Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)
	)
Massachusetts Institute of Technology	)
Request for Waiver of Part 15 of the	)
Commission's Rules Applicable to	)
Ultra-Wideband Devices	)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

REQUEST FOR WAIVER

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TABLE OF CONTENTS

Page

I. OVERVIEW OF THE WITRACK SYSTEM AND HOW IT WOULD BENEFIT THE PUBLIC INTEREST 3

A. Aging in place, ongoing care, and emergency interventions 3

B. Clinical Research 5

C. WiTrack 7

II. WAIVERS REQUESTED FOR THE WITRACK SYSTEM 13

A. Consistent with Recent Precedents, the Commission Should Grant a Waiver of Rule 15.503(d) Concerning the Definition of "Ultra-Wideband Transmitter" 14

B. Consistent with Recent Precedents, the Commission Should Grant a Waiver of the Measurement Procedures Defined in Sections 15.31(c) and 15.521(d) 16

III. CONCLUSION 19

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REQUEST FOR WAIVER

Massachusetts Institute of Technology ("MIT"), pursuant to Section 1.3 of the Commission's Rules, requests a limited waiver of certain Federal Communications Commission's Part 15 rules governing ultra-wideband ("UWB") indoor devices. MIT seeks to deploy a swept-frequency UWB indoor monitoring device that must be connected to the AC power lines, and that provides non-invasive health and safety monitoring of patients and senior adults (the "WiTrack System"). Certification for the WiTrack System requires waivers of Sections 15.503(d) (the definition of "UWB transmitter"), 15.31(c) (measurement standards for swept frequency equipment), and 15.521(d) (UWB measurement procedures).

The Commission has the authority to grant a waiver request when the purpose of the rule (i.e., protecting against harmful interference) would not be thwarted and the granting of the waiver would be in the public interest. Given that the minimal risk of harmful interference is far

outweighed by the important health and safety benefits from the WiTrack System, there is good cause for the Commission to grant a limited waiver of its Part 15 rules.

SUMMARY

By supporting remote health monitoring, the ultra-wideband technology employed in the WiTrack system facilitates fall detection and physiological measurements such as gait, breathing, heart rate, and sleep. Approval of the limited waivers requested for the WiTrack System therefore will improve in-home safety and health care for senior adults and people with disabilities thereby encouraging independence and aging in place. Furthermore, grant of the waivers will also give medical researchers a valuable new tool for collecting research data heretofore largely obtainable only in laboratory settings, or not obtainable at all.

The WiTrack system uses an indoor swept signal of up to 2.5 GHz in the 6 - 8.5 GHz range. The bandwidth of the signal as it sweeps is never more than 50 kHz while the dwell time in any continuous 50 kHz is less than 2 microseconds. Devices using WiTrack will satisfy the peak power limitations mandated by Subpart F of Part 15 and the average power limit of -41.3 dBm as calculated over the duration of the device cycle, which is always less than 64 seconds. Nevertheless, like many other UWB devices the FCC has considered, approval of the WiTrack System requires a waiver of the definition of ultra-wideband transmitter and a waiver of the measurement process to permit the testing to be conducted with the sweeping function active. As discussed in this request, MIT submits that the WiTrack System poses an extremely low probability of causing harmful interference yet offers great public interest benefits to enhance health and safety.

I. OVERVIEW OF THE WITRACK SYSTEM AND HOW IT WOULD BENEFIT THE PUBLIC INTEREST

Non-invasive health and safety monitoring is increasingly important for multiple reasons in our society – for aging-in-place, ongoing care, emergency interventions, and clinical research.

A. Aging in place, ongoing care, and emergency interventions

Our society is aging rapidly. The fraction of the population that is 65+ is growing at a very high rate fueled by advances in medicine and the aging of baby boomers.[1] Concurrently, there is a shortage of caregivers and health workers.[2] The problem is exacerbated by the fact that over 13 million seniors live alone and are subject to falls, accidental injuries, and chronic disease.[3] Remote health monitoring can alleviate the problem. In particular three areas stand out in which remote monitoring can help dramatically reduce cost and improve outcomes.

