

PNNL's Energy Sector Position, Navigation, and Timing Testbed

ENHANCING ENERGY SECURITY THROUGH TEST AND EVALUATION IN A SIMULATED, SAFE SUBSTATION-LIKE ENVIRONMENT

Precise and synchronized time is essential for advanced measurement and control of our nation's electric power grid. Currently, the energy sector primarily relies on Global Navigation Satellite System (GNSS) receivers due to their availability and low cost, typically using the GPS to provide at least microsecond resolution.

GPS receivers are typically deployed in small, localized areas for a limited range of electric utility equipment. However, various natural and man-made threats, such as solar storms, jamming, and spoofing, pose risks to the grid's safety and reliability—highlighting the need for alternative time sources.

To assist in identifying these alternative timing capabilities and improve the ability of electricity providers to mitigate such risks, Pacific Northwest National Laboratory (PNNL) has established an Energy Sector Position, Navigation, and Timing (PNT) testbed in Richland, Washington.

USE CASES

PNNL's research is focused on feasibility and the performance of alternatives to GPS for use in substations and field locations. Initial example use cases include:

- Island reconnection
- Current differential protection
- Synchrophasor scenarios
- Fault location, isolation, and service restoration
- Traveling wave fault location

MODULAR AND FLEXIBLE

Developed with efficiency and reuse in mind, the advanced Energy Sector PNT testbed supports a wide range of use cases for integrating and testing multiple complementary and precision timing sources.

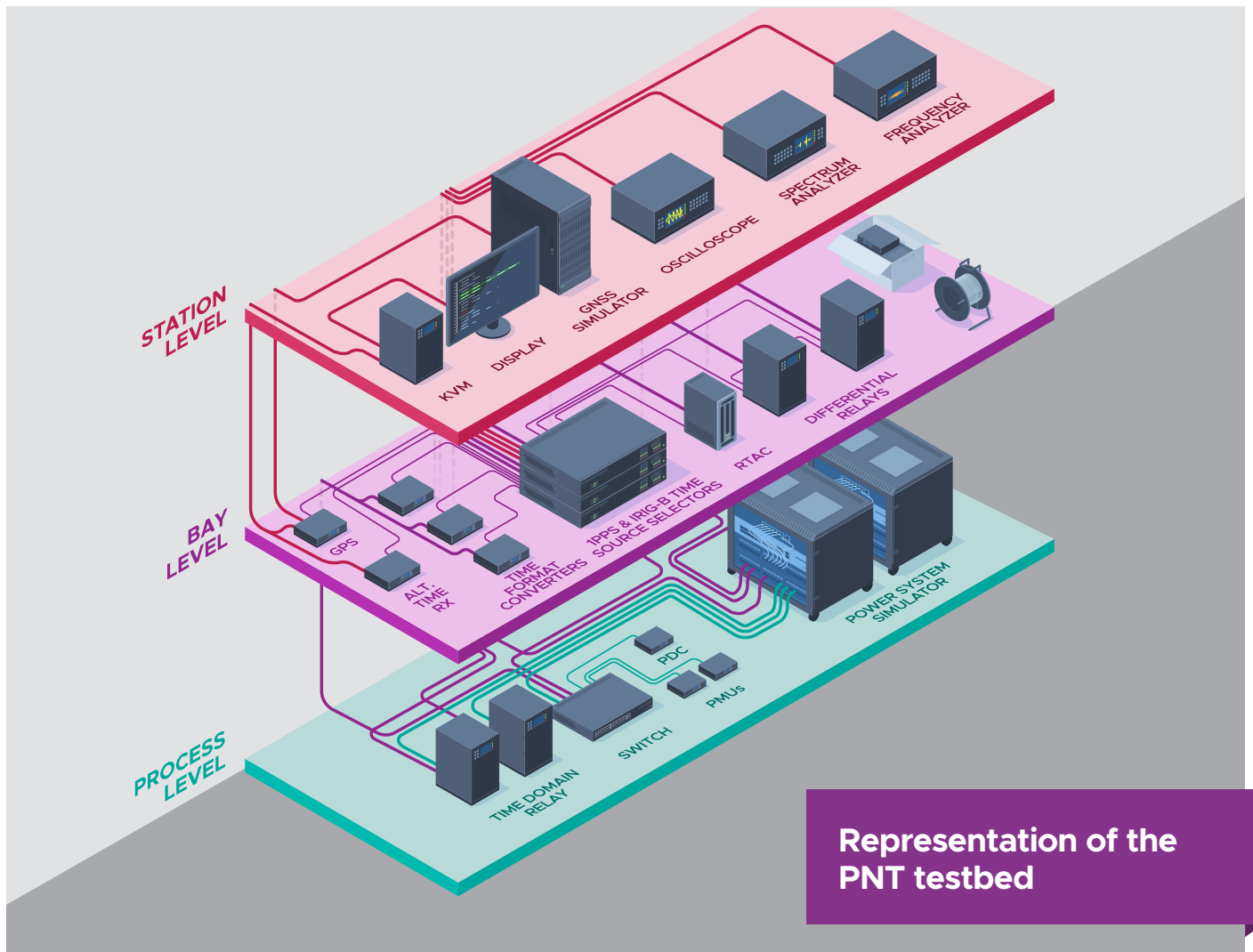
As additional use cases are developed, substation specific devices can be connected to the Energy Sector PNT testbed. Additionally, the power system simulator can be programmed to model and simulate the behavior of various transmission and distribution scenarios likely to be encountered in the electric utility environment. The Energy Sector PNT testbed can be augmented with other time sources as they are developed and become available for testing, whether they are terrestrial landline, radio, satellite based, or a combination of different technologies.

Mission & Expertise

- ✓ Scientific experimentation
- ✓ Technology assessment
- ✓ Dataset generation
- ✓ Simulation and modeling
- ✓ Low and high technology readiness level studies
- ✓ Subject matter experts with industry experience and expertise in international standards

Capabilities and Facilities

- ✓ Models of realistic operational technology (OT) environments
- ✓ Remotely accessible
- ✓ Configurable, real-world systems in a controlled environment
- ✓ eLORAN and several GPS receivers
- ✓ Extensible for other time sources and technologies
- ✓ GNSS signal and hardware-in-the-loop power system simulators
- ✓ Interchangeable antenna capability



EXPERTISE

Staff at PNNL have hands-on experience at electric utilities, and with international standards, advanced testbed design, and execution proficiency, which allows for a real-world approach to testing. This group of subject matter experts is uniquely qualified in both experimentation and implementation.

IMPACT

PNNL's Energy Sector PNT testbed enables the identification of risk reduction and mitigation strategies that U.S. grid operators can use to continue safe and

reliable electric grid operations, even when PNT sources are degraded or denied due to natural or man-made scenarios.

ABOUT PNNL

PNNL draws on its distinguishing strengths in chemistry, Earth sciences, biology and data science to advance scientific knowledge and address challenges in energy resiliency and national security. Founded in 1965, PNNL is operated by Battelle and supported by the Office of Science of the U.S. Department of Energy.

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