PAWR Project Office

July 15, 2019

Ira Keltz, Chief
Electromagnetic Compatibility Division
Office of Engineering and Technology
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Dear Mr. Keltz:

As we have previously discussed, I am writing to you in my role as the Principal Investigator and Project Director for the Platforms for Advanced Wireless Research Project Office. As a part of this project, we previously wrote to you requesting that the FCC establish two Innovation Zones, one in New York City, and the other in Salt Lake City, per 47 CFR 5.313 and the Public Notice published on April 14, 2017. That letter, sent on March 1, 2019, is attached here as Enclosure A for reference.

We currently understand that the FCC is reviewing our request for the creation of these Innovation Zones. As a part of your review, we would like to amend our previous letter to include one additional frequency band in the table of frequencies requested for each Innovation Zone, as well as one additional frequency band in Salt Lake City. The frequency bands we would like to add include the 3700-4200 MHz band in Salt Lake City (which was previously listed just for New York City) as well as the 5925-7125 MHz band for both Salt Lake City and New York City. Revised tables of requested frequencies for each Innovation Zone are included as Exhibit 1 (Salt Lake City) and Exhibit 2 (New York City) below. The requested additions are highlighted in each table in yellow.

We understand that there may be further details required by the FCC in consideration of this request. Please do not hesitate to contact me with any additional questions or requirements.

Sincerely,

Joseph Kochan
Project Director

EXHIBIT 1

TABLE for POWDER Requested Frequencies of Operation

Frequency Band	Maximum power (dBm)	Type of operation	Allocation
698-763 MHz	65	Fixed & Mobile	Non-federal
914.87-915.13 MHz	65	Fixed & Mobile	Shared
1710-1780 MHz	65	Mobile	Shared
2110-2180 MHz	65	Fixed	Non-federal
2390-2483.5 MHz	65	Fixed & Mobile	Shared
3300-3600 MHz	65	Fixed & Mobile	Shared
3700-4200 MHz	65	Mobile	Non-federal
5650-5925 MHz	55	Fixed & Mobile	Shared
5925-7125 MHz	65	Fixed & Mobile	Non-federal

EXHIBIT 2

TABLE for COSMOS Requested Frequencies of Operation

Frequency Band	Maximum power (dBm)	Type of operation	Allocation
2500-2690 MHz	20	Fixed	Non-federal
3700-4200 MHz	20	Mobile	Non-federal
5850-5925 MHz	20	Mobile	Shared
5925-7125 MHz	20	Fixed & Mobile	Non-federal
27.5-28.35 GHz	20	Fixed	Non-federal
38.6-40.0 GHz	20	Fixed	Non-federal

ENCLOSURE A

Copy of March 1, 2019 letter sent by the PAWR Project Office to the FCC requesting consideration of the creation of two Innovation Zones, in Salt Lake City and New York City.

PAWR Project Office

March 1, 2019

Ira Keltz, Chief
Electromagnetic Compatibility Division
Office of Engineering and Technology
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Dear Mr. Keltz:

As we have previously discussed, I am writing to you in my role as the Principal Investigator and Project Director for the Platforms for Advanced Wireless Research Project Office. As a part of this project, we are requesting that the FCC establish two Innovation Zones, one in New York City, and the other in Salt Lake City, per 47 CFR 5.313 and the Public Notice published on April 14, 2017. Further details about the project and this request are below.

Innovations in wireless communication networks and applications relying on them have now become vital components driving the nation's economic growth and productivity. Sustaining the rapid growth in these technologies is essential to maintaining the nation's leadership and economic competitiveness. In July 2016, the National Science Foundation announced a multi-year effort, called Platforms for Advanced Wireless Research (PAWR), aimed at creating a set of city-scale testbeds to promote research in advanced wireless communication and networking technologies over the next decade. In this effort, the NSF was joined by a Consortium of 29 technology and telecommunications companies, including all four major US wireless carriers, with commercial interests in the wireless technologies resulting from this investment. PAWR will enable experimental exploration of robust new wireless devices, communication techniques, networks, systems, and services that will revolutionize the nation's wireless ecosystem, thereby enhancing broadband connectivity, leveraging the emerging Internet of Things (IoT), and sustaining US leadership and economic competitiveness for decades to come. PAWR will also enable rapid commercialization of promising technologies, bringing jobs and economic vitality. Researchers will have access to realistic, city-scale testbeds for testing new wireless theories and concepts, while a whole new generation of participating graduate students will emerge with hands-on practical training.

In order to support the design, development, deployment, and operations of the advanced wireless research platforms, the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE) selected US Ignite and Northeastern University to form the PAWR Project Office (PPO). Working closely with the wireless research community, the PPO has responsibility for design, development, and deployment of a set of advanced wireless research platforms. Upon successful completion of the design of advanced wireless research platforms, the PPO will proceed to the development and deployment phases with funding provided by NSF as well as the 29-company Industry Consortium. The PPO will professionally establish and manage the advanced Research Platforms needed to unleash American innovation, drive economic development, and help extend US global leadership in

the wireless industry. The PPO works closely with the wireless research community in all aspects of the design, development, deployment, and operations of PAWR. A PAWR Steering Council (PSC), comprising research leaders in wireless networking technologies and a subset of the Industry Consortium, represents the community's research interests in PAWR. The PSC is chartered and supported by the PPO, with the goal of obtaining advice on all aspects of the deployment and operations of the advanced wireless research platforms.