First, falls are the leading cause of accidental death and injury in older adults.[4] One in four adults over the age of 65 experiences a fall each year, with a significant fraction suffering an injury requiring a hospital visit.[5] Falls account for nearly 90% of fractures in seniors and result

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[1] U.S. Census Bureau, Report No. P25-1144, *Demographic Turning Points for the United States: Population Projections for 2020 to 2060*, at 1 (Mar. 2018), https://www.census.gov/content/dam/Census/library/publications/2018/demo/P25_1144.pdf.

[2] Paul Osterman, *Who Will Care For Us?: Long-Term Care and the Long-Term Workforce* (2017).

[3] Admin. on Aging, Admin. for Cmty. Living, U.S. Dep't of Health & Human Servs., *A Profile of Older Americans: 2017*, at 5 (Apr. 2018), https://acl.gov/sites/default/files/Aging%20and%20Disability%20in%20America/2017OlderAmericansProfile.pdf.

[4] Nat'l Council on Aging, *Fact Sheet: Falls Prevention*, at 1 (2018) https://www.ncoa.org/wp-content/uploads/Falls-Prevention-Fact-Sheet-2018.pdf.

[5] *Id.*

in $50B of direct medical costs annually.[6] Existing solutions require seniors to wear a pendant or other sensors. Yet, years of medical research has shown that mobile health devices do not work well for the elderly.[7] Seniors are typically encumbered by wearable technologies, and many of them suffer from memory problems and hence may forget to wear or charge their devices. Furthermore, those sensors can be dangerous; recently an elderly woman strangled on her fall-detection pendant.[8]

Second, gait velocity (i.e., a person's habitual walking speed) is a critical health indicator for older adults. Multiple papers have shown that gait velocity predicts future hospitalization for congestive heart failure,[9] chronic obstructive pulmonary disease,[10] and hemodialysis patients.[11] Degradation in gait velocity and stride length are correlated with an increase in fall risk and a

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[6] Curtis S. Florence et al., *Medical Costs of Fatal and Nonfatal Falls in Older Adults*, 66 J. Am. Geriatrics Soc'y 693, 693 (2018), https://onlinelibrary.wiley.com/doi/full/10.1111/jgs.15304.

[7] David M. Levine et al., *Trends in Seniors' Use of Digital Health Technology in the United States, 2011-2014*, 316 J. Am. Med. Ass'n 538, 539 (2016), https://jamanetwork.com/journals/jama/fullarticle/2540389.

[8] Nina Golgowski, *Elderly Woman Strangled by Medical Alert Necklace After Fall*, Huffington Post, https://www.huffingtonpost.com/entry/medical-necklace-strangles-woman_us_56d75817e4b0871f60edbb47 (last visited Dec. 27, 2018).

[9] Giovanni Pulignano et al., *Incremental Value of Gait Speed in Predicting Prognosis of Older Adults With Heart Failure: Insights From the IMAGE-HF Study*, 4 JACC: Heart Failure 289 (April 2016), http://heartfailure.onlinejacc.org/content/4/4/289.

[10] Samantha S C Kon et al., *Gait speed and readmission following hospitalisation for acute exacerbations of COPD: a prospective study*, 70 Thorax 1131 (2015), https://thorax.bmj.com/content/thoraxjnl/70/12/1131.full.pdf.

[11] Nancy G. Kutner et al., *Gait Speed and Mortality, Hospitalization, and Functional Status Change Among Hemodialysis Patients: A US Renal Data System Special Study*, 66 Am. J. Kidney Diseases 297 (2015).

decline in one's ability to live independently.[12] However, currently these metrics are measured only occasionally during medical visits. Such infrequent measurements hamper the opportunity to detect changes and intervene early in the impairment process.

Third, breathing, heart rate, and sleep are critical vital signals that indicate overall health and wellness. Early detection of disturbance of one or more of these signals can provide an important alert of brewing problems.

B. Clinical Research

Understanding diseases and evaluating the efficacy of treatments require doctors and researchers to measure accurately patient biomarkers and track them over time. In the absence of a reliable ability to measure biomarkers in the home, researchers and pharmaceutical companies are forced to limit themselves only to metrics that can be measured in the clinic. Stylized gait and other mobility tests must be administered when patients are in the clinic. This limits the amount of information available to evaluate the efficacy of a drug, its potential side effects, and its overall impact on the patient's quality of life. In particular, there are at least three benefits of remote non-invasive monitoring for clinical research.

