Life Cycle Testing of Synchrophasor Based Systems used for Protection, Monitoring and Control

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Introduction

Tools and Methodologies:

- Lab testing
- Field testing

Example: Timing intrusion testing

CIGRE WGB5.62

IEEE SGSMA Conference

Conclusions

Introduction

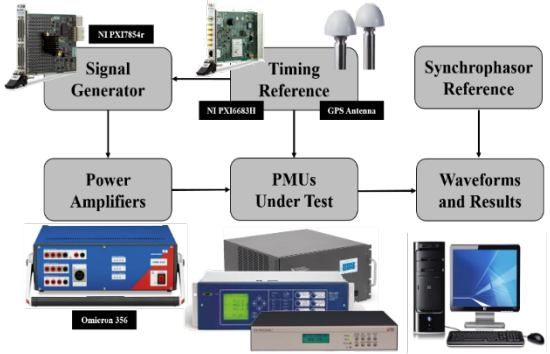
Testing stages:

- Device acceptance testing and certification
- Commissioning and end-to-end testing
- Periodic testing and trouble shooting testing

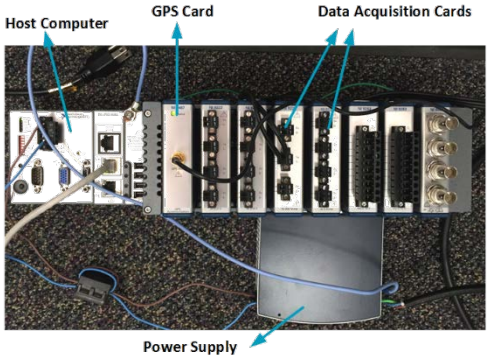
Testing approaches:

