Platforms for Advanced Wireless Research (PAWR):
Seeking teams to design, deploy, and operate advanced wireless research platforms

REQUEST FOR PROPOSALS (RFP)

Questions:

If you have any questions about this RFP, please see https://advancedwireless.org/apply for office hours and outreach activities, and/or contact PPO staff at info@advancedwireless.org.

Key Dates:

Letter of Intent (required)
October 25, 2019
6pm Eastern Time

Full Proposal (required)
December 13, 2019
6pm Eastern Time

Finalists announced
No later than February 2020
Site visits to be completed by the end of April 2020
Winner(s) announced during the third quarter of 2020

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SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title

Platforms for Advanced Wireless Research (PAWR): Seeking teams to design, deploy, and operate advanced wireless research platforms.

Synopsis of Program

The PAWR program aims to enable experimental wireless communications research across devices, communication techniques, networks, systems, and services conceived by the US academic and industrial wireless research community and deployed in partnership with local communities. PAWR seeks to accelerate the Nation's wireless innovation ecosystem, thereby enhancing broadband connectivity; enabling the emerging Internet of Things (IoT), next-generation cellular xG standards and heterogeneous wireless connectivity technologies; and sustaining US leadership and economic competitiveness for decades to come. Each research platform conceived under the PAWR program will enable at-scale experimentation by supporting the geographic size, technical diversity, and user density representative of a small city/community.

The National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE) has established the PAWR Project Office (see http://advancedwireless.org/) to support the design, deployment, and operations of the PAWR research platforms. Working closely with NSF and the wireless research community, the PPO has assumed responsibility for overseeing the design, deployment, and operations of a set of research platforms. Subject to the availability of funds/contributions, the PPO is soliciting proposals for one at-scale platform for advanced wireless research proposal to be funded by up to $8 million in cash from NSF and up to $8 million of in-kind contributions from the PAWR Industry Consortium. Additional funding might become available from other federal agencies depending on the scale and scope of the selected

platform; the PPO will discuss any such funding possibilities with the selected platform at the appropriate time. In this round, the PPO is specifically seeking proposals that can support research in novel technologies and architectures to reduce the cost of delivery of broadband to rural communities.

PPO Contacts

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Award Information

Anticipated Type of Award: Subaward Agreement

Estimated Number of Awards: 1

Anticipated Funding Amount: Up to $8 million in cash from NSF and up to $8 million of in-kind contributions from the PAWR Industry Consortium over five years, subject to the availability of funds/contributions. Additional funding might become available from other federal agencies depending on the scale and scope of the selected platform; the PPO will discuss any such funding possibilities with the selected platform at the appropriate time.

ELIGIBILITY INFORMATION

Who May Submit Proposals?

Proposals may only be submitted by the following:

Institutions of Higher Education (IHEs)

Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Non-profit, non-academic organizations

Local governments, community-owned utilities, research labs, foundations, economic development organizations, research and startup incubators, professional societies and similar organizations in the US associated with economic development, educational or research activities.

Academic institutions and non-profit organizations such as local governments are strongly encouraged to form teams to respond to this RFP to adequately achieve the goals of the PAWR program. Teams comprising three types of partners -- academic institutions, local non-profit/municipal leadership, and a local Internet Service Provider (ISP) -- will be considered the

strongest and most sustainable teams. For-profit organizations that are not members of the PAWR Industry Consortium may also participate on proposing teams but may not lead proposing teams. It is hoped that local ISPs and for-profit organizations will contribute facilities and other resources to enhance team capabilities. While for-profit companies can be vendors in a proposal, only not-for-profit organizations are eligible to receive funding via the PAWR program.

Limit on Number of Proposals per Organization: 1

An organization may participate as a lead proposer in no more than one proposal submitted to this RFP but may be listed as a subawardee in additional proposals. For collaborative proposals involving multiple institutions, the proposal should be submitted by only one institution, with funding for participating institutions made through subawards or subcontracts. *Proposals should not be submitted as separate collaborative proposals.* **These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently**. In the event that an organization exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission. **No exceptions will be made.**

Who May Serve as Project Director and/or Principal Investigator (PI)?

Project Directors/PIs may be affiliated with universities/colleges or with non-profit, non-academic organizations as defined above.

Participation in any project by investigators from federal agencies beyond NSF and/or non-NSF-funded FFRDCs may be via a letter of participation indicating that those organizations will provide, at no cost, the services and research as indicated in the proposal.

Alternatively, Federal agencies beyond NSF and non-NSF-funded FFRDCs can participate as subawardees, provided that those organizations include in the proposal a letter from the responsible agency confirming that agency's financial support of the agency's or FFRDC's participation should the project be funded by the PPO (i.e., PAWR program funding may not be used to pay for FFRDC/federal agency staff or resources).

An individual who is PI on one proposal may not participate in this role on any other proposal, but may participate in other proposals in another role, such as "senior personnel." **These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently**. In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission. **No exceptions will be made.**

Additional Institutional Eligibility Information:

For non-profits as well as US IHEs with overseas branch campuses, this RFP restricts eligibility to research activities using the facilities, equipment, and other resources of the campus(es) located in the US only.

INTRODUCTION

Wireless communication networks and applications have evolved to become a vital part of the Nation's economic growth and productivity. The number of smartphones, connected tablets, and wearable devices in use across the US today has doubled over the last decade. The burgeoning Internet of Things and emerging next-generation broadband mobile wireless technologies are expected to add several billions of connected devices worldwide within the next five years. Devices will also continue to consume increasing amounts of data. To support this unparalleled growth in devices and traffic, ubiquitous wireless connectivity at speeds covering the range from megabits per second (Mbit/s) to gigabits per second (Gbit/s) along with improvements in coverage, reliability, and latency will be required.

In past generations of wireless technologies (e.g., 3G, 4G, Wi-Fi), NSF-funded academic research in the US laid the foundations for the underlying technology [e.g., Code Division Multiple Access (CDMA) and Multiple Input Multiple Output (MIMO)]. Continuing this trend of research investments, NSF has in recent years supported fundamental research in massive MIMO, full-duplex wireless, millimeter-wave (mmWave) networks, dynamic spectrum sharing, network virtualization, emergent wireless network architectures, software-defined and cognitive radios, wideband antennas, and dynamic tunable filters—all of which have been touted as critical components of the emerging standards in wireless technologies for both local- and wide-area networks.

Research in these topics has offered promising preliminary results in theories, simulations, and lab-scale prototypes of very small numbers of advanced wireless nodes. However, due to a lack of appropriately sized resources available to the academic research community, it has been challenging to test these preliminary results at scale.

To meet this challenge, NSF, through the PAWR Project Office and in collaboration with the 30-member PAWR Industry Consortium, has formed a public-private partnership (i.e., the PAWR program) to support creation of four at-scale experimental platforms for advancing fundamental wireless research. These research platforms will enable pursuit of new research challenges, enhance education about wireless technologies and data networking, further academic-industry cooperative partnerships, and spur greater technology transfer from academia to industry, thereby maintaining US leadership in developing the next round of technological innovations. Importantly, these platforms for advanced wireless research will further the capacity of the academic research community to help envision and shape next-generation wireless communication networks and services outside of, and beyond, '5G'.

This effort will be accelerated by the fact that, in the past several years, the US has become the first country in the world to make vast quantities of both sub-6GHz and millimeter wave spectrum available for both licensed and unlicensed use. These newly available spectrum bands, in combination with other spectrum already available, promise to enable higher data rates and increased capacity in future wireless networks.

In the long term, these at-scale research platforms will collectively serve as a powerful research and development infrastructure that will support innovation in next-generation technologies broadly, giving rise to Smart & Connected Communities (S&CC) research and innovations of the

future. Indeed, the proposed advanced wireless research platforms will benefit a multitude of research and education communities that are supported by ongoing NSF research programs (e.g., Networking Technology and Systems, Communications and Information Foundations, Communications, Circuits & Sensing-Systems, Computer Systems Research, Cyber-Physical Systems, Secure and Trustworthy Cyberspace, S&CC, and Smart and Connected Health). Each research platform will be made available as a community resource in such a way that its operations can be sustained well beyond the platform deployment phase.