First, in-home patient monitoring can provide new digital biomarkers. This is particularly the case for diseases that affect the Central Nervous System (CNS) such as Parkinson's, Multiple Sclerosis, Alzheimer's, ALS, Huntington's, Depression, Bipolar, etc. Such diseases create a challenge for the existing drug development process since animal models

[12] A Biderman et al., *Depression and falls among community dwelling elderly people: a search for common risk factors*, 56 J. Epidemiology & Cmty. Health 631 (2002), https://jech.bmj.com/content/jech/56/8/631.full.pdf.

for these diseases do not translate well to humans.[13] In-home monitoring of patients' gait, mobility, sleep and behavior can help in developing new biomarkers and enabling a better understanding of the disease. For example, there are studies that link changes in gait and sleep to pre-symptomatic Alzheimer's.[14] Being able to monitor these metrics continuously in the home over long periods can lead to new biomarkers for the diseases.

Second, in-home monitoring during drug clinical trials can reduce cost and save time.[15] A clinical trial can cost tens to hundreds of millions of dollars. Metrics related to gait and movements are common in evaluating drugs for neurodegenerative diseases (e.g., Parkinson's) and muscle wasting diseases (e.g., sarcopenia). Enabling continuous measurements of such metrics at home reduces measurement variance. This allows a clinical trial to achieve the desired statistical significance using a smaller population and a shorter period, hence reducing the overall cost.

Third, in-home monitoring during clinical trials provides a better understanding of drug side effects and improves safety. Drugs tend to have undesirable side effects that may affect some fraction of the population. Common side effects include diarrhea, nausea, falls, balance issues, etc. However, the exact side effects of a new drug are unknown. In-home monitoring during clinical trials can reveal such side effects and improve drug safety. Additionally,

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[13] Rafael Franco & Angel Cedazo-Minguez, *Successful therapies for Alzheimer's Disease: why so many in animal models and none in humans?*, 5 Frontiers in Pharmacology, art. 146 (2014), https://www.frontiersin.org/articles/10.3389/fphar.2014.00146/full.

[14] Anna Brzecka et al., *Sleep Disorders Associated with Alzheimer's Disease: A Perspective*, 12 Frontiers in Neuroscience, art. 330, (2018), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5990625/.

[15] Firma Clinical Research, *Improving Your Clinical Trial & Enhancing the Patient Experience*, at 6 (2017), https://www.firmaclinicalresearch.com/wp-content/uploads/2017/11/Firma_eBook_RemoteVisits_20171114.pdf.

sometimes drugs can have unanticipated beneficial side effects that enable repurposing the drug for new treatment. For example, Iproniazid, one of the first anti-depressants, was initially used to treat tuberculosis. Clinicians then noticed that some patients exhibited euphoria and hyperactive behavior.

C. WiTrack

The WiTrack System can monitor passively a wide variety of physiological signals – gait, mobility, activity, breathing, heartrate, sleep –without asking the monitored person to wear sensors on her body. As such, it addresses the needs and challenges for the aging population and clinical research. Further, its ability to monitor physiological signals without requiring sensors on the body makes it particularly suitable for older people who tend to be encumbered by wearable technologies.

The WiTrack System uses a technology developed by the Massachusetts Institute of Technology that has been tested and evaluated in multiple peer-reviewed studies that

demonstrated its ability to measure gait,[16] mobility,[17] sleep,[18] respiration and heart rates.[19] The WiTrack System was also featured in a recent TED Talk by Professor Dina Katabi.[20]

The WiTrack System is intended to operate indoors while connected to the AC power lines. It transmits an RF signal and receives its reflections from the environment. The signal bounces off nearby objects and people. WiTrack analyzes the received radio reflections to measure location, gait velocity, falls, breathing, heart rate, and sleep quality. Different versions of the device may measure a subset of these metrics.