- Design test
- Application test

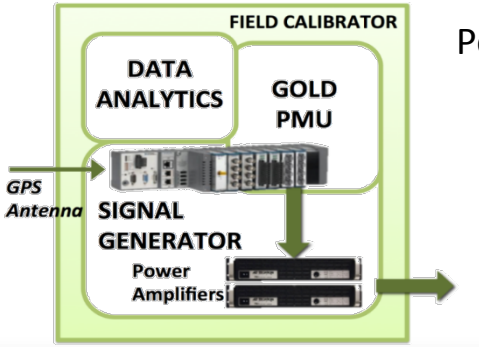
Tools and Methodologies



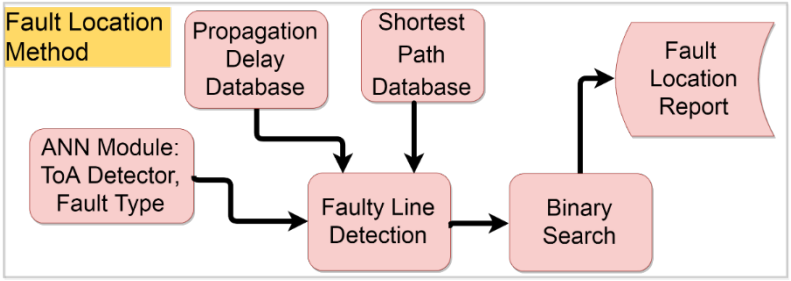
PMU Calibration/Testing Laboratory



Gold PMU Development in NI CompactRIO



Portable field calibrator



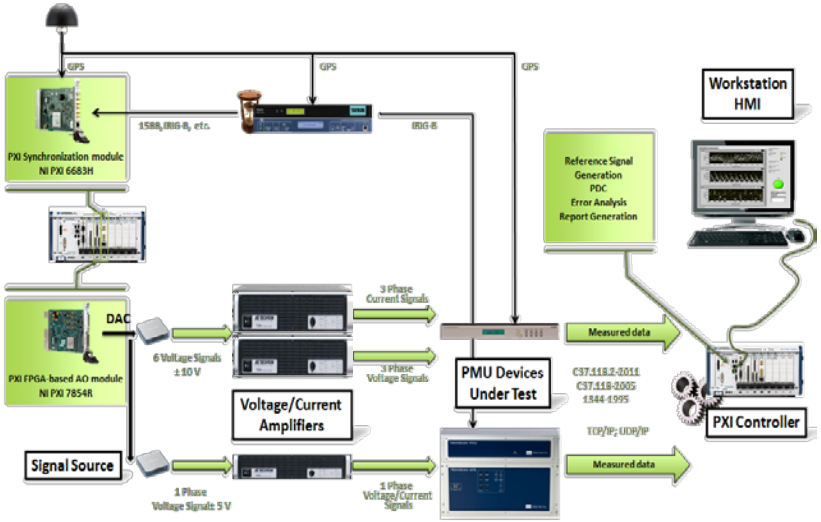
Fault Location Application Module

Lab Testing

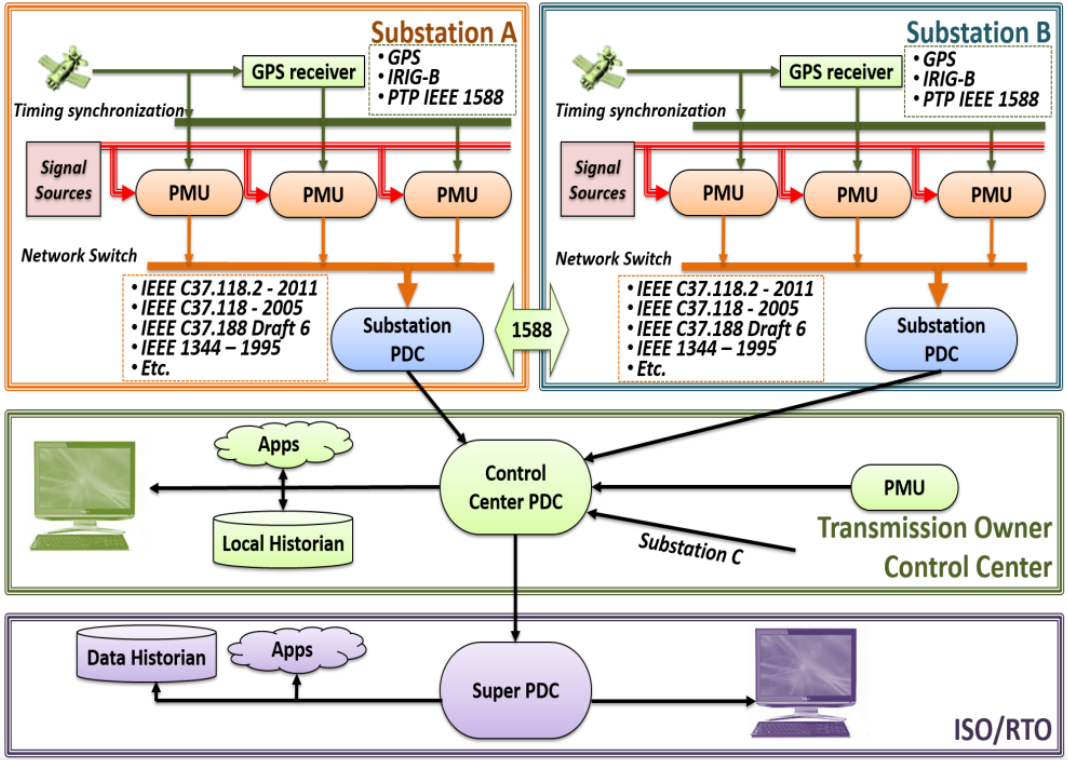
- Evaluate *device* performance
  - Certify against a standard
  - Calibrate performance under events of interest
- Evaluate *system* performance:
  - Certify performance under events of interest
  - Tests using replay of recorded waveforms
  - Tests using simulated waveforms

Use Cases: certification/evaluation PMU Testing

- PMUs with TCP Communication Protocol
- PMUs with UDP Communication Protocol
- PMUs with Serial Communication Protocol
- Digital Fault Recorders with PMU Functionality

