

August 7, 2019

Via ECFS

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
Washington, DC 20554

Re: Massachusetts Institute of Technology
ET Docket No. 19-89
Ex Parte Comments

Dear Ms. Dortch:

Massachusetts Institute of Technology ("MIT") hereby submits these *ex parte* comments with respect to the Reply Comments and questions raised by the Wi-Fi Alliance regarding coexistence between the MIT WiTrack device and Radio Local Area Networking ("RLAN").

Executive Summary

The Commission is currently evaluating the responses to its *Notice of Proposed Rulemaking* ("NPRM")¹ to allow unlicensed operation in the 6 GHz band under the Commission's Part 15 Rules. The Wi-Fi Alliance, in its filing, expressed an interest in understanding the coexistence between WiTrack and RLAN technologies envisaged under this NPRM.

MIT notes that its waiver petition and responses are related only to the WiTrack system, and do not in any way take a position on the NPRM.

MIT appreciates the interest of the Wi-Fi alliance in understanding the coexistence of WiTrack and RLAN. MIT believes that the WiTrack device does not raise coexistence concerns for RLAN. Section 1 describes the relevant WiTrack parameters and provides information that supports MIT's position that WiTrack raises no coexistence issues for RLAN. Further, as detailed in Section 1.4, the Commission has, in prior waiver reviews,

¹ Unlicensed Use of the 6 GHz Band, 33 FCC Rcd 10496 (rel. Oct. 24, 2018).

taken the position that detailed parameters are not necessary as long as the available information demonstrates that granting the waiver would lead to a negligible risk of interference.

MIT also notes that the WiTrack device has the potential to significantly improve the health and quality of life of the American public, as described in Section 2. A diversity of supporting letters from the AARP, LeoPharma, and Harvard Medical School Division of Geriatric Psychiatry/McLean Hospital argue that the passive, non-intrusive health monitoring enabled by WiTrack can improve health outcomes, reduce the costs of medical care, and enable new breakthroughs in drug development.

Given this combination of negligible risk of interference from WiTrack, and its profound positive impact on healthcare, MIT urges the Commission to move forward with the grant of its waiver petition.

1 WiTrack does not Raise Coexistence Concerns for RLAN.

MIT believes that the WiTrack device does not raise coexistence concerns for RLAN. In this section, MIT describes its reasoning in detail. We start by elucidating the operational parameters for WiTrack relevant to its coexistence with RLAN, then review coexistence of unlicensed devices under Part 15 and the implications for the coexistence of WiTrack and RLAN, and then answer specific points in the Wi-Fi alliance Reply Comments.

1.1 Operational Parameters of WiTrack Relevant to RLAN coexistence

MIT's petition provides a detailed description of the parameters of the WiTrack device for which MIT requests a waiver.² However, below, we highlight a few of the operational parameters that are most relevant to coexistence with RLAN.

- We request the waiver for the WiTrack system only for indoor operation. As described in the petition, the system requires connection to AC power.³

² Massachusetts Institute of Technology Petition for Waiver, December 27, 2018, at 6 – 12.

³ We specify this detail since it is the criterion for determining indoor operation listed in the FCC Part 15 regulations. 47 C.F.R. §15.517(a)(1).

- WiTrack transmissions are directed towards indoor areas in order to provide health and safety monitoring of the inhabitants of that area. The WiTrack transmit antenna gain is at most 6 dBi.
- The WiTrack peak transmission power is 0 dBm.
- The WiTrack transmission employs swept frequency modulation, often described in the technical literature as a chirp. This mode of transmission is similar to frequency hopping except that changes in the carrier frequency are continuous instead of discrete. WiTrack's chirp sweeps a bandwidth of at least 1.5 GHz.
- At any point of time, the signal occupies a maximum bandwidth of 50 kHz, that is, the 20dB instantaneous bandwidth is less than 25 kHz.
- The device operates in cycles which last for up to 64 ms.
- The device duty cycle (the percent of time spent in any frequency in a device cycle) is less than 0.04%.
- The average power limit is -41.3 dBm.
- Since WiTrack measures motion with respect to itself, it is intended to have a fixed position, and is typically mounted on the wall like a picture frame.

For clarity, MIT is not requesting a waiver for operation of the WiTrack system in automobiles. Also, for clarity, there is no intention to have WiTrack and the proposed RLAN technologies in the 6 GHz reside on the same device.