The WiTrack radio employs a switched antenna array that transmits a swept frequency continuous-wave signal —i.e., an array of closely spaced transmitting antennas that transmit sequentially over a large band of spectrum to gather all the needed data. The signal sweeps up to 2.5 GHz of bandwidth in the range 6 GHz to 8.5 GHz. Different versions of the device may

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[16] Chen-Yu Hsu et al., *Extracting Gait Velocity and Stride Length from Surrounding Radio Signals*, Proc. 2017 ACM Conference on Human Factors in Computing Syss. (2017), https://people.csail.mit.edu/cyhsu/papers/wigait_chi17.pdf.

[17] Fadel Adib et al., *3D Tracking via Body Radio Reflections*, 11th USENIX Symposium on Networked Systems Design & Implementation (2014), http://witrack.csail.mit.edu/witrack-paper.pdf.

[18] Chen-Yu Hsu et al., *Zero-Effort In-Home Sleep and Insomnia Monitoring using Radio Signals*, Proc. ACM Interactive, Mobile, Wearable &Ubiquitous Techs. (2017), https://people.csail.mit.edu/cyhsu/papers/ezsleep_ubicomp17.pdf.

[19] Fadel Adib, *Smart Homes That Monitor Breathing and Heart Rate*, Proc. 2015 ACM Conference on Human Factors in Computing Syss. (2015), https://dam-prod.media.mit.edu/x/2017/03/24/vitalradio-paper.pdf.

[20] Dina Katabi, *A new way to monitor vital signs (that can see through walls)*, TED2018 (Apr. 2018), https://www.ted.com/talks/dina_katabi_a_new_way_to_monitor_vital_signs_that_can_see_through_walls.

sweep slightly different frequencies within the 6 to 8.5 GHz range. For example, one version of the radio sweeps from 6 to 7.8 GHz, while a second version sweeps 6 to 8.5 GHz.

To obtain a single useful measurement, the WiTrack radio must combine signals from all antennas in the array. Specifically, the antenna array along with the swept frequency signal allows for separating the received signals based on their distance and direction with respect to the WiTrack device. This separation is necessary to home in on signals from one monitored person and eliminate interference from signals that bounce off other nearby people or objects. Hence, even one measurement requires transmitting from all antennas in the array. Furthermore, all antennas in the array transmit sequentially back-to-back without additional delay. The antennas have to transmit back-to-back so that the signals from all antennas in the array can be combined coherently, as if the signals from all antennas were captured at the exact same time. This is possible only if all antennas in the switched array transmit their signals within a very short period during which the environment can be assumed static. Given that the system operates at high frequencies (6 to 8.5 GHz), even sub-millimeter motion (whether caused by human motion such as walking, tremors, heartbeats, or object motion, such as a fan, can cause the signal to have a significant phase change, which breaks the above assumption. Thus, all antennas in the array have to transmit sequentially without any additional delay. We refer to the time it takes to transmit from all antennas in the array as "array cycle."

Furthermore, to capture small signals such as tremors or heartbeats, the WiTrack radio must combine signals across multiple array cycles. This is because the WiTrack device transmits at a very low peak power, as required by part 15 subpart F. To boost the small signal variations due to tremor, heartbeats, or other minute effects, the WiTrack device has to combine the received signals from multiple array cycles. These array cycles must transmit sequentially back-

to-back since any delay causes the monitored signal to change and hence smears the measurement. Thus, a full cycle of the WiTrack device includes one or multiple array cycles.

The WiTrack device operates in cycles. A full cycle for the device includes an integer number of array cycles, where the integer can be any number between 1 and 4. The cycle ends with a "quiescent period." The duration of the quiescent period is chosen to ensure that the device meets the mandated FCC average power limit of -41.3 dBm, with the average power calculated over the duration of the device cycle. In the current version of the device, each cycle lasts between 16 and 64 milliseconds, depending on the averaging required to capture the physiological signal of interest.

MIT has developed multiple versions of the WiTrack device and would like to continue optimizing the design to improve performance and enable innovation. Different versions of the device may differ in the frequencies they sweep in the range 6 to 8.5 GHz, the number of antennas in the array, and the number of array cycles in a device cycle. However, all versions of the WiTrack System satisfy the following constraints:

- The peak power satisfies the value mandated by Part 15 Subpart F, and the measurement procedure in section 15.521.
- The device meets the mandated FCC average power limit of -41.3 dBm, with the average power calculated over the duration of the device cycle, which is always at most 64 milliseconds.
- Since the device uses swept frequency, the signal is by definition narrowband. Conservatively, the signal bandwidth at any time is less than 50 KHz.