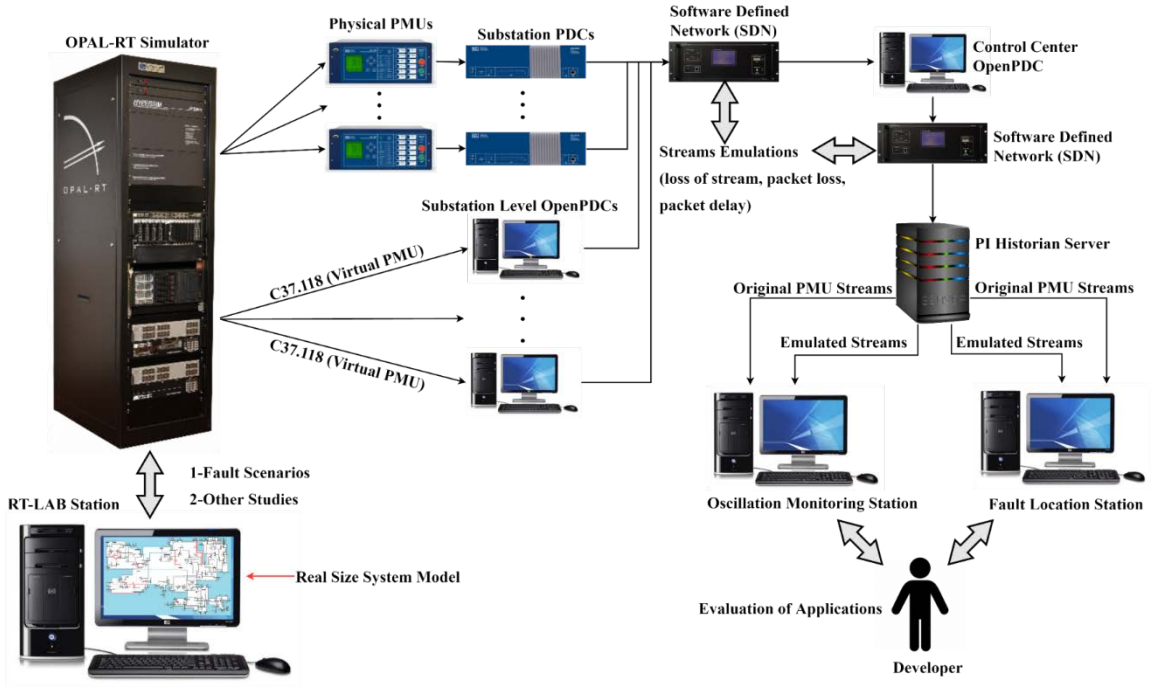


Use Case: End-to-end Testing



Use Case: Application Testing

- Fault Location Application
- Oscillation Monitoring Application

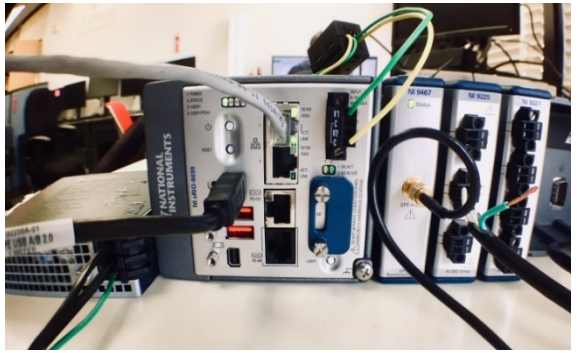


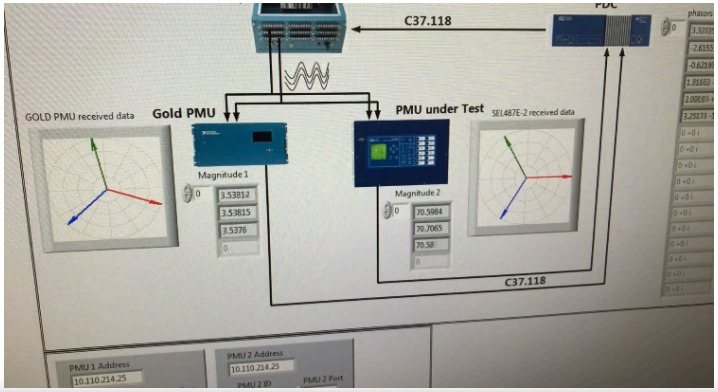
Field Testing

- Evaluate *device* performance:
  - PMU, PDC
  - Relay with PMU functionality
  - DFR with PMU functionality
- Evaluate *system* performance:
  - System components (nested testing)
  - Entire system with applications