1.2 Coexistence and Operation of Unlicensed Devices Under Part 15

In this section we make four points:

1. First, the NPRM, while focused on Wi-Fi/RLAN, is more generally targeted at unlicensed use of the 6 GHz band. The Commission states that its proposals “draw from, and are consistent with, the existing technical rules applicable to Unlicensed National Information Infrastructure (U-NII) devices that already operate in the 5 GHz band.”⁴ The WiTrack specifications and operational parameters as stated above are significantly more conservative than the constraints imposed on unlicensed frequency hopping devices in the 5 GHz band,⁵ and the power constraints proposed for unlicensed operation in the 6 GHz band.⁶ Therefore, the WiTrack waiver is aligned with the Commission's expressed intent in the NPRM.

⁴ NPRM ¶ 2.

⁵ 47 C.F.R. §15.247.

⁶ NPRM App. B, Proposed Section 15.407.

2. Wi-Fi has successfully coexisted and thrived under the existing Part 15 rules and in the presence of unlicensed devices that use modulations closely related to WiTrack but transmit at a much higher peak power. For instance, in the 5725-5850 MHz Band authorized at 47 CFR §15.247, the FCC permits unlicensed frequency hopping devices with maximum peak conducted output power of 1 Watt, and a duty cycle of 0.4 second in each 30 seconds. In comparison, the WiTrack system which is effectively a continuous-carrier frequency hopping system transmits at a much lower peak power of 1 mW and has a much smaller duty cycle of 0.4%. Accordingly, WiTrack imposes negligible coexistence concerns in comparison to existing unlicensed spectrum use regulations, and, therefore, should not hamper RLAN operation.
3. As stated by Section 15.5 of the Commission's Rules, and also noted by the Wi-Fi alliance in its filing, no Part 15 device is entitled to regulatory protection from interference. Notwithstanding this, MIT believes that the information provided in its original petition and this filing demonstrates that RLAN can coexist with WiTrack during simultaneous unlicensed operation.
4. Finally, as detailed in the original petition, the waiver is aligned with the Commission's past waivers for UWB frequency hopping devices operating under part 15 Subpart F. MIT would like to reiterate its remarks in the original petition that its WiTrack device is an UWB device, which is under the ambit of Part 15, Subpart F of the FCC Rules. MIT is only requesting a waiver of Section 15.503(d), and the measurement procedure in Sections 15.31(c) and 15.521(d). The Commission has already waived these rules and procedures for several UWB radios that use gating and frequency stepping, while determining that such waivers will not undermine the intent of the Commission's rules. MIT's request is in the same spirit as these existing waivers.

1.3 Response to Specific Points Raised by the Wi-Fi Alliance

In this section, we address specific questions raised by the Wi-Fi Alliance in relation to co-existence with RLAN. However, before delving into the details, we emphasize that we believe the WiTrack specifications provided in the original petition and in Section 1.1 above are sufficient to evaluate coexistence with RLAN, while providing MIT, as a research institution, the flexibility necessary to innovate and evolve its design. Such

flexibility is essential in order to meet new health monitoring requirements and improve accuracy for the health metrics captured by the device.

1. **Deployment Density:** In their Reply Comments, the Wi-Fi Alliance has asked about typical deployment densities. MIT notes that WiTrack's usage mode is that any particular area is covered mainly by a single WiTrack device. Hence, when a second WiTrack device is deployed, it is only to cover locations that are not covered by the signal from the primary WiTrack device. Such a sparse deployment model naturally ensures that multiple WiTrack devices do not jointly create additional interference in any particular location. Furthermore, the wide bandwidth of operation of the WiTrack device implies that it is extremely unlikely that two WiTrack devices are active in the same RLAN band at the same time. For instance, because WiTrack sweeps at least 1.5 GHz of bandwidth, the probability that two WiTrack devices are transmitting in the same 20 MHz RLAN channel is ~ 0.01 and the probability that three WiTrack devices are transmitting in the same band is ~ 0.0002 .
2. **WiTrack Quiet Period:** Given that WiTrack uses a chirp-based modulation, and sweeps at least 1.5 GHz, and due to the significant difference between the peak and average power requirements, WiTrack has to be quiet in any RLAN band for almost all the time. While we expect RLAN to be able to sustain communication even when WiTrack is actively transmitting in the RLAN band (see next point), we understand that the Wi-Fi Alliance may want to ensure that WiTrack has sufficiently long periods where it is *completely* quiet (i.e. periods when WiTrack does not transmit in any frequency) that are longer than an RLAN packet. In order to allow MIT to continue to innovate in scheduling transmissions while still ensuring that the quiet time is not overly fragmented, MIT is happy to stipulate that in any WiTrack device cycle, at least 50% of the time is completely quiet, and that this 50% completely quiet time is never fragmented more finely than 1 millisecond intervals. We believe that 1 millisecond is a reasonable bound since the original average power measurement scheme under 47 C.F.R. §15.521(d), which we are asking to be waived, performs the average measurement over 1 ms.
3. **Low Peak Power:** The previous two points note that WiTrack does not transmit in any particular RLAN band for almost all the time. However, even when WiTrack is transmitting, its peak power is 0 dBm. To compare this power to RLAN transmission power, MIT notes that WiTrack devices are analogous to RLAN access points, in that there are typically only one or two per home, and in a fixed