- The dwell time defined as the continuous transmission time in any continuous 50 KHz band is less than 2 microseconds.
- The frequency duty cycle, defined as the ratio of time spent in any 50 KHz band to the shortest interval of time before the device returns to a transmission in that band is less than 0.04 percent.[21]

Figure 1 shows a schematic of transmissions from the device.

[21] Waivers granted to stepped frequency devices have required limiting the dwell time and the device duty cycle. In particular, the Proceq waiver limits the dwell time to 2 microseconds and the duty cycle to 0.04 percent.

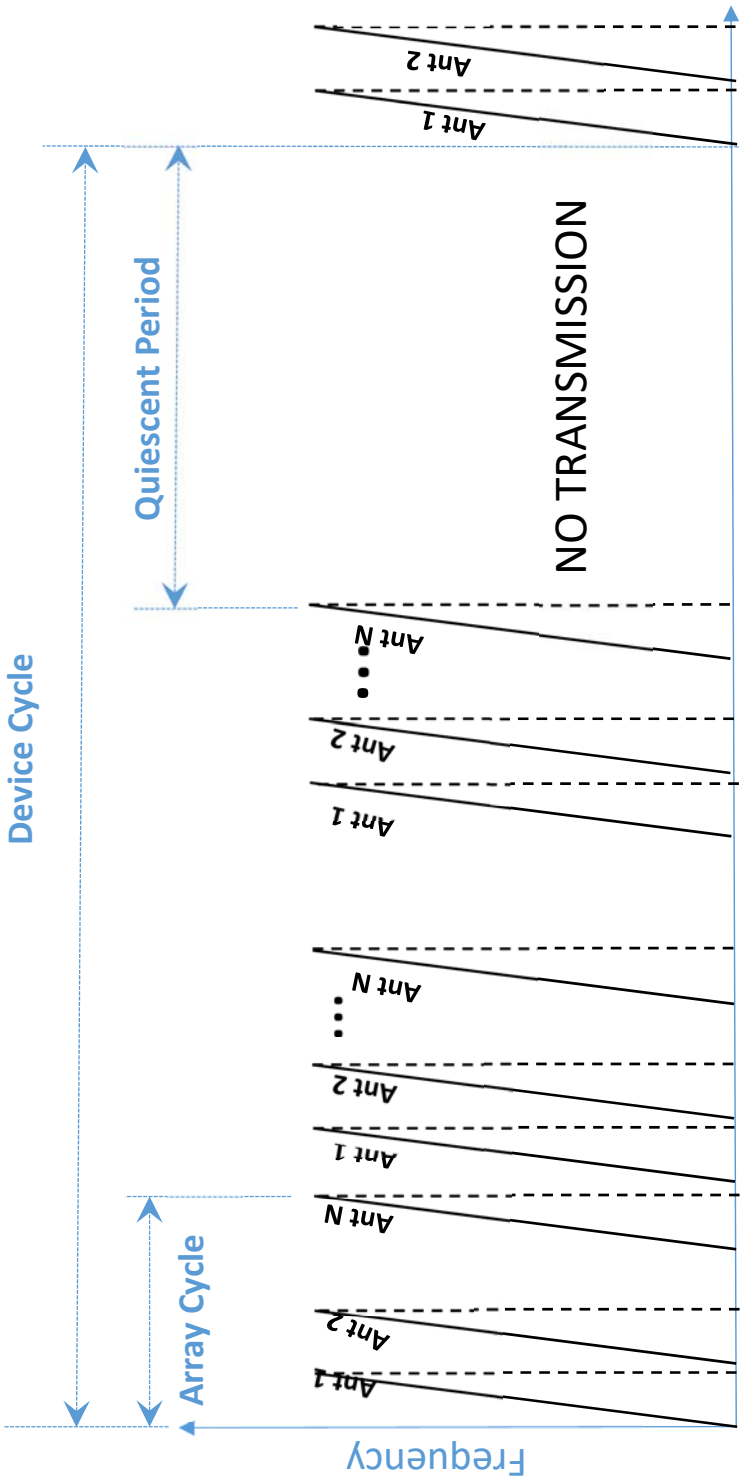
Ant 2
Ant 1
NO TRANSMISSION
Quiescent Period
Ant N
Ant 2
Ant 1
Ant N
Ant 2
Ant 1
Ant N
Ant 2
Ant 1
Array Cycle
Device Cycle
Frequency

