# Welcome to PI World Transmission & Distribution Industry Session

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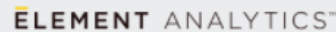**SILVER SPONSORS**

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# Exhibitors

# Save the Date! PI T&D User Group Meeting!

- When: October 3rd thru 5th
- Where: Indianapolis, IN
- Location: Westin Indianapolis

Combined with the Power User Group meeting

Registration Site will be is up and running soon!

- **CALL FOR PAPERS!  Reach out to Kevin Walsh or your EPM/Sales Person**

# Today's Lin-up: AM

- The PI System Solution for Advanced Grid Management

- The Modern PI System for AMI Meter data

- Deep dive into Transformer Monitoring with PI

- PI and PowerRunner – Reducing AMI Latency to Improve Near real-time Situational Awareness.

# Today's Lin-up:  PM

- Improving the daily Operation Report with OSIsoft PI

- New Approach to SCADA at Solar Farms

- Simplifying Complexities of Power Distribution by Implementing PI AF

# T&D Industry Dinner - Tonight

- Fogo de Chao – 201 3rd Street
- (415) 427-0004
- https://piworld-tnd.app.rsvpify.com/
- 7:30 PM



Your Journey Begins At
FOGO DE CHÃO
BRAZILIAN STEAKHOUSE

# National Lab & Academic Research in T&D


Cyber Security of Distribution Systems Using Distribution PMU Measurements and SCADA


Security & Resiliency Cyber Infrastructure for Energy Delivery System (EDS) Resiliency


Multi-Purpose Testbed w/Live Utility Data


NFS Smart Grids
Big Data Spoke


Interdisciplinary Research Institute for Cyber Physical Infrastructure and Energy

# Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

# Please remember to…

Complete the Online Survey for this session

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Merci

谢谢

Спасибо

Danke

Gracias

감사합니다

Thank You

ありがとう

Grazie

Obrigado

Optional: Click to add a takeaway you
wish the audience to leave with.

# National Lab & Academic Research in T&D

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# Cyber Security of Distribution Systems Using Distribution PMU Measurements and SCADA

**BERKELEY LAB**

New method of detecting certain classes of cyber attacks against distribution substations

Scalable solution already being deployed by major utilities to analyze natural faults.



Current Magnitude Fast Changes
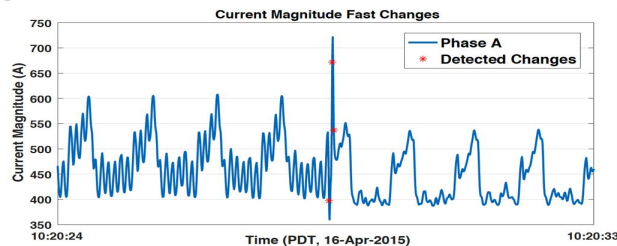
## CHALLENGE

- Cyber security for energy delivery systems often doesn't consider the condition of power-grid elements, and the effects of that condition on the grid

- Current IT security systems have no knowledge of these physical aspects

## SOLUTION

- Use *both* physical (µPMU) sensors (~120 Hz) in distribution grid to measure electrical power system parameters *and* SCADA traffic to *independently* view grid ops.

- Compare *physical state from µPMUs with view of network (SCADA) commands,* and correlate equipment operation (or lack thereof)

***Contact us!***

Sean Peisert, Ph.D. (sppeisert@lbl.gov)

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## RESULTS

- **much harder to spoof traffic or mask attacks**

- **operators more accurately identify the effect of attacks, not just "anomalies"**

- **"physical" aspect of the grid become an asset, not just a liability**

# Analysis Methodology

Two parallel detection mechanisms:

1. **_"Reconnaissance attacks"_** — attacker tests controllability of substation devices without being observed in SCADA

   - Learn control logic of discrete switching devices (e.g. voltage regulators and capacitor banks), using relative topology of sensors and control devices.
   - Alert operators when device operates unexpectedly