position, similar to RLAN access points. WiTrack's 0 dBm peak power is 24 dB below the output power of an RLAN AP in the low power access point scenario, and 30 dB below the output power of RLAN in the standard power access point scenario.⁷ Unlike RLAN, WiTrack does not have active clients, and relies only on reflections of the transmitted signal from the environment. The power of these reflections is typically negligible compared to the 18 dB output power of RLAN client devices. As such, this considerable power advantage of both RLAN APs and clients ensures that RLAN devices are likely to attain sufficient SNRs and operate successfully in most locations even in the presence of a WiTrack device in the same RLAN bands.

4. **Automatic Gain Control (AGC):** The Wi-Fi Alliance has asked about the interaction between WiTrack and the RLAN's AGC. As mentioned earlier, for at least 50% of the time, WiTrack is completely quiet and hence will have no impact on the AGC during those periods. In the remaining 50% of the time, there are three scenarios: (1) WiTrack transmits during the Short Training Sequence (STS) used to determine the AGC setting for the packet, but not during data symbols, (2) WiTrack does not transmit during the STS, but does transmit during a data symbol, or (3) WiTrack transmits during both STS and data symbols. Cases (1) and (3) allow the RLAN receiver to successfully receive packets. Case (2) might cause some clipping of the RLAN samples impacted by the WiTrack transmission. However, given the disparity in power between WiTrack and RLAN, the clipping is likely negligible.
5. **User Choice and Control for Guiding Deployments:** The Commission has affirmed the importance of prioritizing user choice and control in determining their wireless environments. Users can further improve co-existence between WiTrack and RLAN AP with a small standoff. Specifically, a small standoff of two meters reduces the WiTrack power at an RLAN receiver by about 50 to 60dB.⁸ The reduction can be made even larger by exploiting the directionality of WiTrack. Given that there is already a significant disparity in transmission power between WiTrack and RLAN, this additional standoff would eliminate any residual

⁷ NPRM, App. B, Proposed Section 15.407(a)(4) and (5).

⁸ Recommendation ITU-R P.1238-9 (06/2017) Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz P Series Radiowave propagation – Pages 4 and 5 - https://www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.1238-9-201706-!%PDF-E.pdf

interference concerns. Note that a standoff of a few meters is reasonable, and often natural, given the typical Witrack deployment scenario where the device is mounted on the wall with some spatial separation from furniture and clutter. Further, even in dense apartment situations, the fact that WiTrack devices are deployed directed inwards at people's dwelling locations means that WiTrack signals are significantly below the RLAN noise floor once they propagate through the user's dwelling and traverse through walls into neighboring homes, and do not pose an interference concern to neighboring residences.