Figure 1

II. WAIVERS REQUESTED FOR THE WITRACK SYSTEM

The Commission is authorized to grant requests for a waiver under Section 1.3 of the Commission's rules if the petitioner demonstrates good cause for such action.[22] Good cause may be found "where particular facts would make strict compliance inconsistent with the public interest."[23] "To make this public interest determination, the waiver cannot undermine the purpose of the rule, and there must be a stronger public interest benefit in granting the waiver than in applying the rule."[24]

MIT seeks certification for the WiTrack System as an indoor UWB transmitter under Part 15 of the Commission's rules. The public interest arguments for a waiver of various UWB rules are set forth herein and present a compelling case for authorizing the WiTrack System, which enables older adults to live a safer and more independent life, improves outcomes for patients, and reduces the cost of the healthcare system. In addition, the Commission's policy underlying its UWB rules will not be undermined because the WiTrack System is a very fast frequency sweeping device that sweeps 1.8-2.5 GHz of bandwidth and is similar to the 3d-Radar device and the Kyma uCor device that were granted UWB rule waivers.[25]

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[22] 47 C.F.R. § 1.3. *See also* 47 C.F.R. § 1.925(b)(3)(i) ("The Commission may grant a request for waiver if it is shown that: [t]he underlying purpose of the rule(s) would not be served or would be frustrated by application to the instant case, and that a grant of the requested waiver would be in the public interest . . . .").

[23] *ICO Glob. Commc'ns (Holdings) Ltd. v. FCC*, 428 F.3d 264, 269 (D.C. Cir. 2005) (citing *Ne. Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990)).

[24] Kyma Medical Technologies Ltd. Request for Waiver of Part 15 of the Commission's Rules Applicable to Ultra-Wideband Devices, Order, 31 FCC Rcd. 9705, ¶ 5 (Sept. 6, 2016) (citing *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969)) ("Kyma Waiver Order").

[25] *See* Kyma Waiver Order; Curtiss-Wright Controls Inc. Request for Waiver of Part 15 of the Commission's Rules Applicable to Ultra-Wideband Devices, Order, 27 FCC Rcd. 234 (Jan. 11, 2012) ("CWCI Waiver Order"); Proceq USA Inc. Request for Waiver of Part 15 of the

The Commission has shown a willingness to waive technical restrictions when a UWB device presents little threat of harmful interference and a waiver would further public interest goals. Indeed, many of the UWB waivers that the Commission has granted involve the same types of issues for which MIT seeks relief. For example, the Commission granted a waiver to Curtiss-Wright Controls, Inc. ("CWCI"), Kyma and Proceq regarding the specific minimum operational bandwidth of a UWB transmitter and the UWB measurement procedure outlined in Sections 15.503(d) and 15.521(d), respectively.[26]

A. Consistent with Recent Precedents, the Commission Should Grant a Waiver of Rule 15.503(d) Concerning the Definition of "Ultra-Wideband Transmitter"

Section 15.503(d) defines a UWB transmitter as a device "that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of fractional bandwidth."[27] In the past, the Commission staff has interpreted the phrase "at any time" to be synonymous with "instantaneous." Under this interpretation, the WiTrack System does not satisfy the UWB definition. Specifically, while the WiTrack System sweeps a continuous wave signal through a bandwidth of about 2 GHz, at each point in the sweep, the transmitted signal has a bandwidth less than 500 MHz, resulting in an instantaneous fractional bandwidth of less than 0.2 and individual transmissions of less than 500 MHz. Thus, MIT seeks a waiver of Section 15.503(d).

Commission's Rules Applicable to Ultra-Wideband Devices, Order, 33 FCC Rcd. 2258 (Mar. 14, 2018) ("Proceq Waiver Order").

[26] *See Kyma Waiver Order*; *CWCI Waiver Order*; *Proceq Waiver Order*.

[27] 47 C.F.R. § 15.503(d) (emphasis added).

