant.

ELO-Device
66 Cushing Ave
Belmont MA 02478
N42°22’54”; W71°10’11”

III. PUBLIC INTEREST CONSIDERATIONS

Sigfox anticipates that its proposed experimental operations will contribute greatly to enhancing terrestrial IoT networks by greatly extending network range and capabilities through the use of satellite technology. Business sectors including transport, oil and gas, and agriculture, all have the need to transmit information critical to business operations in the U.S. and abroad. When operators in these sectors venture outside service areas of traditional terrestrial based networks, that critical information cannot be transmitted. This experiment seeks to extend terrestrial-IoT networks through the use of advanced satellite technology, allowing business to receive that critical information consistently and reliably. The proposed experimental IoT device evaluations will help validate the capabilities of this innovative IoT technology for the benefit of the U.S. public.

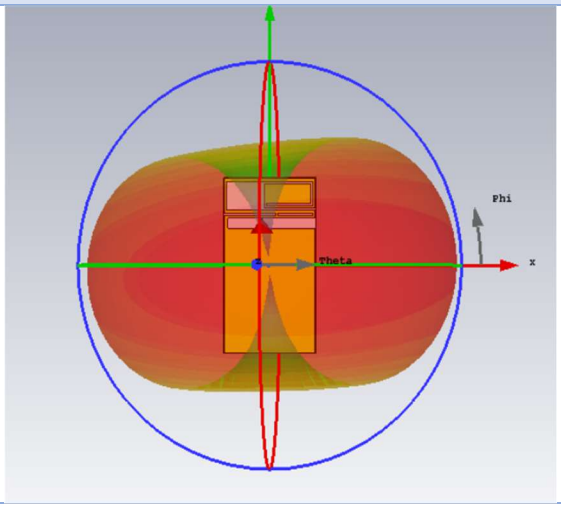
IV. CONCLUSION

Based on the foregoing, Sigfox respectfully requests that it be granted a six-month experimental STA commencing on August 15, 2021, to permit critical experiments to validate the IoT device communications with the Loft satellites.

Attachment A – IoT Devices

I. Non-integrated device (ELO-Rack)

ELO-Rack Characteristics:

Parameter	Values
Uplink center frequency	Tunable, with nominal center frequencies at 902.20MHz or 920.80MHz
Downlink center frequency	400.1MHz
Max conducted output power	1W
EIRP	4W
Doppler pull range (TX mode)	+/- 20KHz
Modulation	600bps D-BPSK
Antenna	Linear
Radiation pattern	

Power Characteristics:

Parameter	Values
Power supply	110V -AC
Power consumption	60W (max)

Networking Interface:

Parameter	Possible values
data port	10/100/1000 RJ45 Ethernet Port

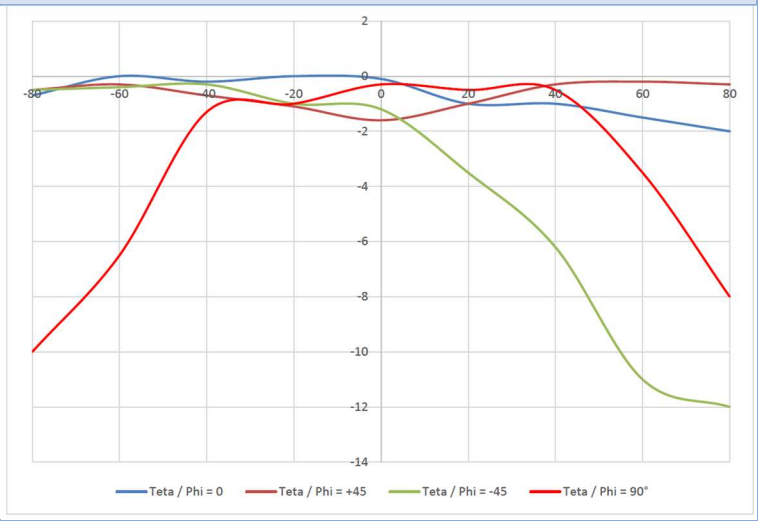
Packaging:
Size: Rack 19" 3U

Rack		
Antennas		

Figure 1 – ELO-Rack

II. Integrated device (ELO-Device)

ELO-Device Characteristics:

Parameter	Values
Uplink center frequency	Tunable, with nominal center frequencies at 902.20MHz or 920.80MHz
Downlink center frequency	400.1MHz
Max conducted output power	0.15W
EIRP	0.25W
Doppler pull range (TX mode)	+/- 20KHz
Modulation	600bps D-BPSK
Antenna	Linear
Radiation pattern	

Power Characteristics:

Parameter	Values
Power supply	2,7V
Power consumption	1W (max)
Power	2 x AA

Packaging:
Size: 126 x 79 x 28 mm

Figure 2 – ELO-Device