The success of the PAWR program ultimately rests on collaboration among three important stakeholders within the information technology innovation ecosystem: **university researchers, private sector companies such as local ISPs and network providers, and local communities**. Participating university researchers will benefit by: gaining access to open, at-scale research platforms; receiving industry input earlier in the research process; and speeding up transition of innovations from university research to end users. Participating companies will benefit by: helping to sustain US industry leadership and economic competitiveness in wireless communications for the next decade and beyond; shaping the design of the research platforms; and securing cutting-edge research returns well in excess of initial investment. Participating local communities will benefit by building core wireless capabilities through creative university partnerships; attracting government and corporate research funding and local wireless jobs; and utilizing advanced wireless capabilities to enhance community services and local/regional economic development.

In this round, the PPO is specifically seeking proposals that can support research in novel technologies and architectures to reduce the cost of delivery of broadband to rural communities.

PROGRAM DESCRIPTION

The PAWR program is a joint effort by NSF and a wireless Industry Consortium currently comprising 30 companies and industry associations to create at-scale research platforms (i.e., at the scale of entire small cities/communities) to accelerate fundamental research on wireless communication and networking technologies. The PPO is managing this anticipated $100 million public-private partnership to stand up and oversee these eventual research platforms. The PPO is run jointly by US Ignite, Inc., and Northeastern University.

The PPO will work closely with NSF, the wireless research community, local communities, and industry in the design, deployment, and operations of the research platforms. PAWR will enable experimental exploration of new applications and services enabled by new wireless devices, communication techniques, networks, systems, and services.

The PPO, in conjunction with NSF and the PAWR Industry Consortium, has developed this third-round RFP that calls for teams of communities and research universities to propose the design, deployment, and operations of one platform for advanced wireless research across the country.

PAWR constitutes an unprecedented opportunity to create and grow an evidence-driven community of wireless networking experimenters with a shared culture and high standards, starting from undergraduate and graduate students in the field. For this to happen, the PPO seeks platforms that can demonstrate alignment with, and support of, the following principles:

- **Reproducibility.** Platforms must be set up, maintained, and documented to guarantee the highest scientific standards in terms of accuracy and reproducibility of the experiments.
- **Usability.** Too often, research platforms that are in principle "open" require a learning curve and very specialized expertise that make them practically inaccessible to a vast portion of the research community. The guiding criteria of this effort will be the principle that, through well-defined interfaces, the platforms should be usable by any individual in the advanced stages of working towards a bachelor's degree in a technical or scientific subject. More advanced functionalities that require sophisticated reconfiguration or reprogramming of the platforms will be available to advanced users. For PAWR to fulfill the promise of becoming a nationwide, shared, innovation lab, the PPO will ensure that each city-/community-scale PAWR platform is designed, tested, and documented to guarantee true usability, predictability, repeatability, and statistical significance of the experiments.
- **Programmability.** Platforms should be programmable at multiple levels (e.g., radio, resource allocation, backbone) with clearly defined interfaces and APIs to support rich experimentation possibilities within the target scope of the platform.
- **Open Access.** All platforms must be accessible by the research community at large, with true fairness in opportunities for researchers throughout the Nation. Data generated should be, whenever possible, made available to the community for comparison and further experimentation.
- **Interoperability.** It is crucial to overcome the natural tendency of networking platforms to become isolated from the rest of the research ecosystem. The ability to use PAWR resources by leveraging existing management frameworks to extend experiments and federate a larger base of researchers is important. PAWR platforms will have to be based on well-defined management interfaces to ensure interoperability among the new city-/community-scale platforms, as well as interoperability with other NSF-funded large-scale platforms, including others created in this program.
- **Diversity.** The combination of all PAWR platforms must cover a broad range of application areas and topics in wireless networking, including (but not limited to) wireless protocols, last mile access, architectures, wide-area backhaul, and network measurements.
- **Sustainability.** Equally as important, it is expected that collaboration among proposing teams of university researchers, local non-profit or municipal organizations, and/or local for-profit companies will help to leverage NSF and PAWR Industry Consortium investments and enhance sustainability. For example, a community that facilitates low-cost access to wireless infrastructure such as low-cost real estate and backhaul while streamlining permitting processes will enable additional funds for the purchase of advanced wireless equipment as well as time for deployment and operation of the corresponding platforms.

The PPO will provide advice and share best practices on design, development, and overall project management with the winning platform. Once the platform is up and running, the PPO will be responsible for providing common, centralized services and best-practice policies (e.g., related to financial management, sustainability, safety, data security, and researcher outreach) to avoid

duplication across the platforms, including assistance in allocating and managing time for experimentation on the platforms. The PPO will also coordinate and make available to all platforms a single interoperable framework as part of a shared services model, with well-defined application programming interfaces (APIs). Please refer to Appendix 1 – Shared Platform Services – for additional details.

The resultant shared services suite will make the platforms accessible to the broadest set of researchers, industry, and community members, including support for experiments/users such as the following:

- Beginners as well as expert wireless researchers;
- Industry as well as academic researchers; and
- Wireless research experiments as well as services leveraging the new PAWR-enabled wireless system.

Research time on each platform will be allocated equally between industry and NSF-supported academic researchers; the two allocations should complement each other: allocations to NSF-supported researchers will advance fundamental knowledge in the long term, while allocations to industry researchers may seek to accelerate nearer-term research and development activities.

PAWR Platform Design Elements

The PPO has completed two rounds of PAWR RFPs and issued awards to three platforms, in Salt Lake City, Utah,, New York City, NY, and Raleigh/Cary, NC (see http://advancedwireless.org/platforms):

- The Platform for Open Wireless Data-driven Experimental Research (POWDER) led by the University of Utah will provide software-defined radios (SDRs), network boxes that can add or change features by just reprogramming the software, combined with "software-defined networking" (SDN) and cloud computing. POWDER will also provide next-generation equipment from Reconfigurable Eco-system for Next Generation End-to-End Wireless (RENEW) developed at Rice University. These include massive MIMO, a transmission scheme that uses base stations with hundreds of antennas to simultaneously serve many users on the same frequency.
- Led by researchers at Rutgers University, Columbia University, and New York University, the Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment (COSMOS) platform will leverage technologies such as mm-Wave and SDRs, edge cloud, and advanced wavelength division multiplexed optical networking to enable end-to-end programmable experimentation and research.

- Aerial Experimentation and Research Platform for Advanced Wireless (AERPAW), led by North Carolina State University (NCSU), will accelerate the integration of Unmanned Aerial Systems (UAS) into the national airspace and enable new advanced wireless features for a varied set of ground and aerial mobile vehicles, such as flying base stations for hot spot wireless connectivity. In addition, the AERPAW Platform will accelerate the advancement of autonomous transportation systems.

Achieving geographical and topographical diversity across the ultimate platforms remains an important goal of the PAWR program. In addition, the ability to deploy IoT, smart and connected communities, and autonomous vehicle technologies in the future will be greatly affected by the ubiquity, affordability, and reliability of network access throughout all parts of the United States. Delivering affordable rural broadband is seen as essential to enhance the economic competitiveness of the United States and restore rural communities as vital economic engines of the nation. Affordable rural broadband increases the quality of life for residents and the ability to participate fully in the digital economy, while leveraging advances in artificial intelligence and advanced manufacturing to improve the productivity of industry based in these regions.

Accordingly, this third-round RFP seeks to focus on applying advanced wireless technologies to transform the deployment and operations of fast, low-latency, and reliable broadband networks in rural and other low-density geographic areas in an efficient and affordable way. Residential and business users in low-density areas of the country have not received the same low-latency, high-speed services offered to urban users due in part to the cost of deploying fiber and existing wireless technologies across long distances.   Despite reductions in the cost of fiber backhaul and wireless equipment, high deployment, operations, and maintenance costs to reach low-density areas continue to present higher "cost per bit" for broadband services.