2. Detection and corroboration (with SCADA) of anomalies.

   - Distributed threshold detection and unsupervised algorithms are used to rapidly **_detect anomalies._**[1]
   - _Static_ rules trigger alarms agnostic of placement, e.g., trigger alarm if voltage < 0.9 p.u.
   - _Dynamic_ rules employ _semi-supervised ML_
     - Learns normal/abnormal behavior of active/reactive power & current for feeders
   - **Alerts operator if signature is absent from SCADA packets, indicating potential packet spoofing**
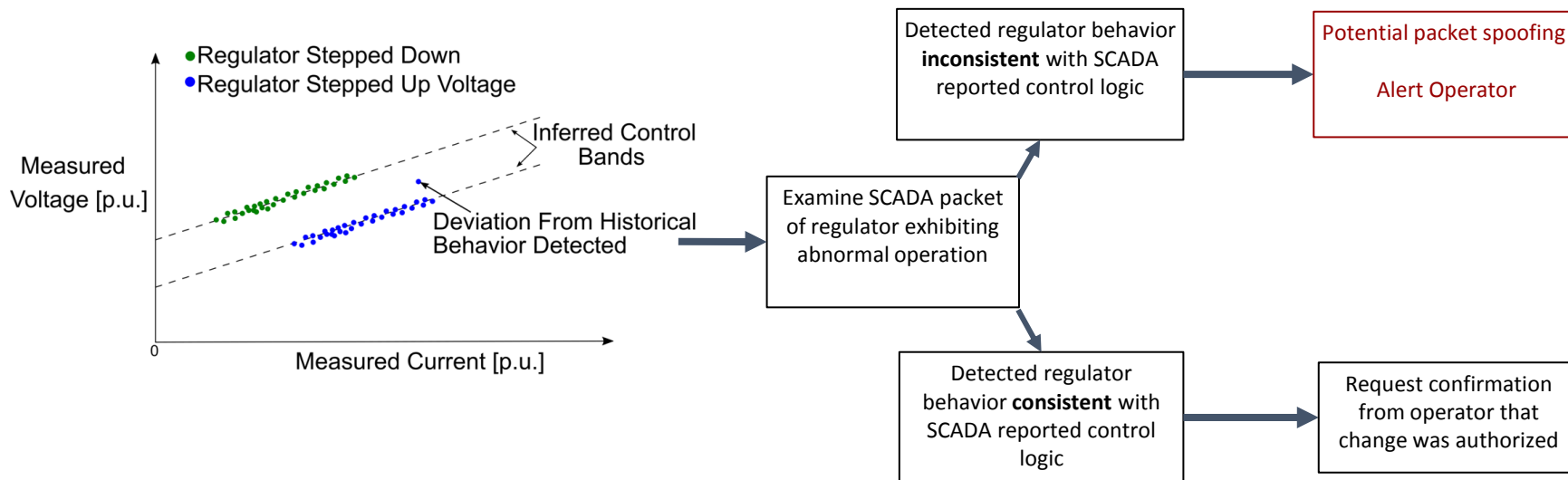


Power Distribution Grid



Current Magnitude Fast Changes

9 seconds of μPMU data
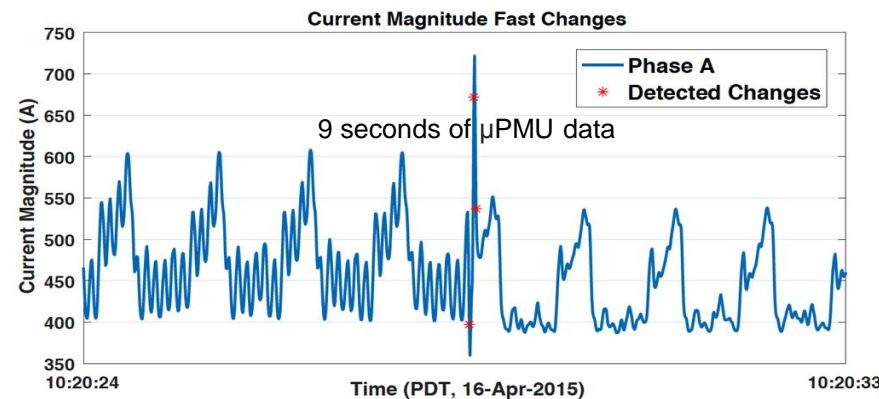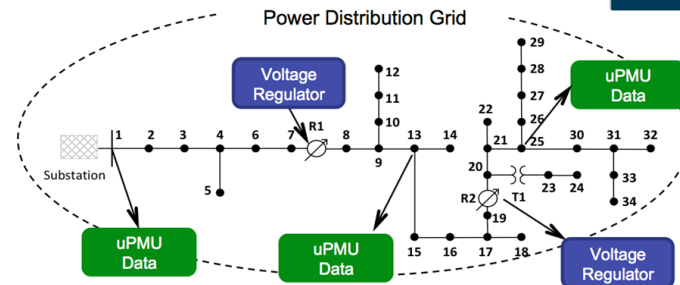
1. Jamei, Mahdi, et al. "Anomaly Detection Using Optimally-Placed μPMU Sensors in Distribution Grids." _IEEE Transactions on Power Systems_ (2017).

# Use Case

- Adversary performs '***reconnaissance attack'*** to confirm controllability of SCADA controlled devices
  - uPMU detects abnormal behavior of voltage regulator



Measured Voltage [p.u.]

- Regulator Stepped Down
- Regulator Stepped Up Voltage

Inferred Control Bands

Deviation From Historical Behavior Detected

Measured Current [p.u.]