Use Case: Gold PMU installed in the test set

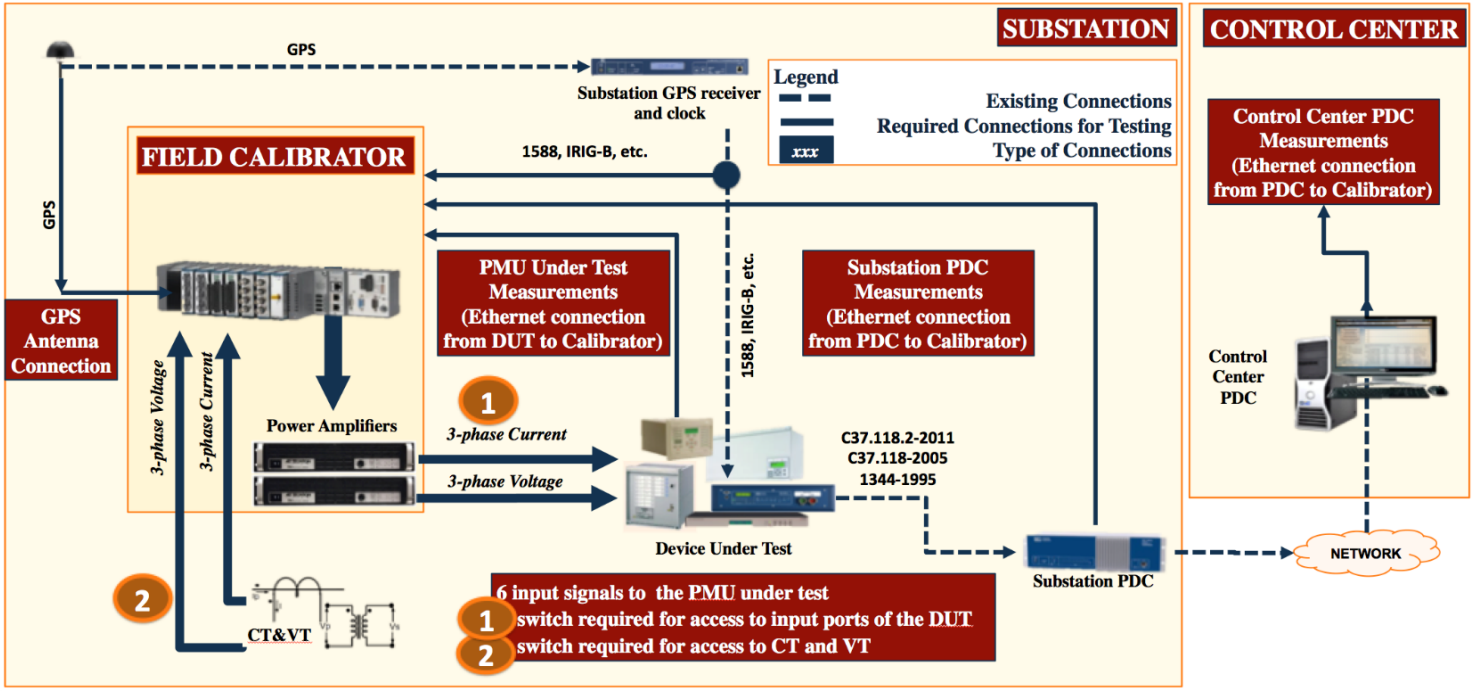
- Coordination with Field Test Set in commercial PMU testing
- The integration requires proper wiring to capture outputs from commercial PMU back to the test set
- Screenshot of interface during testing (integrated within Field Test Set)





Use Case: Portable Field Calibrator

- Periodic Maintenance in the field
- Troubleshooting synchrophasor system applying nested testing approach



Example: Timing Intrusion Detection Testing

- Detect timing intrusion on:
  - GPS receiver
  - PMU/PDC
  - Communications
- Evaluate impact on:
  - System performance:
  - Application

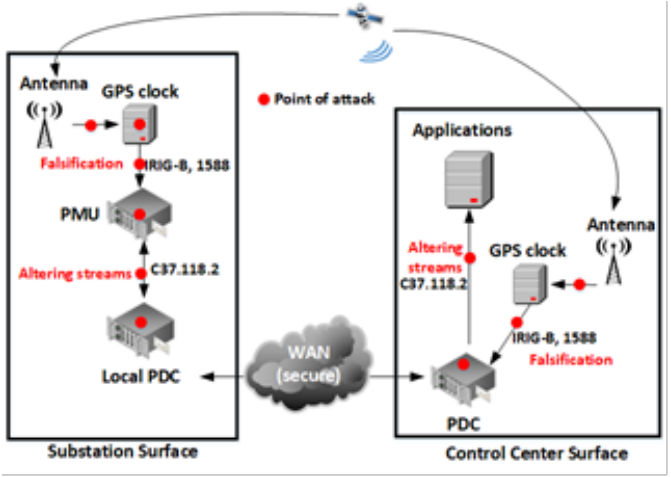
Timing Intrusion Management Ensuring Resiliency (TIMER)

Objective

- Make end-to-end Synchrophasor systems and applications more resilient under timing attacks
- Goal: to develop detection methods & tools to manage timing signal intrusions.

