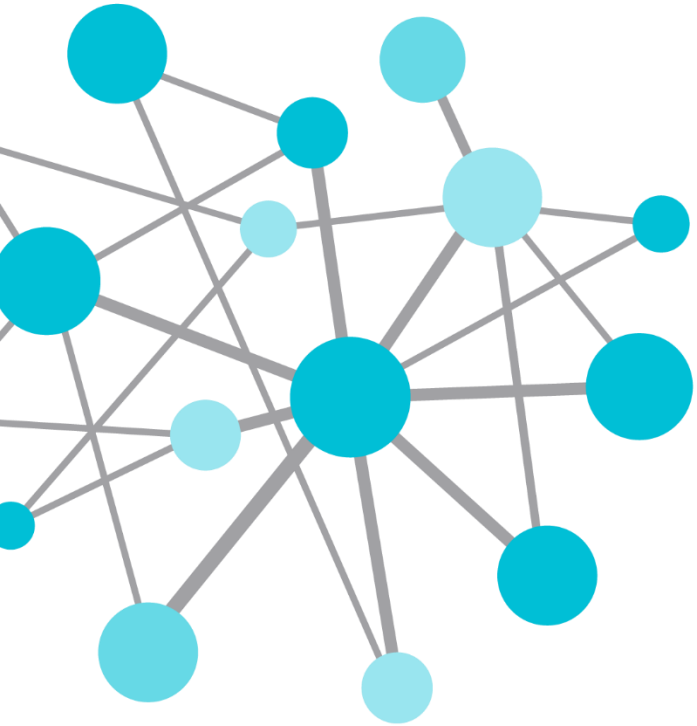


National Infrastructures: *Surety, Security and Reliability*

Presentation at OSIsoft Federal Workshop

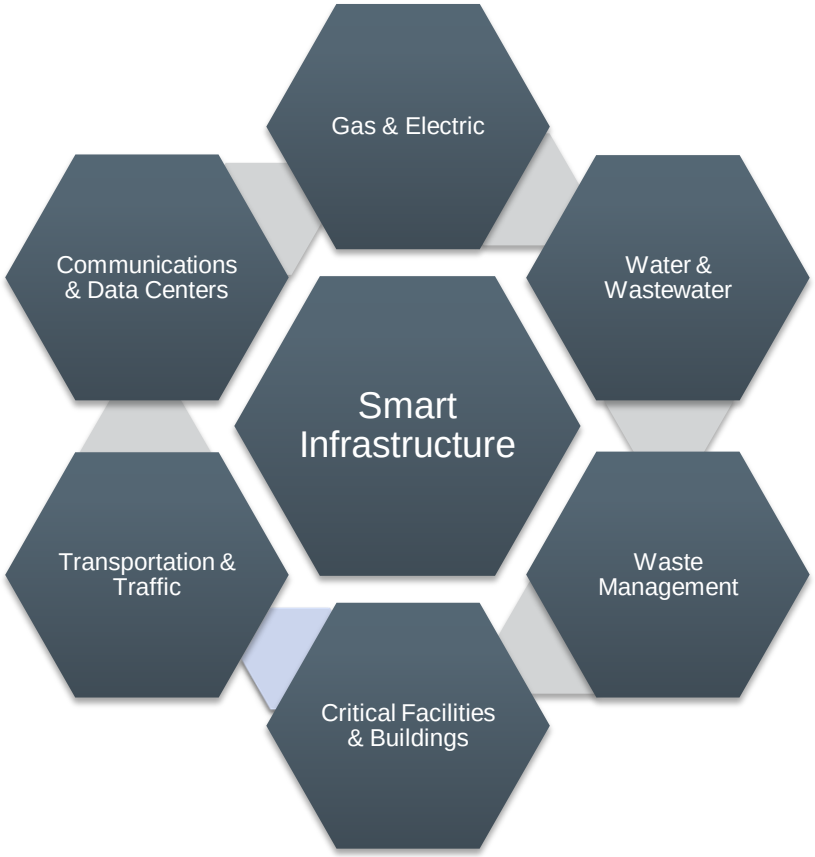
Presented by **Dave Roberts, OSIsoft Fellow**