In this round, proposers are asked to create a testbed for experimenting with advanced wireless technologies and network architectures – combined with existing technologies – that may transform the existing broadband deployment cost curve through innovations in technologies and engineering processes. Proposers are asked to envision solutions that combine novel network architectures supporting wireless transmission technologies and end-to-end protocol solutions that can connect end users over a span of tens of kilometers/miles, while supporting delivery of data rates higher than achievable today (e.g., several hundreds of Mbit/s per user) and at lower costs. This may require creating robust long-distance, high-rate data link layers, which poses challenges both in design and cost-effective implementation. There are mature technologies that optimize a subset of bandwidth, range, and/or cost/bit metrics (see Diagram 1 below). The financial cost of deploying and running infrastructure, captured in the cost/bit metric, has traditionally not been the focus of advanced network architecture and design, and proposers are asked to incorporate this metric in their solutions. As illustrated in Diagram 1, a desired solution would fall into a "platform operating region" that, for example, might offer bandwidth per user comparable to current Wi-Fi, range comparable to and beyond that offered by LORA, and cost/bit delivered significantly lower than current LTE-based solutions but comparable to LORA and Wi-Fi. Proposers are free to choose technologies included in the upcoming 5G rollout, as well as to consider other completely different, innovative solutions that currently do not appear in a standardization roadmap.

Figure 1: Desired Platform Operating Region
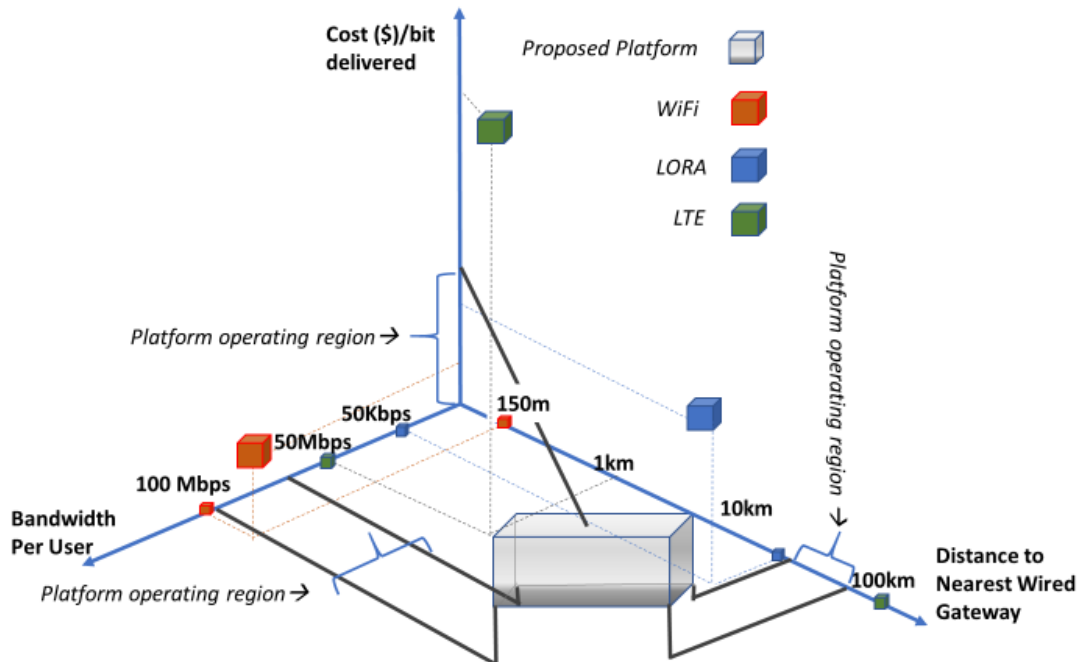
The RFP calls for a reexamination of network design assumptions leading to a fresh approach (including innovations at the physical and higher layers of the protocol stack, architectures, systems, network design and engineering, and operational processes) that will allow the platform to operate at a point not currently possible through ready off-the-shelf technologies. Since the platform is aimed toward enabling rural broadband, proposers can leverage additional degrees of freedom not possible in urban deployments such as (but not limited to) availability of real estate for wider infrastructure footprint, increasing transmission power in permissible spaces, ability to deploy mobile infrastructure on demand, opportunistically leveraging wide swaths of spectrum, flexibility to engineer the propagation environments, coverage along narrow population corridors as opposed to wide geospatial areas, among others. Proposers are, however, expected to ensure compliance with all Federal Communications Commission (FCC) and local regulations. The scale of the platform does not necessarily come from the geographical area covered; rather, it is defined by the extent of coverage in terms of distance between the nearest wired gateway and the users (which can be up to 100 km in practical scenarios), and the ability to experiment with diverse network architectures across these distances.

There is unlikely to be a single solution that can work well in every rural context, and users of the platform might bring in new technologies to evaluate. To that end, the platform should feature architectural flexibility and design diversity to support novel solutions. We seek responders to this RFP to propose a platform that allows users to experiment with some combination of the following wireless-enabled solutions:

- A robust, multi-modal, high-capacity, long-distance, low-cost wireless backhaul;

- Novel architectures that can simplify deployment costs (such as radio frequency (RF)-in-the-middle to connect fiber islands);

- Integrated Access and Backhaul (IAB), or multi-hop relay and mesh networks with a very large coverage space and sparse deployment density;

- Creative engineering in terms of tower architectures, modular systems, and novel infrastructure to overcome limitations posed by the wireless propagation environment that constrain current deployments from providing higher throughput;

- Multi-antenna (beamforming and MIMO) systems to combat low signal-to-noise ratio (SNR) conditions and increase spectrum utilization;

- Spectrum bands that include, but are not limited to:
    - TV White Spaces;
    - 6 –7 GHz, 12 GHz (licensed for microwave backhaul);
    - mmWave (a subset of 24, 38, 60, 95 GHz, but focusing on backhaul)
    - Optical and Laser LOS/NLOS links; and
    - mmWave or sub-THz NLOS communications (using reflectors in air or ground towers);

- Tethered airborne platforms (balloons/drones) that can act as relays and/or base stations; and

- Satellite backhaul (a backhaul transmission mechanism that is reliable, quickly deployable, and cost-effective) including, but not limited to, satellites in Geostationary Equatorial Orbit (GEO), Middle Earth Orbit (MEO), and Low Earth Orbit (LEO) orbits.

Proposers are also asked to incorporate how the proposed wireless technology breakthroughs made on their testbed might provide benefits to residents in rural communities like those in urban neighborhoods. Examples of potential use cases include, but are not limited to, the following:

- Connected first responders;
- Remote health providers;
- Semi- or fully-autonomous vehicles and farming equipment;
- IoT-enabled precision farming, livestock, and dairy management; and,
- Utility grid management (e.g., power, pipelines, water).

In their platform design description, proposers should incorporate overall community and local ISP or network provider commitment and engagement, and the level of community and network facilities, resources and services made available for the project, including but not limited to campus or community IT support, fiber backhaul and power provided to the sites, and expedited permitting for site deployment. Demonstration of such support from each community's Chief Technology Officer (CTO), Chief Information Officer (CIO) or equivalent leader, and from any ISP or network partner representatives will be particularly important. As part of their proposals,

proposers should also submit information about specific frequencies of operation available around the radio sites by consulting the FCC's Program Experimental license website (see Appendix 3) or provide plans for obtaining such licenses themselves.

At-scale experimentation within the PAWR program is not just about the infrastructure: it requires support for usage scenarios as well. Proposed platforms should be designed to support realistic experiment workloads, which might include in many instances a critical density of end users complementing the focused research area. As an illustration, a spectrum-sharing research platform might require a small pool of users across a large geographical area whereas a low-powered IoT radio platform might require a large pool of users in a building. Proposers are encouraged to articulate how realistic experimenter workloads can be achieved on their platforms, especially for rural use cases. Institutional Review Board (IRB) considerations are paramount for any experimentation involving human subjects, including to safeguard personally identifiable information (PII) for experiments collecting radio-level or network-level data and making them available. A PAWR platform must permit researchers from other institutions to perform research on the PAWR infrastructure. Therefore, external researchers can agree to defer to a single IRB's assessment of the project by each countersigning an IRB Authorization Agreement (IAA) with the lead IRB at the institution hosting the PAWR infrastructure. This only applies for research exclusively using PAWR infrastructure (a guiding template can be found here: http://www.hhs.gov/ohrp/assurances/forms/irbauthagree.html).

Individual researchers will have to obtain approval from their Institutional Review Boards (IRB) if their experiments are using resources other than just PAWR-provided infrastructure. Similarly, intellectual property (IP) and licensing terms and conditions can be found within the "Apply – Round III RFP and Other Information" tab at https://www.advancedwireless.org/.

