ReCAS

Resilient Control Architectures and Systems

AN ICIS NEWSLETTER

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Resilience Week 2014

During the third full week of August, a symposium on resilient systems was held in Denver. The symposium was sponsored by INL, IEEE and other partners with academic, industry, and professional organizations. Resilience Week is dedicated to promising research in resilient systems that will protect cyber-physical infrastructure from unexpected and malicious threats – securing our way of life. Dr. Craig Rieger chaired the symposium with over 160 attendees who included numerous representatives from other DOE national laboratories and DoD, regulatory agencies such as DHS and NERC, and corporations such as Chevron and HECO.

Resilience Week was established in 2008 to develop a multidisciplinary community to extend and endorse particular concepts that will generate innovative research solutions and codify resilience in next generation control system designs. Since then, the symposium has evolved into the four co-located R&D symposia, reflecting the cyber security, human interaction, and communications aspects of engineered systems. In addition, this year added a symposium on resilient critical infrastructures. This symposium is designed to facilitate productive discussion of tools, technologies, and policies for improving our National critical infrastructure resilience.

When one individual was asked why they attended the symposium, their response was, "To learn more about how resilience programs, current research and organizations involved in critical infrastructure protection, state of the initiatives, cyber-security research, tools and methodologies development and deployment are all proceeding across the nation and abroad. The ability to meet new people and see what they are working on, in both academic and professional contexts was invaluable."

Plenary keynote speakers included Dr. Kevin Moore, dean of the College of Engineering and Computational Sciences at Colorado School of Mines, Samara Moore, senior policy advisor for the Under Secretary for Science and Energy within the Department of Energy, and Rosemary Wenchel, deputy assistant secretary for cybersecurity coordination in the Department of Homeland Security's National Protection and Program Directorate. Each of the five resilience-focused symposia (control, cyber, communication, cognitive, critical infrastructure) had semi-plenary keynote speakers focusing on those specific disciplines. Presentations provided by the keynote speakers can be found on the Resilience Week website. Resilience Week 2015 will be held in Philadelphia, PA, from Aug. 18 to 20.

Instrumentation Control & Intelligent Systems

INL
Idaho National Laboratory

Relevant Peer-Reviewed Publications

A. Giani, E. Bitar, M. Garcia, M. McQueen, P. Khargonekar, and K. Poolla, "Smart Grid Data Integrity Attacks,"IEEE Transactions on Smart Grid, vol.4, no.3, pp.1244-1253, September 2013.

C. Rieger, "Resilient Control Systems Practical Metrics Basis for Defining Mission Impact," Resilience Week, August 2014.

T. Vollmer,M. Manic, "Cyber-Physical System Security With Deceptive Virtual Hosts for Industrial Control Networks," IEEE Transactions on Industrial Informatics, vol. 10, no. 2, May 2014.

C. Rieger, "Notional Examples and Benchmark Aspects of a Resilient Control System," 3rd International Symposium on Resilient Control Systems, August 2010.

W. Lin; K. Villez; H. Garcia, "Experimental Validation of a Resilient Monitoring and Control System," Journal of Process Control, vol. 24, no. 5, pp. 621–639, May 2014.

D. Wijayasekara, O. Linda, M. Manic, C. Rieger, "FN-DFE: Fuzzy-Neural Data Fusion Engine for Enhanced Resilient State-Awareness of Hybrid Energy Systems," Special Issue on Resilient Architectures and Systems, IEEE Transactions on Cybernetics, vol.44, no.11, pp.2065-2075, November 2014.

Grid-centric Demonstration of Resilience Technologies

A two-year project was recently initiated to perform an integrated demonstration of several resilient control system technologies to protect the nation's power grid from natural, operational, or man-made disruptions. This demonstration's principal investigator Craig Rieger along with co-investigators Humberto Garcia, Tim McJunkin and Miles McQueen focused on the research and development (R&D) activities needed to apply several innovative INL technologies developed under the Instrumentation, Control, and Intelligent Systems (ICIS) Distinctive Signature mental technologies to a common power grid platform.