Examine SCADA packet of regulator exhibiting abnormal operation

Detected regulator behavior **inconsistent** with SCADA reported control logic

Potential packet spoofing

Alert Operator

Detected regulator behavior **consistent** with SCADA reported control logic

Request confirmation from operator that change was authorized

# Next Steps

- Goal is to help put this technique into practice
- Further test deployments across utilities
  - Data acquisition system is built
  - µPMUs commercially-available
  - Detection algorithms developed and evaluated against PG&E, RPU, and Southern Co µPMU data
  - Publicly available for exploration on limited datasets: https://powerdata.lbl.gov
- *What would it take for a utility to do a pilot?*
  - *Contact us!*
  - Sean Peisert, Ph.D. (sppeisert@lbl.gov)
  - Ciaran Roberts (croberts@lbl.gov)

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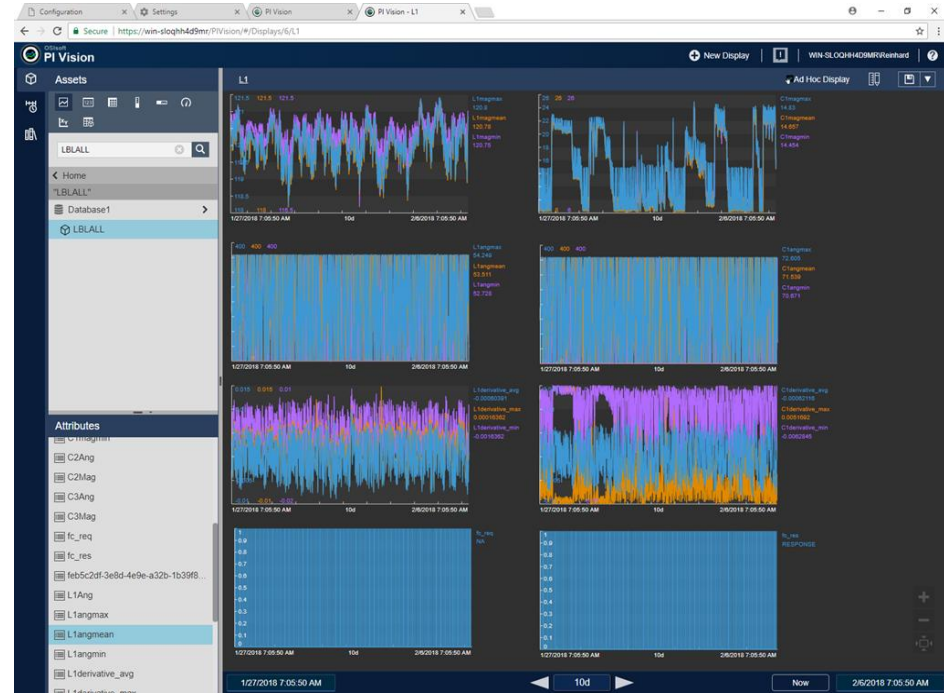
# Cyber Physical Research Data Infrastructure

## Lawrence Livermore National Laboratory

Launching a Multi-Purpose Testbed
Live Utility Data - Grid Analytics & Cyber Testing
Smart Grid Visualization and Analytics Linked to Cyber
Component Test Lab (SkyFall)

**Lawrence Livermore National Laboratory**

### CHALLENGE

- Cyber security & Grid Analytics requires live grid energy data, not simulated data.

- Building an smart grid infrastructure is solved. Researchers want to focus on industry problems not software development.

### SOLUTION

- Create an OSIsoft based infrastructure in the Lab that is configured to integrate to Skyfall & LLNL HPC resources.

- Securely connect industry data PI Systems to LLNL research test bed based on OSIsoft.

### RESULTS

- **Securely Link Utility Industry Data to World Class Researchers & Tools**

- **Improved Security Review of Utility Operations**

- **Extends Existing Leading Tools High Performance Computing Resource**

- **Provides Research Solutions for Prototype Testing**

**OSIsoft. PI World** SAN FRANCISCO 2018

*Contact us!*

Emma Stewart, Ph.D. (stewart78@llnl.gov)

# Institute for Cyber Physical Infrastructure & Energy (I-CPIE)

*Lehigh University Interdisciplinary Research Institute, launched April 18, 2018*

- **Cyber Infrastructure & Energy (CPIE) systems are critical to society**
    - **Communities depend on CPIE systems for shelter, water, food, internet, and power**
    - **Economies are driven by CPIE systems for manufacturing, transportation and logistics**
- **CPIE systems must be sustainable and resilient to various attacks and hazards**
- **I-CPIE builds on Lehigh expertise in smart and resilient infrastructure; smart grid and renewable energy; cybersecurity; energy technology; social sciences...**

## CHALLENGE

- Smart, transformational technologies to sustain, advance, protect CPIE systems
- How will connected communities exploit data to advance health and well-being?
- What advances in science and technology at the food-water-energy nexus will sustain future populations?

## SOLUTION

- Smart Infrastructure for Connected Communities
- Sustainable, Resilient Energy Delivery Systems
- Infrastructure System Risk and Resilience
- Food-Energy-Water Science and Technology

## RESULTS

- Connected community of CPIE scholars and industrial and government partners
- New generation of data-savvy graduate students with breadth in CPIE science and technology
- Implementations of CPIE systems research, resulting in product and process advances, and solutions to critical societal needs

*Contact us!*

Richard Sause, Ph.D. (iri@lehigh.edu)