PAWR Deployment Elements

Proposers will be required to describe overall deployment plans that will clearly lay out timelines and costs associated with:

- Location, site plans, and costs;
- Permitting, licensing, and other permissions necessary for deployment;
- Partners/vendors responsible for deployment, keeping in mind any federal or local requirements for open bidding and competition; and
- Any risks and contingencies that might delay or alter deployment in any way.

As previously stated, the PAWR program encourages coordination among three major groups of stakeholders: academic researchers, local non-profits and municipal governments, and industry partners – with an emphasis in this round on local ISP or network partners that can contribute backhaul, sites, equipment, power and other essential assets to support the rural-focused platform. The ability and commitment of local partners to deploy a platform, and their willingness to lower costs or speed up deployment, is critical to the feasibility and sustainability of a platform proposal. Proposed platforms should optimize end-to-end value by identifying available resources, facilities, and services such as backhaul and site rentals.

The PPO expects some basic testing functionality to be available for general use within one year of award and expects the platform to be fully available and operational within three years.

Functionality definitions will be part of the discussion during the award process, and the exact timelines may vary based upon platform complexity and will be subject to negotiation prior to the actual award. The functionalities must be validated by internal uses-cases and demonstrate the core capabilities of the overall platform.

PAWR Operations Elements

Sustainability of the platforms for the duration of the program and beyond is a critical factor in the success of the PAWR program. While the PAWR program will provide financial support for the first five years of platform operation, every effort should be made to secure local corporate, municipal, or non-profit partners who can provide additional operational support that will increase the likelihood of long-term platform success. Some items that might be provided by a partner include but are not limited to:

- Dedicated engineering or operations staff;
- Reduced or subsidized rental rates for locations and sites; and
- Reduced or subsidized costs for utility services for network elements.

AWARD INFORMATION

Anticipated Type of Award

Subaward Agreement

Estimated number of Awards

1

Anticipated Funding Amount

Up to $8 million in cash from NSF and up to $8 million of in-kind contributions from the PAWR Industry Consortium over five years, subject to the availability of funds/contributions.

PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

Letter of Intent Preparation Instructions (required)

Potential proposers may not submit a proposal without first submitting a Letter of Intent (LOI), compliant with the instructions below, by the LOI deadline. **Failure to submit a required LOI will result in a Full Proposal being returned without review.**

Submitting a LOI does not oblige potential proposers to submit a proposal. A single LOI should be submitted by the lead institution only. **LOIs are not subject to merit review, but rather are used for internal planning purposes. Investigators should not expect to receive any feedback on their LOI.** The lead PI and institution must remain the same for the Full Proposal. However, the composition of the team (e.g., co-PIs, Senior Personnel, partner institutions, and community organizations) may change at the discretion of the proposer.

Each LOI (please use the LOI template available for download on the PAWR website) must include the following information and be submitted through EDAS:

- A LOI title must begin with "PAWR Platform LOI: Your Project Name."
- In the Synopsis section, provide a synopsis that describes the work in sufficient detail to permit an appropriate selection of potential reviewers (limit: maximum of 1000 words, or approximately 1 page).
- In the Project PI and Other Senior Project Personnel sections, list the full names and institutional affiliations for the PI and all co-PIs and Senior Personnel on the project, including all subawardees. The point of contact for NSF inquiries must be the PI, with the PI's e-mail address. There is no limit to the number of Other Senior Project Personnel that can be included in the LOI.
- In the Participating Organizations section, list all the institutions involved in the project including community partners. There is no limit to the number of Participating Organizations that can be included in the LOI.
- In the Budget section, enter the intended cash budget (up to $8 million in cash). This figure is intended for internal planning purposes.

EDAS LOI Submission Guidance

Please click here if you have not already registered for the EDAS submission system; click here if you have already registered for EDAS (note that proposal submissions are referred to as "papers" within EDAS). You should search for "Round 3 (2019): Platforms for Advanced Wireless (PAWR) Proposal Submission" via the Submit Paper mechanism to register your LOI in EDAS.

There should be one upload within EDAS for your LOI submission – your completed LOI . The LOI template is available for download on the PAWR website.

Within EDAS, you should add all Senior Personnel associated with the proposed project within the "Add or Delete Authors" section. Each Senior Personnel associated with the LOI should have the following information: Name, EDAS ID, affiliation, and email.

Proposers must submit the LOI in response to this RFP by 6pm Eastern Time on October 25, 2019.

Full Proposal Preparation Instructions

Proposers must submit full proposals in response to this RFP by 6pm Eastern Time on December 13, 2019. Proposals must be submitted through the EDAS system. **Failure to submit the required LOI (due October 25, 2019 by 6pm Eastern Time) will result in a Full Proposal being returned without review.**

Proposal Title:
A proposal title must begin with "PAWR Platform Full proposal: Your Project Name."

Project Description:

Proposals with incomplete, incorrectly formatted or missing Project Description documents will be returned without review. The PPO reserves the right to request that proposers provide additional supplementary and other information documents during the review process. **The Project Description section must not exceed 30 pages, including figures, charts, graphs, maps, photographs, and other pictorial representations. Proposals exceeding this length will be**

returned without review.

The Project Description **MUST** contain the following sections (i.e., Sections I – X) with the headings shown below. Page lengths for each section within the Project Description are suggested below, but only the 30-page total section limit will be enforced:

Section I: Platform vision (up to 3 pages)

In this section, proposers should outline the wireless technical approach that will deliver transformative delivery of affordable broadband services to rural areas. The proposed technologies should represent the potential for significant reduction in the cost to serve low-density, rural areas of the US.

Section II: Platform Technical Architecture Design (up to 4 pages)

This section will describe the proposed architecture design to deliver on the platform vision, drawing on the design principles described in the PAWR Platform Design Phase of this RFP.

Section III: Description of research community support and new research to be uniquely enabled by the platform (up to 3 pages)

This section should document evidence of interest from the research community in the areas that the platform seeks to support. It should also describe how such research would be uniquely enabled by the proposed platform vision and technical architecture design.

Section IV: Description of engagement among academic researchers, industry, and the local community (up to 3 pages)

This section should describe how academic researchers, industry (e.g., representatives of local ISPs), and the local community will work together to achieve the vision of the PAWR program, including demonstrated evidence that links and commitments have been established among the groups. It will be particularly important to demonstrate how the local municipality and local ISP are providing support for the proposed platform, and their expectations of the platform in return. Detailed descriptions of support from these constituencies (university, industry, and local community) including, but not limited to, backhaul, deployment sites, power supply, network operations support, and any steps being taken to expedite permitting and other regulatory approvals typically required to deploy wireless networks should be separately included in the **Facilities, Equipment, and Other Resources** section of the proposal.

Section V: Alignment with the PAWR vision (up to 3 pages)

The proposer should provide evidence that the platform will ensure reproducibility of research, usability, interoperability with other platforms, programmability, open access, and diversity within the platform.

Section VI: Platform Development Plan (up to 6 pages)

This section describes the activities and schedules for design, deployment, and operations. Proposers shall describe all key milestones, tasks/activities/deliverables, and key resource (i.e., staff) assignments for the 5-year project period. The plan must include three critical phases – Platform Design, Deployment, and Operations. The PPO expects the Final Design Baseline to be

delivered within 90-days of award, which represents a key milestone. The PPO expects some basic testing functionality to be available for general use within one year of award (a key milestone). Finally, the PPO expects the platform to be fully functional within three years (a key milestone). The schedule should show the sequencing of all major activities to be conducted in sufficient detail to justify and align with the proposed budget. The realism of the schedule will be a critical evaluation factor during the proposal review process.

Functionality definitions will be part of the discussion during the award process, and the exact timelines may vary based upon platform complexity and are subject to negotiation prior to the actual award.

The PPO will require those finalists that proceed to the Site Visit phase (expected to be during March 2020) to provide a Gantt Chart to Work Breakdown Structure Level 2 or higher, aligning activities with milestones and resource-loaded staffing and costs with those who will be assigned to the tasks or activities. The Gantt Chart must display the critical path activities. The resource-loaded costs must be consistent with the budget, and this should be provided before the Site Visit.