Similar waivers have been requested and granted for stepped frequency devices. In particular, the FCC granted Curtiss-Wright Controls Inc. a waiver of Section 15.503(d) for its 3d-Radar, which identified the ambiguities in the rules as applied to continuous wave emitters and varying interpretations by the Office of Engineering and Technology ("OET") as to how the definitional requirements are satisfied for such devices. The Commission granted waivers of Section 15.503(d) for the Curtiss-Wright Controls 3d-Radar system, the Kyma uCor device, and the Proceq GPR device.

In granting the above waivers of Section 15.503(d) the OET observed that the original UWB rules were designed to accommodate devices that emit impulsive or transient-like signals that are spread across a very wide bandwidth. Further, OET considered whether the system was functionally equivalent to other UWB devices and that the risk of interference from the petitioned device will be no greater than from UWB devices. Specifically, in granting a waiver for the Proceq GPR, the OET stated that:

> The primary difference between the Proceq device and other UWB GPR devices provided for in the rules is that the Proceq GPR device uses stepped frequency CW modulation—*i.e.*, an array of closely spaced transmitting/receiving antennas that transmit sequentially over a large band of spectrum—to gather all the needed data. This modulation scheme is functionally equivalent to other types of UWB GPR devices in that it uses transient-like signals spread across a wide bandwidth. The risk of interference from the Proceq GPR device in this scenario is no greater than that from other such UWB GPR devices. Accordingly, we find that a waiver will not undermine the intent of our rule.[28]

Similar to the Proceq GPR device that received a waiver of Section 15.503(d), the WiTrack System differs from the impulse-based UWB devices that the Part 15 UWB rules were intended to address. Also, it uses swept frequency CW modulation—i.e., an array of closely

[28] *Proceq Waiver Order* ¶ 6.

spaced transmitting/receiving antennas that transmit sequentially over about 2 GHz of spectrum—to gather all the needed data. Since the Commission has considered the Proceq GPR device to be equivalent to other UWB GPR devices in that it uses transient-like signals spread across a wide bandwidth, the WiTrack System should be considered equivalent to other indoor UWB devices in the same sense. Hence, the WiTrack device does not pose more interference risk than the UWB indoor devices permitted under Commission rules given that the spectral density at any frequency and point in time will be less than that allowed under the rules. Indeed, as the Commission has noted, indoor systems suffer additional attenuation from the shielding provided by building walls, and therefore pose an even smaller risk of interference to other signals.[29]

Accordingly, for the reasons set forth above, and given the public benefits of the WiTrack System, MIT respectfully requests a waiver of Section 15.503(d).

B. Consistent with Recent Precedents, the Commission Should Grant a Waiver of the Measurement Procedures Defined in Sections 15.31(c) and 15.521(d)

Section 15.31(c)[30] defines the measurement standards for unlicensed devices to demonstrate compliance with applicable emissions limits and requires that swept frequency equipment measurements be made with the frequency sweep stopped. Section 15.521(d)[31] defines measurement procedures to demonstrate that operation of an UWB device is within applicable limits. For radiated emissions levels above 960 MHz, this rule requires that, if pulse

[29] Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order, 17 FCC Rcd. 7435, n.41 (Apr. 22, 2002) ("UWB First Report and Order").
[30] 47 C.F.R. § 15.31(c).

[31] 47 C.F.R. § 15.521(d).

gating is used and the transmitter is quiescent for longer intervals than the nominal pulse repetition interval, measurements are made with the pulse train gated on. MIT requests a waiver of both of these requirements to allow for RMS measurements to be done with the swept frequency function active and the averaging time being set to a full cycle including quiescent time during gating off. The WiTrack device will meet all other emission limits and technical requirements under the UWB rules.

