

## Attachment A – Background Information – 0879-EX-CN-2019

This application is intended to replace WO9XJM (0671-EX-ST-2019) and WJ2XEA (0775-EX-CN-2017), which expire in the near-term; to include TV white spaces for experimentation; to increase power levels slightly;<sup>1</sup> and to expand the geographic footprint in California to allow important research being conducted with the United States Geological Survey (“USGS”) in remote locations of the state. A larger footprint is also being requested in Pennsylvania to cover all of Allegheny County.

Carnegie Mellon University (“CMU”), an international research university, wishes to use both commercial and experimental radios (LoRa-based radios) operating in the TV white spaces, 430-440 MHz band and the ISM band (902-928 MHz).<sup>2</sup> The intention is to expand its research beyond current discoveries and to enable other entities, such as the USGS<sup>3</sup> and the United States Army and Navy, to improve their operational performance through the use of advanced radio technology. CMU’s research, both under earlier experimental licenses and this application, is not intended for future commercial use by CMU.

The University shares the results of its research directly with affected federal agencies, as well as with other interested parties through presentations at academic conferences, other events and in scientific and engineering papers and journals. This information to be shared would include: a) The complete program of research and experimentation proposed including

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<sup>1</sup> While CMU has proposed to increase power (EIRP) to 10w in order to advance its research, CMU will make reasonable efforts to use only the minimum power level at each station necessary for reliable communication.

<sup>2</sup> In addition to the Ettus Research devices listed in Form 442, CMU has have developed and will continue to develop experimental devices for communication using the LoRa protocol (linear chirp, spread spectrum, 125 and 500 kHz bandwidth). This equipment includes the use of directional antennas, installation of antennas on man-made structures and vegetation (trees), and both mobile and fixed operation. The radio modules themselves are designed to deliver power at their respective outputs of +22 dBm.

These may be combined with antennas and antenna arrays for each specific device installation as may be required (including omni, Yagi-Uda, patch, grid, dish, sector with gains up to +18 dBi and with switchable polarization).

Representative antennas include, but are not limited to:

- <http://www.l-com.com/wireless-antenna-900-mhz-13-dbi-120-degree-sector-panel-antenna>
- <http://www.l-com.com/wireless-antenna-824-960-mhz-15-dbi-die-cast-grid-antenna>
- <http://www.l-com.com/wireless-antenna-900-mhz-14-dbi-heavy-duty-yagi-antenna-n-female-connector>
- <https://www.ui.com/airmax/airmax-yagi-antenna/>
- <https://www.telcoantennas.com.au/optus-rfi-16dbi-yagi-directional-antenna>

<sup>3</sup> For example, CMU has supplied USGS with combination radio-sensor devices that are often placed on a pole in seasonally dry stream valleys to measure water volume and depth during flash floods. USGS is planning to use these devices in other states, with appropriate radio authorizations, without the direct participation of CMU. CMU’s research enables these devices to operate for several years on small batteries. This is but one example of how CMU’s radio experiments have directly benefited the public interest.

description of equipment and theory of operation; b) The specific objectives sought to be accomplished; and c) How the program of experimentation has a reasonable promise of contribution to the development, extension, expansion or utilization of the radio art, or is a long a line not already investigated. CMU would not share any information that a government agency determined to be confidential in nature.

In order to promote more efficient research, while protecting the rights of existing licensees in the affected bands, CMU requests the Commission consider modification of certain conditions imposed on WO9XJM and WJ2XEA. Specifically,

- WO9XJM condition 3.<sup>4</sup> *“Operation is subject to consent of the following licensees within 50 miles of the contours of the testing area: Location & Monitoring Service (“LMS”) licensees (902-928 MHz).”* Given the large footprints for LMS licenses and the fact that there only two LMS companies in both California and Allegheny County, Pennsylvania (Progeny LMS, LLC and Telesaurus Holdings GB LLC), it would be extremely burdensome for CMU and the licensees to develop such understanding each time an experiment is conducted and/or if the CMU experiment is sufficiently far from the location of an existing LMS antenna<sup>5</sup> that path loss will result in the experimental signals being well below the noise floor at the licensed location, thereby posing little practical possibility of harmful interference. Indeed, the LMS licensees are far more likely to experience harmful interference from nearby Part 15 devices in the 902-928 MHz band than they would experience from CMU’s experiments. A baby monitor operated on 100 milliwatts near an LMS service provider’s facility in a metro area will produce much more interference than CMU’s devices will operating on 10 watts at a distance of 25 miles.

Accordingly, CMU requests that it be required to notify operating LMS licensees only when it proposes to conduct an experiment within the boundaries of the 50 largest Metropolitan Statistical Areas at more than 5 watts of power.