Schedule

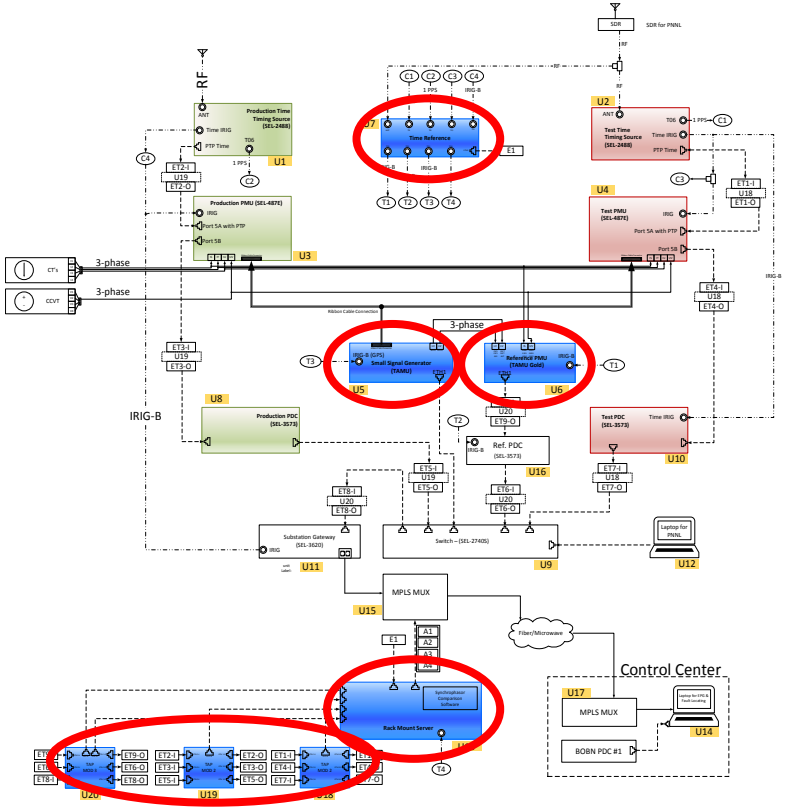
- Key deliverables: 1) Software & hardware solutions to detect timing intrusions; 2) Advanced testbed & field evaluations; 3) Risk-based evaluation methodology & metrics;
- Transition to the energy sector: Field demonstration at IPC; Promotional meetings with end-users.



Total Value of Award:	**$4,429,451**
Funds Expended to Date:	**2020**
Performer:	**Texas A&M Engineering Experiment Station**
Partners:	**PNNL, Idaho Power, EPG**

Use Case: Field Installation at IPC

- Timing reference with model of GPS receiver
- Field test set for reference waveform injection
- Gold PMU as a stand alone reference unit
- Reference model for PDC
- Reference Models of communication protocols for C37.118.2 and 1588
- Alarm processor and interfacing to EPG software for control center display



CIGRE WGB5.62: Life Cycle Testing of Synchrophasor Based Systems used for Protection, Control and Monitoring

Scope:

- What are the existing PMU and Synchrophasor system standards, and what is their impact on testing and certification?
- What is the importance of the concept of interoperability and why it matters?
- Why the certification may be needed and who is authorized to do it?
- How certification may be accomplished and what are associated costs?
- What are acceptance, commissioning, periodic maintenance and troubleshooting test procedures and how do they relate to the life-cycle management of synchrophasor systems?
- Why such life cycle test procedures matter and how are they implemented today?
- How to plan for the PMU certification and the lifecycle testing of PMUs and Synchrophasor Systems?

The First IEEE Intl. Conf. On Smart Grid Synchronized Measurements and Analytics-SGSMA

- **Venue, dates**:
  - College Station, TX
  - May 20-23, 2019
- **Participating organizations**:
  - National Science Foundation
  - NASPI
  - Sponsors: NSF, IEEE PES, SEL, EPG, VR Energy, EPRI, NuGrid, Arbiter Systems, Texas A&M University/TEES
- **Pre-conference events**:
  - 2 tutorials
  - 2 workshops
- **Conference events**:
  - Keynote and 3 Invited talks
  - Six panels (industry, government, academia)
  - 13 paper sessions with presenters from over 20 countries

Thank you

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building a prosperous future
where energy is
clean, abundant, reliable, safe, secure and affordable