Section VII: Sustainability Plan (up to 2 pages)

Discuss how the platform will be sustained beyond the initial 5 years of operation, including but not limited to proposals to fund ongoing research via user fees, local company contributions, and/or community funding for economic development purposes. The proposed sustainability plan should explain key assumptions, commitments, and other factors that will ensure the platforms continued viability.

Section VIII: Risk Mitigation Plan (up to 1 page)

Discuss any risks associated with completing the PAWR platform design, deployment, and operations activities, including technical and organizational risks. Discuss lessons learned by the proposing team from past experiences, and how the project plan covering costs and schedule has been risk-adjusted.

Section IX: Management Plan, Organizational Structure, and Project Staffing (up to 3 pages)

Describe the platform's organizational and management structure. Describe the structure and processes to be used to provide effective leadership of the platform, including ensuring productive, collaborative interactions with the PPO, the PAWR Steering Council (on which each platform will have a representative), and the anticipated PAWR research community. Describe the approach to be used to identify and prioritize development activities, and the competitive process to be used in the selection of development and deployment sub-awardees and consultants. Describe how the platform will adhere to the project management principles set forth in the NSF *Large Facilities Manual* and the project's strategy to implement earned value management techniques. Please see
https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf17066 for details.

Section X: Contributions of Key Personnel in the Past Five Years (up to 2 pages)

For the Principal Investigator, co-PIs, and other senior personnel, describe their qualifications and contributions made in the most recent five years that demonstrate (for the team, not for a single

individual):

- An ability to work effectively with the US wireless research community;
- Experience with advanced networking infrastructure planning, deployment, and operations;
- Effective management of large infrastructure projects, including establishing project management control systems and usage of earned-value management methodology; and
- Experience working with multi-stakeholder partnerships (e.g., teams involving community, corporate, and university team members).

Reviewers will be asked to comment on the quality of the prior work described in this section of the proposal.

Other Required Documents and Information (Pages in this section do not count against the 30-page limit for the Program Description above):

Biographical Sketch(es):

Please see https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_2.jsp#IIC2f) for description of content and format required for the full proposal phase of the PAWR program. Please limit biographical sketches to **up to ten personnel,** including the Principal Investigator, co-PIs, and senior personnel and each biographical sketch to 2 pages. One of the co-PIs or senior personnel must be a qualified project manager with demonstrated, relevant experience. Please ensure that **all ten team members** (i.e., PI, co-PIs, and other senior personnel) are registered **as co-authors** in EDAS so that any potential conflicts of interest can be identified and addressed.

Budget and Budget Justification:

Budget Form

Please see https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_2.jsp#IIC2g for cost category definitions. A Five-Year Budget Excel spreadsheet template will be made available to those proposals that proceed to the full proposal stage.

Budget Justification (up to 5 pages)

- The Budget Justification is narrative and must be no more than five pages.
- Each budget line item must be documented and justified in the Budget Justification as specified below.
- The proposal may request funds under any of the categories listed so long as the item and amount are considered necessary, reasonable, allocable, and allowable per 2 Code of Federal Regulations (CFR) § 200, Subpart E. For-profit entities are subject to the cost principles contained in the Federal Acquisition Regulation, Part 31. Amounts and expenses budgeted also must be consistent with the proposing organization's policies and procedures and cost accounting practices used in accumulating and reporting costs

The Budget and Budget Justification proposed to the PPO should include the total request for funds, including the costs of all platform equipment and services to be covered by the award, and all applicable federally-negotiated indirect costs.

To confirm budgets available during round 3 of the PAWR RFP, each winning platform will receive up to $8 million in cash from NSF and up to $8 million of in-kind contributions from the PAWR Industry Consortium over five years, subject to the availability of funds/contributions and quality of proposals received. Each proposer who proceeds to the Full Proposal stage will be asked to include proposed cash funding in the Budget section of the proposal and proposed in-kind contributions from the Industry Consortium or any other sources (e.g., local resource contributions) in the Facilities, Equipment, and Other Resources section of the proposal. Proposers are strongly encouraged to make creative, full use of the available in-kind contributions from the Industry Consortium.

Prior to the Site Visit stage each finalist team will be provided with a more detailed In-Kind Contribution Worksheet with benchmarks for equipment and services available from the Industry Consortium. Through discussions with the PPO and Industry Consortium points-of-contact, each proposer will "pull" equipment and services valued at up to $8 million from the In-Kind Contribution Worksheet as needed to meet the proposer's platform design requirements. Such equipment and services "pulled" from the Industry Consortium worksheet will be included in the Facilities, Equipment, and Other Resources section of the Final Proposal without reference to the pricing of that equipment or services. Any design, deployment, or operational requirements not met by the equipment and services provided by the Industry Consortium or other sources as in-kind contributions will require cash expenditures (up to $8 million over five years) and should be justified in the Budget section of the Full Proposal. Note that such cash expenditures may be "named" expenditures (e.g., custom-built 5G+ radios from equipment manufacturer "X") or generic "unnamed" expenditures (e.g., commercially available radios that provide "Y" functionality, system integration services to provide "Z" functionality).

Finalists selected for site visits will hold an in-depth technical negotiation with the PPO and Industry Consortium representatives (other than Industry Consortium board members) to create a Bill of Materials ("BOM") outlining more exact details for proposed deployment and operation planning.

Cost Sharing

Voluntary committed cost sharing is prohibited. Proposers and/or proposing partners (i.e., cities/communities, universities, and/or industry) may contribute resources to a given research platform, such as development facilities, backhaul, deployment sites, power supply, network operations support, and any capabilities needed to expedite permitting and other regulatory approvals typically required to deploy and operate wireless networks and support the broader goals outlined in this RFP for the PAWR program. These resources should not be included in the Budget or Budget Justification; instead, all such resources necessary for, and available to, a project must be clearly described in the Facilities, Equipment and Other Resources section of the proposal (see below).

The final award will contain two parts:
1. Facilities, Equipment and Other Resources, specifying contributions from the proposer and/or proposing partners, along with in-kind contributions from the Industry Consortium meant to complement this section; and

2. Budget for funding to be primarily provided by NSF, including federally-negotiated indirect costs (note that voluntary committed cost-sharing is prohibited).

Facilities, Equipment and Other Resources Section (up to 7 pages):

In this section, proposers should describe facilities and resources that are available to the proposing team to support the proposed platform, including, but not limited to, research and development facilities, backhaul, deployment sites, power supply, network operations support, and any steps being taken to expedite permitting and other regulatory approvals typically required to deploy and operate wireless networks and support the broader goals outlined in this RFP for the PAWR program. As a part of this description, proposers are requested to clarify if the contribution is owned or leased. For the case of leased assets, proposers are requested to clarify the time frame of the contribution. Any partner or community resource contributions should be explicitly listed in this section, including but not limited to:

- Equipment and services supporting proposed use cases.   Proposers should specify the number and type of deployment sites, backhaul links (e.g., dark fiber, Ethernet or microwave links with expected capacity/performance profile, etc.), staff members, and other resources over the life of the project.
- Equipment and services for wireless network operations, with the number and type of staff, specific services and equipment supported.
- Research facilities including universities, national labs, companies, and Federally Funded Research and Development Centers (FFRDC) that will offer access to research labs, staff, or other resources to the proposing team. These facilities should detail the scope of labs, the number and type of staff, and other resources that will be contributed to the project free of charge.
- Commercialization support can include wireless workforce development for high-skilled jobs, commercialization programs to offer rapid prototyping, or support for startup accelerators. Proposers should detail the number and type of staff devoted to these programs and the estimated number and type of individuals and small businesses that will benefit from their operations.

Data Management Plan (up to 2 pages):

Proposals must include a document of no more than two pages labeled "Data Management Plan". This document should describe how the proposal will conform to the PPO Data Management Plan (see link at https://advancedwireless.org/apply and any additional strategies for data management and research sharing. Information that should be considered includes:

1. The types of data, samples, physical collections, software, curriculum materials, and other materials to be produced in the course of the project;
2. The standards to be used for data and metadata format and content (where existing standards are absent or deemed inadequate, this should be documented along with any proposed solutions or remedies);

3. Policies for access and sharing including provisions for appropriate protection of privacy, confidentiality, security, intellectual property, or other rights or requirements;

4. Policies and provisions for re-use, re-distribution, and the production of derivatives; and

5. Plans for archiving data, samples, and other research products, and for preservation of access to them.

Proposals that include subawards are a single unified project and should include only one Data Management Plan, regardless of the number of subawards included.

