

Electronics & Measurement Systems Group
**Embedded Systems
and Systems
Engineering**



PNNL-SA-113791

From Concepts to Solutions

PNNL researchers apply their expertise to problems across the full range of the technology development cycle. This evolves from basic research through proof of concept and prototype development to production and deployment of fully mature systems. This breadth helps PNNL staff understand and effectively deal with all of the challenges of bringing a technology from the idea stage to a working solution in the field.

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Technology Readiness Levels

Research

This phase starts with an idea, defines a technical concept and conducts experiments and modeling to develop an understanding of the basic characteristics of the selected approach.



Development & Demonstration

This phase involves the development and integration of components into initial systems to demonstrate feasibility.



Testing & Evaluation

In this phase, activities are conducted to qualify technologies for application in a true operational environment.



Production & Deployment

In this final phase, system development is completed and the technology is commercialized for deployment in its final form.



About PNNL

The Pacific Northwest National Laboratory, located in southeastern Washington State, is a U.S. Department of Energy Office of Science laboratory that solves complex problems in energy, national security, and the environment, and advances scientific frontiers in the chemical, biological, materials, environmental, and computational sciences. The Laboratory employs nearly 5,000 staff members, has an annual budget in excess of \$1 billion, and has been managed by Ohio-based Battelle since 1965.

Additional web resources are at: www.pnnl.gov.

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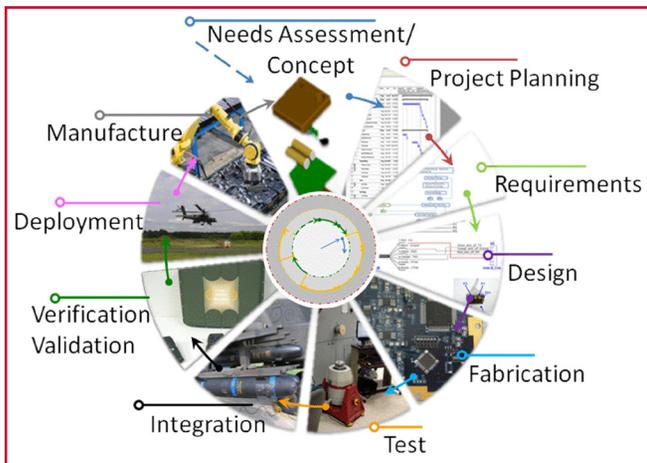
Enabling Technologies

Pacific Northwest National Laboratory's (PNNL's) scientists and engineers work closely with sponsors to develop an understanding of all aspects of their specific problems, and then draw from a broad range of disciplines and technologies to develop effective solutions. PNNL pursues forward-focused solutions that provide innovative and practical solutions that work in the real world. PNNL uses its vast experience and leverages developing R&D areas to implement complete solutions in:

- ▶ **RF Modeling**—antennas & terrain mapping
- ▶ **RFID Vulnerability**—information security & authentication, safeguards, intrusion, & theft detection
- ▶ **Communication Links**—short range & long range RF, cellular, satellite, & telematics
- ▶ **Tagging Tracking & Locating (TTL)**—real-time asset visibility, content status, positional awareness
- ▶ **VLVE (Very Low Voltage Electronics)**—enhanced power reduction
- ▶ **Energy Harvesting**—augment battery life
- ▶ **Low Power Remote Sensing Systems**—10+ year battery life, sensor fusion, embedded analysis & wireless exfiltration

Wireless

Low Power



Systems Engineering and Integration
NATIONAL SECURITY

Asset Monitoring and Tracking

PNNL has developed systems that monitor, track, record and report the status of high priority assets used in commercial and military operations. Each system has required a unique yet rapidly developed solution that leverages existing technologies and capabilities while adapting to emerging user needs. A key objective of PNNL development efforts is to transfer the developed solutions to industry. PNNL is working with industry helping shape user and manufacturing processes to ensure successful acceptance of emerging technologies.

System Engineering

Successful system integration starts by planning during product conception and continues throughout the Technology Readiness Levels (TRLs). PNNL's system-integration process utilizes the expertise of a highly developed team, where subject matter experts' specific skills are combined and applied.

Considerations

- ▶ Unique Application Requirements
- ▶ Ease of Use
- ▶ Reliability
- ▶ Product Lifetime
- ▶ Rapid Development of Tactical Hardware and Electronics

Mobile Source Transit Security

Industrial Radiography



Well-logging



Systems monitor and track mobile radiological sources throughout their usage.

Wireless Monitoring ISO 18000-7

- ▶ 2009 First Production Qty: 800
- ▶ Multi-Vendor
- ▶ System used as reference design



Environmental Monitoring

- ▶ DHID 2010 First Production Qty: 1500
- ▶ DHID Total Production: 5000
- ▶ DSSD 2015 First Production Qty: 200



Sensors and Capabilities

- ▶ Temperature, vibration, humidity, shock
- ▶ Onboard data processing and filtering
- ▶ Adaptive algorithms
- ▶ Predictive modeling
- ▶ Data off-load
- ▶ 11 year battery life
- ▶ Radiation detection

Tools Used to Facilitate Deployment

- ▶ Low Rate Initial Production (LRIP)
- ▶ Technical Leadership
- ▶ Technology Transfer
- ▶ First Article Testing