- WO9XJM condition 4. *“At least 2 weeks prior to emitting, Carnegie Mellon University must coordinate with the Vandenberg Air Force Base Spectrum Manager Shane Berg. Mr. Berg’s phone number is 805-605-3660.”* Vandenberg AFB is located in Santa Barbara County in the southern half of California and near the Pacific Ocean. Many of CMU’s experiments, especially those connected with USGS, will be conducted in the

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<sup>4</sup> The same condition is imposed under WJ2XEA. See condition 5.

<sup>5</sup> It is important to note that buildout of LMS networks has been slow, most especially in rural areas where much of CMU’s experiments will be conducted. *Request of Progeny LMS, LLC for Waiver and Limited Extension of Time*, Order, 32 FCC Rcd 122 (2017). Moreover, NextNav, the owner of Progeny LMS, LLC, states “The NextNav network is designed to complement the GPS satellite constellation. While GPS works well in rural areas and outdoors, its space-based infrastructure doesn’t work well in urban areas or indoors. NextNav is focusing its initial deployment on the areas where GPS isn’t reliable, such as suburban and urban areas where indoor usage of location services is the norm. We use our own spectrum, and devices equipped with our technology switch seamlessly between GPS and NextNav’s service.” <http://www.nextnav.com/network> (accessed October 15, 2019).

A quick glance at the ULS database suggest that many of Telesaurus’s licenses have expired.

northern and western parts of California. It would be burdensome for both CMU and the Air Force to address proposed experiments that could be hundreds of miles from Vandenberg AFB. Instead, CMU proposes to contact the Air Force two weeks before CMU emits when such planned emission is within 25 miles of the Base. This is quite reasonable given the low power limits for CMU's experiments.

- WJ2XEA condition 1. *“Operation is subject to prior coordination with the local Society of Broadcast Engineers, Inc. (SBE) frequency coordinator. Consult the list at [http://freq.sbe.org/pdf\\_files/coordinators.pdf](http://freq.sbe.org/pdf_files/coordinators.pdf) to find the appropriate coordinator.”* Once again, coordination between CMU and SBE for each experiment could be quite burdensome for both entities. Instead, CMU proposes to use Google's white spaces database before commencing an individual experiment to find available frequencies of operation and restricting CMU's use to such frequencies as the Google database may, from time to time, show as available. This should provide licensees in the white spaces band sufficient protection from interference while avoiding additional expenses for both SBE and CMU.

CMU conducts many of its “on-location” experiments from its mobile RF laboratory (a retrofitted EMT rescue vehicle, length 7 meters, height 2.7 meters) with an extendable antenna mast (16 meters maximum from the top of the mast to the bottom of the tires). See Attachment B. This vehicle will be deployed at Camp Roberts and around the rest of the state. Accordingly, it is impossible to provide exact details requested in the questions about antenna height except at Camp Roberts.<sup>6</sup>

Other experiments will be conducted with mobile transmitters outside the mobile lab.<sup>7</sup> When operating in locations within 805 meters of a covered airport, CMU will make notifications to the Federal Aviation Administration (“FAA”) as explained in Section 17.7 of the Commission's rules, 47 C.F.R. § 17.7.

Since the Military and USGS-related experiments will be ongoing, CMU requests that it be granted an experimental license for the maximum period of five years. Section 5.71(a), 47 C.F.R. § 5.71(a).

Also, CMU is seeking approval of this application to continue its work with remote sensing using radio technology and CMU-created sensing platforms. CMU has created sensors that measure changes in intermittent stream depth and water flow volumes and speed. These are placed in streambeds and monitored remotely. Similarly, CMU has created sensors that measure traffic volumes and speeds. These are sometimes embedded in freeway entrance or exit ramps.

The goal is to develop long-lasting, battery-powered devices that are embedded in a single location for as long as five years. Therefore, a single experiment in one location could last

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<sup>6</sup> CMU's application includes antenna height location for Camp Roberts and is the same as that which was approved as part of W12XPQ.

<sup>7</sup> A wide range of antenna types including omni and directional, including but not limited to ceramic, patch, Yagi, and stacked-Yagi sector types. CMU's use of directional antennas will be in compliance with Part 15, Subpart C of the FCC's rules.

five years if the batteries survive. One of the experimental goals is to minimize battery use through efficient sensing and radio transmission. With a shorter license term, the devices would need to be removed mid-test and the research goal frustrated.

Such a grant would allow more CMU resources to be spent on research, rather than on license renewals. Further, CMU has a good compliance record with Commission rules, such that a longer license term does not increase the risk of harmful interference.

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