Letters of Support (up to 2 pages each):

Documentation from each community's Chief Technology Officer (CTO), Chief Information Officer (CIO) or equivalent leader, as well as letters from any partner representatives from the local ISP must be included to precisely document the overall community commitment and level of community facilities, resources and services made available for the project, including but not limited to equipment support, site rentals, campus or community IT support, fiber backhaul, and power provided to the sites and expedited permitting for site deployment.

Please note that Round III platform proposers are strongly discouraged from soliciting letters of support from the three Round I or Round II winners prior to submitting their Final Proposal in Round III. Any potential synergies between a Round III proposer's platform and an existing platform will be explored with the proposers and coordinated by the PPO during a webinar to be held after LOIs are submitted and during the Site Visit stage.

A list of Project Personnel and Partner Institutions [This information may be entered via the EDAS submission system directly]:

Provide current, accurate information for all personnel and institutions involved in the project (i.e., all personnel who are included in the proposal budget). Partner institutions listed should include any community or local company partners. PPO staff will use this information in the merit review process to manage conflicts of interest. The list **must** include all PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

- Mary Smith; XYZ University; PI
- John Jones; University of PQR; Senior Personnel
- Jane Brown; XYZ University; Postdoc
- Bob Adams; ABC Community College; Paid Consultant
- Susan White; Welldone Institution; Unpaid Collaborator
- Tim Green; ZZZ University; Subawardee

Formatting Requirements:

Proposal Pagination

Each proposal section should be paginated prior to upload to the electronic system.

Proposal Margin and Spacing Requirements

For all sections, except figures, captions, tables and the Excel spreadsheet, please use only one of the following typefaces identified below:

- Arial, Courier New, or Palatino Linotype at a font size of 11 points or larger;
- Times New Roman at a font size of 11 points or larger; or
- Computer Modern family of fonts at a font size of 11 points or larger.

No more than six lines of text within a vertical space of one inch. Margins, in all directions, must be at least an inch.

Page Formatting

Use a standard, single-column format for the text.

EDAS Full Proposal Submission Guidance

Click here (or visit https://www.edas.info/newPaper.php?c=26696) to sign into EDAS (note that proposal submissions are referred to as "papers" within EDAS). You should search for "Round 3 (2019): Platforms for Advanced Wireless (PAWR) Proposal Submission" via the Submit Paper mechanism to register your Full Proposal in EDAS.

Within EDAS, you should add all Senior Personnel associated with the proposed project within the "Add or Delete Authors" section. Each Senior Personnel associated with the Full Proposal should have the following information: Name, EDAS ID, Affiliation, and Email.

There should be five total uploads within EDAS for your PAWR Full Proposal submission, including:

- ***Project Description - Part 1:*** This upload should include your Project Description (limit, 30 pages)
- ***Other Required Documents and Information - Part 2 (Budget Documentation):*** This upload should include your PAWR Excel Budget Template
- **Other Required Documents and Information - Part 3:** This consolidated upload should include your Biographical Sketch(es) (up to 20 pages), Letters of Support (up to 2 pages each), a list of Project Personnel and Partner Institutions (this information may be entered via the EDAS submission system directly), Budget Justification (up to five pages per proposer and up to five pages for each subawardee), and Bibliography (optional, no page limit)
- ***Other Required Documents and Information - Part 4 (Facilities, Equipment and Other Resources):*** This upload should include your Facilities, Equipment and Other Resources document (up to 7 pages)

- ***Other Required Documents and Information - Part 5 (Data Management Plan):***
  This upload should include your Data Management Plan (up to 2 pages)

Please note that the option to submit your Full Proposal will not appear in EDAS until October 26, 2019. **Proposers must submit the Full Proposal in response to this RFP by 6pm Eastern Time on December 13, 2019.**

Summary of Proposal Requirements	
Letter of Intent (due October 25, 2019)	**Full Proposal (December 13, 2019)**
Letter of Intent Template available on the [PAWR website (advancedwireless.org)](advancedwireless.org)	**Project Description (up to 30 pages):**
	Platform vision (up to 3 pages)
Project Synopsis (up to 1 page/1000 words)	Platform Technical Architecture Design (up to 4 pages)
PI and Other Senior Personnel	Description of research community support and new research to be uniquely enabled by the platform (up to 3 pages)
Other Participating Organizations	Description of engagement among academic researchers, industry, and the local community (up to 3 pages)
High-level Budget (up to $8M cash)	Alignment with the PAWR vision (up to 3 pages)
	Platform Development Plan (up to 6 pages)
	Sustainability Plan (up to 2 pages)
	Risk Mitigation Plan (up to 1 page)
	Management Plan, Organizational Structure, and Project Staffing (up to 3 pages)
	Contributions of Key Personnel in the Past Five Years (up to 2 pages)
	Other Documents and Information:
	Biographical Sketches (up to 2 pages per individual)
	Budget Form for Proposer and Subawardees
	Budget Justification (up to 5 pages) for Proposer and Subawardees
	Facilities, Equipment and Other Resources Section (up to 7 pages)
	Data Management Plan (up to 2 pages)
	Letters of Support (up to 2 pages each)
	List of Project Personnel and Partner Institutions

PROPOSAL PROCESSING AND REVIEW PROCEDURES

The RFP has been written with a view to encourage deep collaborations among communities, academic institutions, local corporate partners, research nonprofits, and civic institutions such as Chambers of Commerce, startup accelerators, and innovation centers.

Merit Review Principles and Criteria

Similar to NSF, the PPO will rely on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing the nation's health, prosperity, and welfare. Accordingly, the PPO will conduct a fair, competitive, transparent merit review process for the selection of projects.

Merit Review Criteria

The following merit review criteria will be used by PPO staff during the Preliminary Proposal phase and by the Full Proposal Review Panels during the full proposal phase to evaluate proposals:

1. Vision and Technical Merit	• Is the research platform focused on important wireless technologies that target the operating range identified in the RFP? • Is the platform able to support innovations in network architecture? • Is the platform development plan technically sound? • Are in-kind contributions from the Industry Consortium used creatively and fully?
2. Research Community	• Does the plan show commitment and evidence of capability to attract a broad and diverse group of academic and industry researchers in both the short and long term? • Is there broad research community support for the proposed platform? Who are the early users? • Will innovative, advanced wireless research be uniquely enabled by the proposed platform?
3. Community Engagement	• Is there close alignment with local stakeholders? • Does the platform development plan leverage local support with contributed deployment and operations resources? • Is the PAWR deployment connected to the broader innovation and economic development organizations and plans of the proposed region? •

4. Alignment with PAWR Vision	• Does the proposal provide convincing evidence that the proposed platform will support:
	   1. Reproducibility of research;
	   2. Usability;
	   3. Programmability;
	   4. Interoperability;
	   5. Open Access; and,
	   6. Diversity

5. Implementation plan	• Does the project team have the right expertise and experience to implement the vision – including project management experience – as well as details of the research platform? • Does the proposing team have a track record of operating experimental testbeds that can help assess their ability to manage this project? • Does the plan follow the timeline suggested by the PPO, with sites operational within one year and platform fully operational by year 3? • Is the deployment plan feasible, with clearly designed goals, timelines, and deliverables?
6. Sustainability	• Are there long-term plans to evolve the platform beyond the 5 years of initial operations? • Is the operational model sound? Is it financially sustainable? How will research on the platform be funded (e.g., user fees, local financial support)?

Review and Selection Process

A panel of independent, non-conflicted experts primarily from academia, industry (excluding Industry Consortium members), local communities, and the government sector will be convened to review and evaluate proposals and provide recommendations to the PPO. At this stage and then again at the Site Visit stage, the PPO, in consultation with NSF and non-conflicted, designated representatives of the Industry Consortium, will make final selection and funding recommendations. Conflict-of-interest rules will be implemented consistent with NSF policies at all stages of the review and award process.

