# Advanced Wireless Communications for Embedded Intelligence

**Pacific Northwest**
NATIONAL LABORATORY

**5G**
Center for
Embedded
Intelligence

Pacific Northwest National Laboratory (PNNL) is merging its rich history in advanced wireless communications with our expertise in cybersecurity, artificial intelligence (AI), sensors systems, and Internet of Things (IoT) connectivity.

Our forward-leaning focus on the nexus of these technologies allows PNNL to address the challenges presented by a hyper-connected, physical-digital, 5G world reliant on edge computing to create autonomy at a whole new level, changing the future threat landscape. Over the past decade, PNNL's research and development in advanced wireless communication has garnered attention from many partners who acknowledge PNNL's leadership. This work has featured monitoring of wide spectrum communications, wireless cybersecurity, millimeter wave technology, embedded sensor systems, and IoT connectivity.

## AREAS OF RESEARCH

PNNL is focusing on three main areas of 5G research to support key mission needs based on PNNL's areas of expertise. The critical areas of research include:

1) adopting 5G communications and computing architectures into sponsor mission spaces, advancing sponsor capabilities;

2) exploring security implications of applying emerging 5G solutions for critical or vulnerable systems, and exploring supply chain; and

3) developing novel compute paradigms, bringing PNNL's capabilities and strengths alongside industry early in development.

These combined areas assure our nation can keep pace in the global race for 5G and advanced wireless communications.

# IMPACTS OF RESEARCH

## Advanced Automation

- **Challenge:** Edge applications operating on decentralized computing are capable of processing data at the edge of the infrastructure. This presents new challenges for the detection of bad actors and increases the need for proper security controls to understand and mitigate the current threat and attack landscape at the edge.

- **Research Emphasis:** Edge computing enabled by deploying 5G and AI at the edge holds tremendous promise to transform every portion of civilization. At PNNL, we believe it is imperative to understand how new paradigms will allow devices in the field to compute and respond in real time. In addition, it is important to reduce their size, cost, and complexity while distributing authority and enabling a new level of regional coordination and optimization.

## PNNL CORE CAPABILITIES

- 5G
- Artificial Intelligence
- Augmented / Virtual Reality
- Autonomous Vehicles
- Edge and Cloud Computing
- Cybersecurity
- Embedded Sensor Systems
- Internet of Things
- Radio Frequency
- Streaming Video Analytics
- Millimeter Wave Technologies
- Software Defined Networks
- Software Defined Radios

## Distributed Remote Awareness

- **Challenge:** Assuring a secure, end-to-end connectivity that spans rural to urban environments is required to create a distributed remote awareness, enhancing the connection between individuals and machines to perform complex operations over geographically large regions.

- **Research Emphasis:** At PNNL, we look to 5G to create a distributed remote awareness that can provide first responders and others in the field with a common operating picture and wholistic understanding of how their actions coordinate with the larger picture. It also creates the possibility of remote operations and targeted remote assistance, as well as timely situational awareness for decision makers from response through recovery.

## System Security and Assurance

- **Challenge:** As a national rollout of 5G and associated applications become available and connected to global networks, it is essential to understand the implications and security of hyper-connectivity of devices. It is important to recognize that many of these devices will be autonomous in nature, with little to no human input or direction.

- **Research Emphasis:** PNNL's work in advanced wireless communication is linked to our work securing operational technology. This includes ensuring security across the virtual and physical worlds to assure the protection and resilience of critical infrastructure, the emergence of AI, autonomous systems, and related IoT applications.

## Supply Chain

- **Challenge:** The adoption of automation utilizing advanced wireless communications will transform corporations, governments, agriculture, and cities. Operations will be forced to adopt new technologies to remain competitive. Our country will rely on these newly connected critical national functions, making it imperative to protect them from undue influence.

- **Research Emphasis:** PNNL is supporting efforts to assure our nation has a domestic supply of trusted, certified and/or authenticated materials, hardware, firmware, and software for our wireless communications.
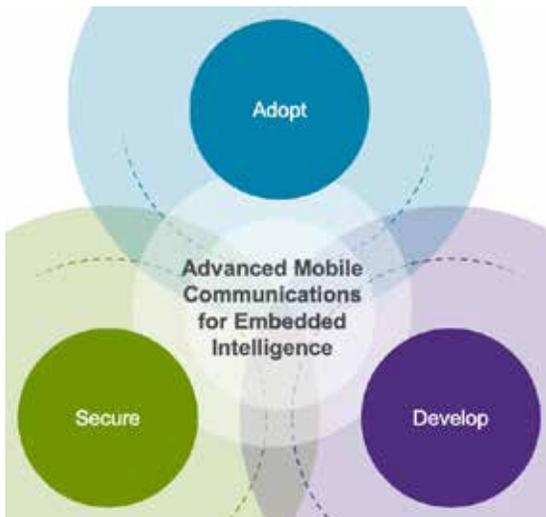


### Contacts:

**Johnathan Cree**
5G Program Principal Investigator
(509) 372-4105  |  5G@pnnl.gov

**Scott Godwin**
Industry Sector Lead, General Manager of Corporate Partnerships & Alliances
(509) 375-7201  |  scott.godwin@pnnl.gov

## WORKING WITH PNNL

Sponsors come to PNNL because of our flexibility and ability to pull in the right set of experts for the project. At PNNL, project teams and testing environments are flexible. We frequently bring together expertise from a broad set of fields to solve current and emerging challenges. Testing can occur in a variety of environments, including walk-in anechoic chambers, faraday cages, and offsite testing environments, from rural to urban settings, to closely match the environments of expected mission need. Given the critical use-cases imagined for 5G, flexibility in project staffing and test locations will continue to be incredibly important for research and development and cross-domain solutions will increasingly be in demand to assure performance.