1.4 The Commission's Precedents support Grant of the Waiver Based on the Provided Information.

The Commission has over many years considered the alleged potential impact of devices for which waivers have been sought. In cases in which the technical details of the proposed device or technology are set forth with reasonable particularity, the Commission has found such specifications sufficient to reach a decision without prolonged additional debate even in the face of opposition demands for additional information. Thus, in *Dexcom*, the agency was able to review the record in the pleadings and determine that the information submitted concerning Dexcom's proposed diabetes monitoring "demonstrated that there is little risk of harmful interference caused by or occurring to the devices" and that notwithstanding assertions by an opponent that the FCC did not have complete information regarding the RF characteristics of the devices, "the information available is sufficient to make this determination when considered in the light least favorable to DexCom."⁹

This decision was importantly informed by the Commission's earlier decision, *In re Biotronik, Inc.*, granting a waiver for another medical device not contemplated in the rules.¹⁰ Biotronik's request was initially denied for failure to make an adequate showing, but, after it supplied additional information, and in the face of opposition, the Commission determined that "[t]he potential for the subject devices to cause harmful interference to other MICS devices or to receive harmful interference is negligible. The Commission went on to note that the subject devices operate with a combination of frequency and duration such that the possibility that two devices would be operating simultaneously in close proximity was extremely small. It also disagreed that several scenarios proposed by the

⁹ *DexCom, Inc.*, 21 FCC Rcd 875 (2006), ¶ 16; see also *Google LLC*, 33 FCC Rcd 12542 (2018).

¹⁰ *In re Biotronik, Inc.*, 19 FCC Rcd 4208 (2004).

opponent created a risk of interference based on the functionality of the device, its power, frequency and duration of its transmissions. The FCC also took note of the relative isolation of the devices in their use case and ultimately determined there was a need for the waiver in order to provide the therapeutic benefits to be delivered.¹¹

2 WiTrack has significant health benefits for the American public.

Diagnosis, management, and treatment of health conditions and illnesses today impose significant mental and economic burdens on patients, their families and caregivers, and the American economy at large. This is becoming especially important as the U.S. population is aging, leading to an increase in the prevalence of chronic conditions and a surge in healthcare costs. The passive, non-intrusive health monitoring enabled by the WiTrack system promises to alleviate these challenges and improve healthcare costs and outcomes, as described by the supporting letters from AARP and the Harvard Medical School Division of Geriatric Psychiatry/McLean Hospital. Further, such passive monitoring has broader application in empowering medical and clinical researchers, and providing new digital biomarkers to enable drug development, as detailed in the supporting letter by LeoPharma Science & Tech Hub. We expand on these points below.

- **Enabling Independent Living for the Aging Population:** As the AARP describes in its supporting letter:¹²

By 2035, the United States will, for the first time ever, be a country comprised of more older-adults than of children. The U.S. Census Bureau projects there will be 78 million people age 65 and over compared to 76.4 million under the age of 18.1 This demographic change will bring both opportunities and challenges. The number of people age 85 and older will increase from about 14 percent of the older population today to 21 percent in 2050.

The AARP letter further highlights the desire of seniors to continue to live in their homes and maintain their independence.

87 percent of adults age 65+ want to stay in their current home and community as they age. Among people age 50 to 64, 71 percent of people want to age in place.

¹¹ Id. ¶¶13 – 15.

¹² Letter of May 23, 2019, from David Certner, Legislative Counsel and Policy Director, Government Affairs, AARP.

Many studies, including those conducted by the Center for Medicaid Services (CMS), have noted that remote patient monitoring systems (like WiTrack) can address the new challenges presented by these changing demographics, as it allows patients to share more live-time data with their providers and caregivers, and thereby receive more tailored care and ultimately, better health outcomes.

The AARP letter specifically emphasizes the importance of the passive monitoring enabled by WiTrack.

Home-monitoring technologies, such as those relevant to this waiver, are promising because their radar-like functionality ensures the intended user is not required to wear sensors, change their daily behaviors, or remember to engage the monitoring technology once initiated. This ease and convenience facilitates greater adoption and impact.

- **Reducing the costs of healthcare:** Chronic conditions affect 90% of the senior population, and account for nearly two thirds of the 3 trillion dollars of annual healthcare costs in the United States. A significant percentage of hospitalizations in chronic diseases are potentially avoidable if we have the ability to monitor health metrics in the home, detect early signs of degradation, and alert medical professionals to enable timely interventions.

In addition to chronic conditions, medical emergencies are a serious health and economic concern as well. The AARP highlights the health and economic impact of falls in its letter:

[F]alls are the leading cause of accidental death and injury in older adults. With 30 percent of adults age 65 or older experiencing falls annually, the cost of such accidents is estimated at \$50 billion a year. For nonfatal falls in adults aged 65 and older, Medicare paid approximately \$28.9 billion, Medicaid \$8.7 billion and private and other payers \$12.0 billion. Overall medical spending for fatal falls was estimated to be \$754 million.