The PPO team will work with the finalists and the PAWR Industry Consortium during the site visits to identify feasible technology contributions, some of which may be proprietary and unknown to proposers before this final stage. Based on these site visits and additional technical negotiations with the finalists, a winning proposal will be selected and appropriate subawards of cash and in-kind contributions will be administered.

AWARD ADMINISTRATION INFORMATION

Notification of the Award
Notification of the award is made to the submitting organization by the PPO. Organizations whose proposals are declined will be advised as promptly as possible by the PPO. Verbatim copies of reviews, not including the identity of the reviewer, will be provided to the Principal Investigator.

Award Conditions for Winning Platforms

An award from the PPO consists of:

1. An award agreement, which includes any special provisions applicable to the award and any numbered amendments thereto;
2. A budget, which indicates the amounts, by categories of expenses, on which the PPO has based its support (or otherwise communicates any specific approvals or disapprovals of

proposed expenditures); this budget will need to conform to NSF standards; once approved, funding will be provided incrementally based on satisfactory completion of project plan milestones;

3. Facilities, Equipment and Other Resources document covering in-kind contributions, which complements the platform budget;
4. The proposal referenced in the award notice;
5. Applicable award terms and conditions; and
6. Any announcement or other PPO issuance that may be incorporated by reference in the award notice.

Special Award Conditions

Within three (3) months of the project start date, the Awardee will provide a Project Execution Plan (PEP) electronically to the PPO for approval. NSF, the Awardee and the PPO will use the PEP in its oversight and assessment of schedule and costs. The Proposer shall update the PEP at key milestones. The PEP shall include the following items:

I. Introduction
   a. Scientific Objectives: Description of research objectives
   b. Scientific Requirements
   c. Facility/Infrastructure: Description of the infrastructure necessary to obtain research objectives
   d. Scientific & Broader Societal Impacts: Description of broader societal impacts associated with facility and scientific impacts
II. Organization
   a. Internal governance & organization and communication: Lines of authority, responsibility, and communication between internal project and institutional governance and any oversight or advisory committees.
   b. External organization and communication: Lines of authority, responsibility, and communication between project, partners, PAWR PPO & others
   c. Other Stakeholders: Description of other project's stakeholders and their roles, responsibilities, and meeting schedules
   d. Roles and Responsibilities: Project personnel roles and responsibilities
   e. Community and Relations and Outreach: Plans for building relationships with local communities and with research community
III. Design and Development Definition
   a. Design and Development Plan: Description of activities that will be undertaken to achieve readiness for construction, including design, prototyping, manufacturing process validation, vendor qualification, modeling and simulation, creating project management plans, forming partnerships, etc. consistent with a Project Plan Gantt chart and Risk Register
   b. Design and Development Budget: Identify NSF funding and partner contributions in Form 1030 Format
   c. Development Schedule: Narrative explaining milestones, consistent with Project Plan Gantt chart referenced in IIIa above.

IV. Construction Project Definition
   a. Construction Management Plan: Description of activities that will be undertaken during the construction phase consistent with Project Plan Gantt chart referenced in IIIa above.
   b. Integration and Commissioning Plan: Summarize plan for systems integration, testing and commissioning
   c. Acceptance/Operational Readiness Plan: Summarize plan for operational readiness, including acceptance criteria and acceptance procedures
   d. Construction Budget: Identify NSF funding and partner contributions in Form 1030 Format
   e. Construction Schedule: Narrative explaining milestones, consistent with Project Plan Gantt chart referenced in IIIa above

V. Systems Engineering
   a. Concept of Operations Plan: Plans for, and estimate of, annual operations and maintenance staffing and funding that will be needed when the facility is operational. Budget must be in Form 1030 Format.
   b. Systems Engineering Management Plan
   c. Systems Engineering Requirements
   d. Quality Assurance and Quality Control Plans

VI. Staffing
   a. Staffing Plan: Provide a resource tables with position/staff names and monthly level of effort and monthly budgets consistent with Design and Development, Construction and O&M budgets.
   b. Hiring and Staff Transition Plan: Required qualifications for key staff; schedule and requirements for hiring and training staff and increasing/decreasing staff levels.

VII. Project Management Controls
   a. Project Management Control Plan: Description of the project management organization and processes
   b. Financial and Business Controls: Description of financial and business processes and controls
   c. Risk and Opportunity Management
        i. Risk Management Plan
        ii. Risk Register
   d. Change Control Plan: Description of how project will manage changes in baseline, changes in scope, modifications to budget or schedule, including approvals thresholds, roles, and responsibilities.
   e. Configuration Control Plan
   f. Document Control Plan
   g. Acquisition Plan
   h. Reporting Requirements

VIII. Cyber-Infrastructure
   a. Data Management Plan: Plans for managing data, including infrastructure, archiving, open data access plans, etc.

      b. Cyber-Security Plan
      c. Code Development Plan

IX. Site and Environment
      a. Site Selection: Site selection criteria and description of selected site(s)
      b. Environmental Aspects: Plan for any Environmental Impact Statements, permitting, site assessments, etc.

Within three (3) months of the project start date, the Awardee will provide a Platform Design Document (PDD) electronically to the PPO for approval. NSF, the Awardee and the PPO will use the PDD to define project **scope**. The Proposer shall update the PDD at key milestones. The PDD shall include the following items:

I.   Introduction
      a. Purpose of the PDD
II. General Overview and Design Guidelines/Approach
      a. General Overview
      b. Assumptions/Constraints
III. Design Considerations
      a. Goals and Guidelines
      b. Development Methods & Contingencies
      c. Architectural Strategies
      d. Performance Engineering
IV. System Architecture and Architecture Design
      a. Logical View
      b. Hardware Architecture
          i. Security Hardware Architecture
          ii. Performance Hardware Architecture
      c. Software Architecture
          i. Security Software Architecture
          ii. Performance Software Architecture
      d. Information Architecture
          i. Records Management
      e. Internal Communications Architecture
      f. Security Architecture
      g. Performance
      h. System Architecture Diagram
V. System Design
      a. Business Requirements
      b. Database Design
          i. Data Objects and Resultant Data Structures
          ii. File and Database Structures
      c. Data Conversion
      d. User Machine-Readable Interface
          i. Inputs

          ii.   Outputs
        e. User Interface Design
  VI. Operational Scenarios
  VII. Platform Detailed Design
        a. Hardware Detailed Design
        b. Software Detailed Design
        c. Security Detailed Design
        d. Performance Detailed Design
        e. Internal Communications Detailed Design
  VIII. System Integrity Controls
  IX. External Interfaces
        a. Interface Architecture
        b. Interface Detailed Design

Reporting Requirements

The Awardee shall provide progress reports as required by the terms of this Award to the PPO, engage in meetings (by telephone, video conferencing, and/or e-mail), as well as providing reports and attending meetings on operations as requested by the PPO.

The Awardee and PPO shall together prepare quarterly and annual reports as designated by the NSF Program Director. The quarterly progress report shall include monthly expenditures in the NSF Form 1030 format and detailed descriptions of the progress, achievements, expenditures and performance data.

The Awardee shall submit quarterly and annual reports to the PPO using the appropriate reporting category. For any type of report not specifically mentioned in Research.gov, the Awardee shall use the Interim Reporting function to submit reports.

The Annual Report shall include a detailed plan for the following year and, if necessary, an update to the Awardee PEP and PDD.

Ongoing Project Oversight

The Awardee shall ensure reasonable progress and performance of subrecipients, including cooperation among the governing structure components and during NSF project management and oversight activities. The Awardee will ensure availability of all key institutional partners during any review as well as timely access to all project documentation.

Routine management and oversight activities conducted by NSF include the following:

- The Awardee, PPO and NSF Program Director will meet quarterly (by telephone, video conferencing, and/or in person) to review the status of the project. Representatives of some or all of the subrecipients may be required to participate in these meetings as needed.
- The Awardee and relevant subrecipients will participate in an annual review meeting either on site or at NSF. The annual review may involve both an internal and external group of reviewers selected by NSF. The purpose of the review will be to examine yearly progress and to suggest any changes that would benefit the user community.