The PPO is the main point of consolidation and oversight for all funds and resources contributed by the Industry Consortium and NSF to construct and operate the platforms. Upon selection and approval of a platform location and operator, the PPO will subaward a total of $50 million in funds to the selected project and, at the same time, issues up to an additional $50 million in equipment, funds, and other resources promised by Industry Consortium partners necessary for the deployment of this platform. The PPO then governs the release of these funds and resources to the platform via suitable funding vehicles (e.g., subawards, contracts, gifts), subject to the platform's adherence to the project plan and reporting and compliance milestones.

In March 2018, the PPO concluded its first-round selection of two platforms:

- **COSMOS**, run jointly by Rutgers University, Columbia University, and New York University in partnership with the city of New York and located in west Harlem; and
- **POWDER**, run jointly by the University of Utah and Rice University in partnership with and located in Salt Lake City.

In order to operate these wireless research platforms most effectively, the PPO is requesting FCC designation of 2 Innovation Zones – on each in New York City and Salt Lake City. The research platforms are described in further depth below. The geographic boundaries and frequencies of operation of each requested Innovation Zone are detailed in **Exhibit 1 and 2** respectively. Per our discussions, the PPO, represented by PAWR, LLC (FRN: **0027193036**) proposes that it be the designated entity responsible for these Innovation Zones.

Below, please find a brief description of the COSMOS and POWDER platforms.

COSMOS: Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment

This project creates a city-scale platform for advanced wireless research that will be deployed over the period 2018 - 2023 in New York City, NY. This Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment (COSMOS) supports at-scale experimentation of novel advanced wireless broadband and communication technologies in the sub-6 GHz bands and in the millimeter wave frequency bands in a densely populated, urban setting. The project features interactions with regional networks and smart community initiatives including municipalities, non-profits, and various tech communities with interest in contributing to and/or using the testbed for application development. The ability to use this platform by early adopter companies/startups, global telecom industry and application developers to evaluate technologies in their pre-commercial phase will have a significant positive impact on the speed of innovation in the data networking and application domains. This effort will also benefit educators and students at all levels of study in communications-related disciplines.

Radio nodes in COSMOS provide a mix of fully programmable software defined radios (SDRs) for flexible wireless experimentation as well as commercial hardware capable of supporting networking and applications research with currently available end-user devices. COSMOS is built in a bottom-up manner with commodity components and customized open-source hardware and software modules. The developed wireless platforms cover the full range of spectrum including the sub 6 GHz bands used for today's services as well as emerging 28 GHz and 60 GHz millimeter-wave (mmWave) bands. SDRs utilize a new design that achieves an order-of-magnitude performance headroom over current technology, achieving real-time processing of wide bandwidths (~500 MHz) via novel acceleration techniques. The COSMOS platform incorporates fast programmable core network technology to keep pace with significant increases in wireless link bandwidth and to effectively integrate emerging radio access networks with edge cloud computing. The design includes novel 100 Gbps+ fiber, free space optical, and microwave backhaul technologies interconnected with a software-defined network (SDN) switching fabric for minimum latency and flexibility in setting up experimental network topologies. Sub-microsecond optical switching technology offers the option of passive Wavelength-Division Multiplexing (WDM) switch fabrics and radio over fiber interfaces for the purpose of achieving ultra-low latency connections to edge computing services, which will be built in as an integral part of the system. Together, this will enable comprehensive end-to-end experimentation across diverse applications and users with tools for scientific workflow management, collaboration, and artifact sharing, all with a goal towards promoting rigorous standards for reproducibility in this field.

POWDER-RENEW: A Platform for Open Wireless Data-driven Experimental Research with Massive MIMO Capabilities

This project creates a city-scale platform for advanced wireless research that will be deployed over the period 2018 - 2023 in Salt Lake City, Utah. This Platform for Open Wireless Data-driven Experimental Research (POWDER) supports at-scale experimentation of novel advanced wireless broadband and communication technologies in the sub-6 GHz band. The project features interactions with regional networks encompassing initiatives on public transportation, broadband delivery, education and health service delivery as well as advancement of science, technology and research by creating an ecosystem of a hundred small companies in allied technical domains. The ability to use this platform by early adopter companies/startups and application developers to evaluate technologies in their pre-commercial phase will have a significant positive impact on the speed of innovation in the data networking and application domains. This effort will also benefit educators and students at all levels of study in communications-related disciplines.

A key feature of the platform is the partnership with the Reconfigurable Eco-system for Next-generation End-to-end Wireless (RENEW) project at Rice University to develop a highly programmable and flexible massive multi-input multi-output (MIMO) platform that is an essential feature of both 5G and beyond-5G wireless networks. The platform will feature (i) heterogeneous systems composed of programmable base stations, mobile devices and static sensors; (ii) state of the art massive MIMO base-stations; (iii) ability to conduct research over a diverse spectrum range (from 50 MHz to 3.8 GHz), and (iv) a large-scale software defined wireless networking testbed integrated with an existing NSF-funded cloud testbed, thereby enabling end-to-end experimentation. Another unique aspect of the platform is support for wireless mobility-based studies, provided by using couriers with predictable movement patterns (e.g., buses), less predictable but bounded mobility (e.g., maintenance vehicles), and controllable couriers (e.g., on-site volunteers). Each of these deployed units will consist of "base" functionality that includes user-programmable software defined radios, "bring your own device" (BYOD) experiments, and will be

connected via a sophisticated platform control framework. Existing fiber links will connect the wireless base stations to about half a dozen edge compute platforms. This will enable complex device provisioning and a set of tools for scientific workflow management, collaboration, and artifact sharing, with a goal towards promoting rigorous standards for reproducibility in this field.

We understand that there may be further details required by the FCC in consideration of this request. Please do not hesitate to contact us with additional questions or requirements

Sincerely,

Joseph Kochan
Project Director