The AARP proceeds to emphasize the need for in-home health monitoring, stating:

As the population ages, and the need grows, effective prevention and early-detection technologies are becoming a necessity.

...

Consumer-directed, remote health-monitoring technology is required to make this a reality.

The WiTrack system described in this waiver petition can address these needs with its ability to continuously and passively monitor health conditions in the home. It has been demonstrated through multiple studies conducted in partnership with doctors and medical researchers, and through peer reviewed publications, that the WiTrack system can passively and continuously measure gait, activity levels, breathing, heart rate, sleep quality, sleep stages, and falls, hence promising to fill in a critical gap in today's healthcare system. In particular, MIT has presented a live demo in the White House demonstrating the ability of WiTrack to detect falls without requiring users to wear pendants or wearables.¹³

- **Managing complex conditions like Alzheimer's and related dementias:** The supporting letter from Harvard Medical School Division of Geriatric Psychiatry/McLean Hospital¹⁴ identifies the challenges presented by Alzheimer's disease and psychiatric illnesses in an aging population:

Alzheimer's disease and related dementias currently affect 5.8 million Americans with prevalence numbers expected to nearly triple by the year 2050. The behavioral symptoms of dementia, including agitation, aggression, depression and psychosis, are nearly universal over the course of illness, drive morbidity and mortality associated with dementia, increase long term care placement and hospitalizations and contribute greatly to caregiver burden and stress.

The letter proceeds to describe how doctors at Harvard Medical School have successively used the WiTrack system to detect and quantify some symptoms associated with anxiety and agitation, commonly exhibited patients with dementia and Alzheimer's. It also highlights the unique aspects of WiTrack that allow it to fill in the needs of doctors caring for Alzheimer's patients:

¹³ https://www.youtube.com/watch?time_continue=737&v=aKsxHS5vptM (last accessed August 6, 2019).

¹⁴ Letter of April 13, 2019, from Brent P. Forester, MD, MSc., Chief of Geriatric Psychiatry, McLean Hospital, and Associate Professor of Psychiatry, Harvard Medical School.

Witrack directly improves patient monitoring, particularly for older patients, since traditional monitoring methods, which often require the patient to regularly charge and wear one or more devices on their body, are ill suited to their needs

...

Witrack fills a crucial gap in treatment and care for geriatric and psychiatric patients. A key difficulty in providing care for such patients is getting reliable information about their health status and activities to understand their condition and progress. Today, doctors have to rely on incomplete, and often inaccurate, information from patients and caregivers. Witrack's ability to provide accurate and objective measurements without encumbering patients in any way will allow doctors to make more informed decisions, and ultimately improve healthcare outcomes for the U.S's aging population.

- **Supporting clinical research and drug development:** Beyond its benefits to older adults and the chronically ill, WiTrack offers a new ability to medical and clinical researchers to get a fine-grained, detailed understanding of disease manifestation and progression, as well as medication response. This is because WiTrack enables continuous measurement, not just of existing health parameters, but also entirely new metrics relevant to disease that have hitherto been complex or impossible to measure. These abilities have positive implications for all population segments. In its support letter, LeoPharma Science and Technology Hub¹⁵ has noted these benefits:

The Witrack device enables companies like us to perform better clinical research, understand patient needs, and react to them in a more effective way. Further, it can lead to the validation of a new standard of measurement for itching to be used as an end-point in clinical trials. Such a measurement of itching can also fundamentally change the way in which doctors manage skin conditions by allowing them to monitor their patients' condition and adjust medication dosage and regimen on an individual basis. The net result will be a significant improvement in the health outcomes and quality of life for a large population - over 10 million children, and 7 million adults.

¹⁵ Letter of April 13, 2019, from Michael Sierra, PhD, Vice President, LEO Science & Tech Hub.

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3 Concluding Remarks

In summary, MIT submits that the WiTrack device for which the waiver is requested does not raise coexistence concerns for RLAN, and that Commission precedent, therefore, supports moving forward to approve the waiver based on the information presented in the original waiver petition and this filing. In light of this and the fact that the WiTrack technology can have an immediate and significant benefit for the health outcomes, medical costs, and quality of life of the American public, MIT would appreciate the Commission's timely and favorable consideration of its petition for the waiver to permit the operation of the WiTrack device.

Respectfully,

/s/ *Dina Katabi*

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