The Commission has expressed willingness to consider alternate measurement procedures.[32] Further, the Commission has granted waivers of the above rules for other UWB transmitters operating above 960 MHz that use stepped-frequency modulation techniques by allowing measurement to take place under normal transmission mode, which also allows a measurement to account for the averaging time during which the UWB emitter is not transmitting.[33]

> In reaching its decisions, the Commission recognized that the interference aspects of a transmitter employing frequency hopping, stepped frequency modulation, or gating are quite similar, as viewed by a receiver, in that transmitters using these burst formats appear to the receiver to emit for a short period of time followed by a quiet period. The Commission concluded that any requirement to stop the frequency hopping, band sequencing, or system gating serves only to add another unnecessary level of conservatism to already stringent UWB standards.[34]

For the same reasons that the Commission granted waivers of Sections 15.31(c) and 15.521(d) for the CWCI 3d-Radar, the Kyma uCor, and the Proceq GPR device, we respectfully request that the Commission grant a waiver of these rules for the WiTrack System.

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[32] *Id.*

[33] *See Kyma Waiver Order*; *CWCI Waiver Order*.

[34] *Kyma Waiver Order* ¶ 11 (citing Petition for Waiver of the Part 15 UWB Regulations Filed by the Multi-band OFDM Alliance Special Interest Group, Order, 20 FCC Rcd. 5528, ¶ 13 (Mar. 11, 2005)).

The WiTrack System is similar to the aforementioned UWB frequency-stepping devices. In particular, like the Proceq GPR, the WiTrack System sweeps a narrow frequency signal no wider than 50 kHz (significantly less than 1 MHz) in a large bandwidth of about 2 GHz. It also uses an array of closely spaced antennas that transmit sequentially and inserts short quiet periods between transmission from different antennas. Further, since the WiTrack System uses swept frequency as opposed to stepped frequency modulation, its dwell time on any frequency is naturally less than 2 microseconds, which is the maximum dwell time that the Commission allowed in the waiver granted to the Proceq GPR. Additionally, the WiTrack System has a dwell time less than 0.04%, which is the maximum value allowed in the Proceq waiver.

The WiTrack system, like the stepped-frequency devices that were granted waivers for Section 15.521(d), spreads power over different frequencies and time periods to create a low average power. This is necessary to deliver the signal-to-noise ratio ("SNR") required to achieve high measurement sensitivity to capture weak physiological signals like breathing and heart rate.

For the reasons set forth above, and given the public benefits of the WiTrack System, MIT respectfully requests that measurements of the average power be conducted with the frequency sweep function active and the averaging performed over a full cycle of the WiTrack System. Similar to the Proceq GPR waiver, the dwell time at any frequency can be limited to less than 2 microseconds and 0.04 percent of the device's minimum scan/cycle rate.[35]

The prior discussion describes why the waivers requested will ensure that the WiTrack transmission behavior is comparable to existing UWB devices. Additionally, there is a low risk that WiTrack will cause harmful interference to incumbents in the frequency bands that

[35] *See Proceq Waiver Order*.

WiTrack proposes to use, which include non-UWB incumbents, such as Fixed Satellite Service uplinks, CARS (Cable Television Relay Service), and BAS (Broadcast Auxiliary Service). These non-UWB incumbent receivers are all outdoors, and further typically at significant height from the ground, in contrast to the MIT WiTrack device, which is intended for indoor operation. As noted, the FCC recognizes that indoor systems, unlike GPR, suffer additional attenuation from the shielding provided by building walls, and therefore pose a smaller risk of interference to other signals.[36] Thus, granting MIT a waiver is consistent with precedents and—given the benefits of the WiTrack System—is in the public interest.

III. CONCLUSION

The WiTrack System furthers an important public interest in clinical research and care management of patients and older adults. By enabling continuous in-home monitoring of health conditions and safety risks, the WiTrack System allows older adults to live more safely and stay longer in their own homes. Its remote monitoring capability can help doctors and health professionals attend to the needs of their patients while reducing the cost of healthcare. It can also reduce the cost of drug development and trial by providing new digital biomarkers.

Since there is little to no risk of harmful interference caused by the WiTrack System, the requested waivers are appropriate under the Commission's standards and precedents, and the Commission should grant these waivers as expeditiously as possible. Finally, because MIT develops technology to be built under license by others, MIT asks that any relief granted in

[36] Like other AC powered indoor UWB devices, WiTrack will communicate with one or more indoor receivers. The receiver may be collocated with the transmitter in some cases, while in others it may be separated from the transmitter. *See UWB First Report and Order*, ¶ 66.

response to this petition also be available to those who will build devices or provide services using the WiTrack System.

Respectfully submitted,

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