Resilience is a measureable attribute of a system's ability to successfully maintain minimum defined operational capacity during operational disruptions due to equipment malfunction, human error, and/or deliberate physical or cyber security attack. The development of technologies to improve the U.S. critical infrastructures capability to perform well under conditions of natural disaster or enemy attack is important to the mission of DOE, DHS, as well as directly applicable to the infrastructure utilities of the U.S. The ability to demonstrate these technologies provides a direct tie to the ICIS science basis and relevance to how a resilient control system might be formed as an enabler to a Smart Grid.To demonstrate an experimental platform, a microgrid (seen in figure 1) was chosen and adapted to enable implementation of Known Secure Sensor Measurements (KSSM), Resilient Battery Monitoring (RBM), Resilient Condition Assessment Monitoring, Adaptation and Control (ReMAC) and Data Fusion/ Visualization technologies.

Resilient technologies included:

- KSSM is a grid wide technology to prevent unobservable attacks to the state estimator of an electric grid through the placement of a secure, encrypted sensor in the form of a phasor measurement unit (PMU).

- RBM was designed to make use of previous R&D 100 award winning technology for active impedance measurement (AIM) of batteries to add resilience to storage systems. The storage systems provide backup, real and reactive power compensation to stabilize voltage and frequency through a power inverter, which is critical to an extremely low inertia Microgrid.

- ReMAC provides a Bayesian algorithmic framework for identifying anomalous sensors based upon data quality and using that information for a health determination of the system.

- Data fusion and visualization was developed to enable dynamic state awareness to the operator of each of the technologies, provide characterization and prioritization of response, and awareness of degradation that includes cyber-physical security.
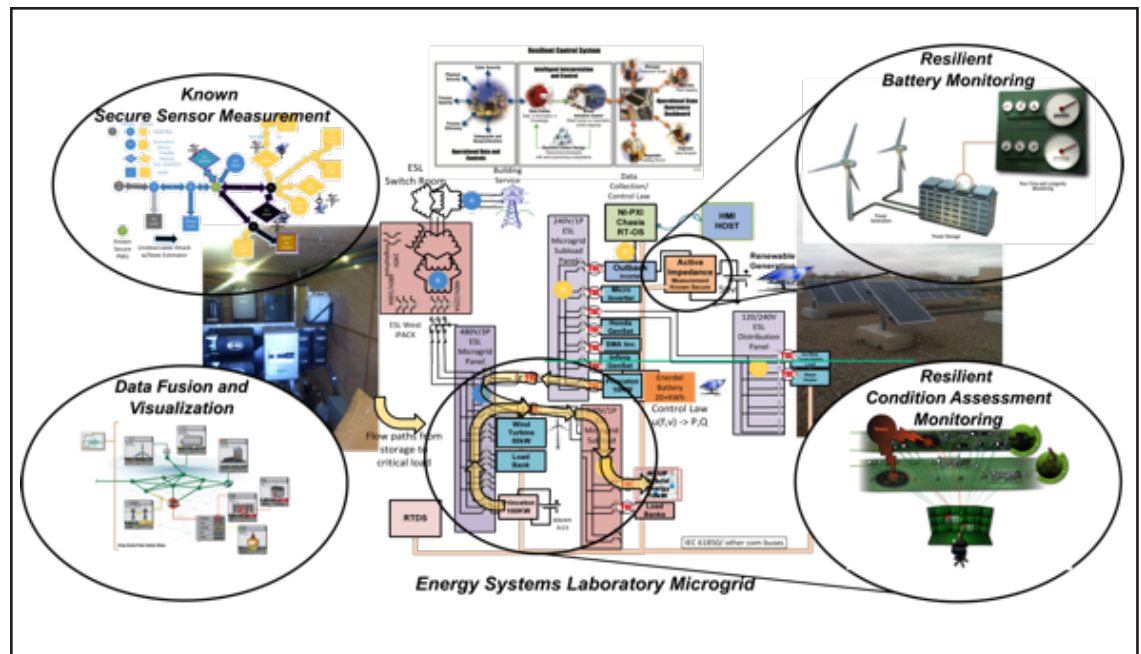

Figure 1. Diagram of the microgrid and the mapping of resilient control technologies on the platform