PPO CONTACTS

General inquiries regarding this program should be made to:

- Joe Kochan, Project Director, PAWR Project Office, joe.kochan@us-ignite.org
- Abhimanyu Gosain, Technical Program Director, PAWR Project Office, agosain@ece.northeastern.edu
- Tommaso Melodia, Research Director, PAWR Project Office, melodia@ece.northeastern.edu
- Kaushik Chowdhury, Academic Outreach Director, PAWR Project Office, krc@ece.northeastern.edu

For questions related to the use of the proposal submission system at https://advancedwireless.org/apply, please contact the PAWR Project Office at info@advancedwireless.org.

OTHER INFORMATION

This RFP and the PPO website (http://advancedwireless.org/) provide the most comprehensive source of information on the PAWR program. Please be sure to also examine supporting documents in the Appendix of this RFP, including:

- Appendix 1: Shared Platform Services
- Appendix 2: PAWR Industry Consortium In-kind Contributions
- Appendix 3: FCC Experimental Spectrum Policies/Tools/Process

Other information can be found within the "Apply – Round III RFP and Other Information" tab at https://advancedwireless.org/apply including: Data Management Plan; Conflict of Interest Standards; IP and Licensing Guidelines; and NSF Workshop report on "Large-scale Networking Platforms Communities of Practice."

ABOUT THE PAWR PROJECT OFFICE

The PAWR Project Office is a project run by the independent non-profit organization US Ignite, Inc., and Northeastern University. Please see https://www.advancedwireless.org/ for a further description.

Appendix 1: Shared Platform Services

The PPO envisions developing and maintaining a single interoperable framework with well-defined API's to manage services common across all platforms. This services and experimenter framework will be available to Round III platform awardee(s). During the Full Proposal stage, proposers will be asked to submit sample workflow(s) and associated shared services requirements that are warranted by their proposed platform. During the Site Visit stage, those requirements will be matched to the PPO's planned services and experimenter framework to ensure optimal platform support. Proposer's shared services requirements will not be a determining factor during the Full Proposal merit review process, but the PPO would like to understand the additions potentially required for its framework.

Any potential synergies between a Round III proposer's platform and an existing platform will be explored with the proposers and coordinated by the PPO during a webinar to be held after LOIs are submitted and during the Site Visit stage. During the Site-Visit stage, the PPO anticipates that proposers will discuss how to align resources with the enhancements needed to this framework to accommodate the specific technical architecture being proposed and where the implementation work would be most easily performed.

Appendix 2: PAWR Industry Consortium In-kind Contributions

The rules of engagement with Industry Consortium (IC) members for preparation of Round III RFP proposals are the following: To support brainstorming and development of a platform vision, proposers may work with their current Industry Consortium points of contact, but not members of the PAWR Industry Consortium board or Industry Consortium members serving on board committees or the PAWR Steering Council (see https://advancedwireless.org/apply for a listing of board member names).

The following Industry Consortium in-kind list represents categories of equipment and services available to PAWR Round III RFP proposers. The categories have been color coded to provide an estimate of remaining contributions after prior round platform drawdowns have concluded. Proposers are encouraged to make creative and full use of available in-kind resources, which will be further detailed (including additional rural-focused Industry Consortium contributions) in an In-Kind Contribution Worksheet provided after LOIs have been submitted, and then further refined and negotiated during the Site Visit stage.

PAWR Industry Consortium Contribution Menu

- GREEN represents categories that have HIGH availability of in-kind contributions.
- ORANGE represents categories that have MEDIUM availability of In-kind contributions.
- RED represents categories that have LOW availability of in-kind contributions; proposers will likely need to budget for cash expenditures.

Product List

Radio Equipment

Type	IC Member
Software Defined Radio (SDR) - Basic Features	National Instruments
SDR Advanced Features	National Instruments
SDR Daughter cards	National Instruments
Cloud RAN (C-RAN)	Ericsson, Nokia
Small Cell (SC)	Ericsson, Nokia
MmWave Point to Point	Ericsson, Interdigital, Telecom Infra Project
5G Base Station	Ericsson, Nokia
User Device Chipset <6GHz	Qualcomm
IoT Radios	SigFox
User Device Chipset >6GHz	Qualcomm, Samsung
5G NR UE <6GHz SDR	National Instruments
5G NR UE mm-Wave SDR	National Instruments

Antenna Equipment

Type	IC Member
Omni directional	CommScope, Carlson
Directional	CommScope
Microwave Antenna (pair)	CommScope

Networking Equipment

Type	IC Member
Router Layer 3	Juniper
Router Layer 2	Juniper
Router Optical	Juniper
SDN Switch	Juniper
SDN Switch Optical	Juniper

Cloud / Compute Platforms

Type	IC Member
Compute Server (CPU/RAM) 1U-2U	Oracle
Storage server 1U-2U (128TB)	Oracle

Test and Monitoring Equipment	
Type	**IC Member**
Spectrum Analyzer	Anritsu, Viavi, Keysight
Signal Generator	Anritsu, Viavi, Keysight
Traffic Generator	Anritsu, Viavi, Keysight
Monitoring and Compliance RF Sensor	Anritsu, Viavi, Keysight
Protocol Analyzer	Anritsu, Viavi, Keysight
Network Packet/Signal Analyzer	Anritsu, Viavi, Keysight
4G/5G Packet Core Network; EPC/5GC	Polaris Networks

User Equipment / Devices	
Type	**IC Member**
Mobile device 4G/Wi-Fi/Data Plans	Sprint, AT&T, HTC, T-Mobile
Mobile device 5G	Samsung
SIM Cards	Sprint
UE simulator	Polaris Networks

Site Equipment	
Type	**IC Member**
Outdoor Enclosure Cabinet (Wall or Pole)	Commscope
Indoor Enclosure Cabinet	Commscope

PAWR Industry Consortium Contribution Menu

Services List

Site and Platform services (Deployment/Engineering)

Service	IC Member
Platform Design/Engineering	Crown Castle
Site Acquisition	Crown Castle
Deployment Engineering	Black and Veatch, Crown Castle
Site Permitting	Crown Castle

Platform Research/Design Services

Service	IC Member
Platform Architecture / Design	Nokia, Ericsson, NI, Carlson, Vapor IO
Network Implementation services	Juniper
Radio Network Design	Nokia, Black and Veatch
Cloud Services and Design	Intel, Oracle, John Hopkins Applied Physics Lab
API Development and Integration	Mathworks

Test Services

Service	IC Member
Test Strategy Creation	Viavi, Keysight
Test Plan Creation	Viavi, Keysight
Test Execution and Data collection	Keysight, John Hopkins Applied Physics Lab
Data Collection and Archiving design	Keysight
Test Automation services	Viavi, Keysight

Recurring Cost Categories/ Services

Service	IC Member
Fiber/Ethernet Backhaul	Verizon
Wireless/Out-of-band management channel	Sprint
Tower Lease	American Tower
Site lease	American Tower, Crown Castle

Appendix 3: FCC Experimental Spectrum Policies/Tools

Experimentation in Radio Frequency bands is subject to Federal Communications Commission (FCC) licensing rules. PAWR will leverage the FCC Program Experimental License to allow experimentation using qualified licensed spectrum on the research platform to enable technology evaluation and development of future capabilities. PAWR will also explore, along with winning proposers, other spectrum access strategies, including via licenses owned by PAWR Industry Consortium members.

Prospective PAWR platform awardees will be required to identify the spectrum that will be available for use in the geographical area(s) of their proposed deployment during the full proposal stage. The recently issued FCC public notice https://apps.fcc.gov/edocs_public/attachmatch/DA-17-362A1.pdf outlines the guidelines for this process.

Each final proposal selected for a Site Visit will be required to complete the location authorization process https://apps.fcc.gov/els/ProgramExpLicensePurposeOption.do to pursue an "Innovation Zone" designation. The PPO will facilitate interactions between the teams and FCC representatives and will also assist proposers with other possible spectrum strategies.

Proposers must identify compliance personnel, develop management software and log-in systems, and document emergency stop enforcement procedures and escalation processes to ensure consistent operation within the FCC rules. All such information must be submitted during the Site Visit phase of the award process. The PPO will provide the interface with the FCC, campus CIOs and local safety officials to verify compliance and license the platforms as experimental zones.

RFP respondents are also encouraged to partner with educational or commercial institutions while looking for spectrum availability (an example would be the EBS/BRS band, if available).