@OSIsoftDRoberts

Infrastructures at Scale

A common data infrastructure that connects all of the various physical assets/infrastructures

- Electrical
- Gas
- Water
- Transportation & Traffic
- Critical Facilities
- Communications
- Buildings



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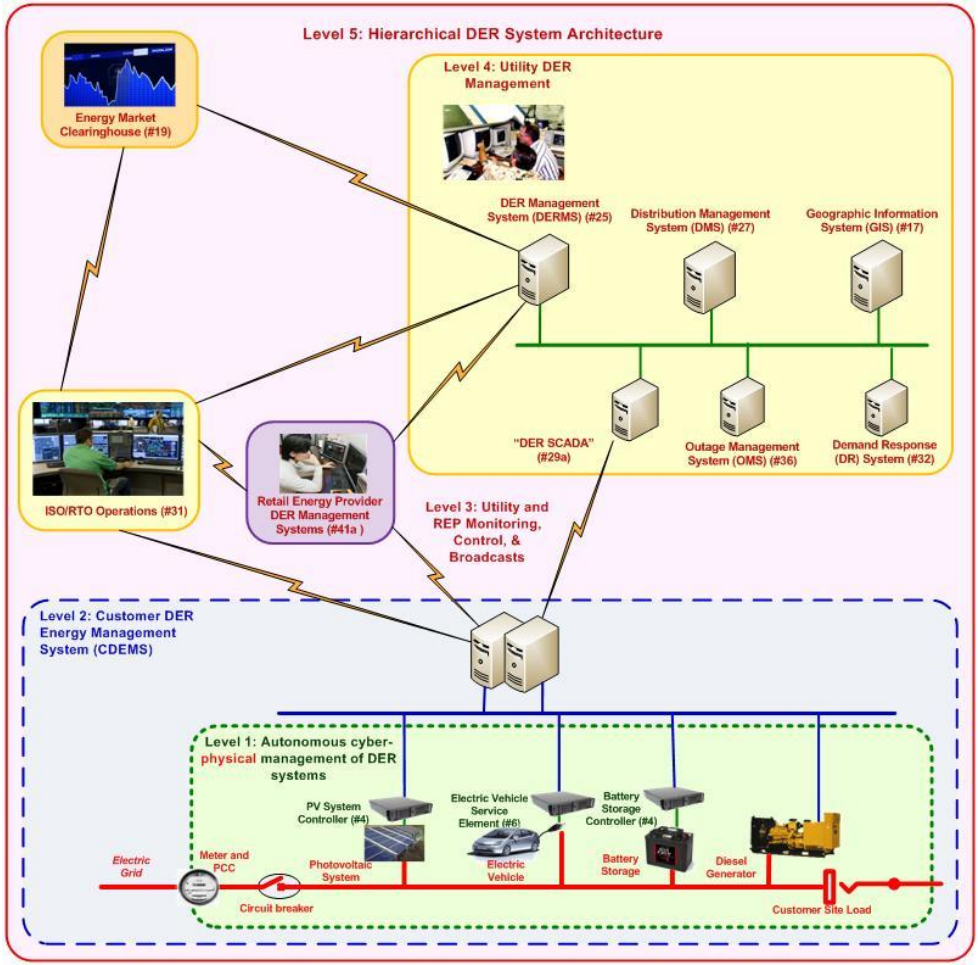
5 Levels to the Infrastructure

- Level 5: Overall Hierarchical DER Management Architecture
- Level 4: Utility Operational DER Management: DERMS
  - *Analysis of power system requirements for safety, reliability, and efficiency*
- Level 3: Utility and/or REP Interactions with DER Systems
  - Level 3a: DER Systems in Substations
  - Level 3b: DER Systems in Residences and Communities
  - Level 3c: DER Systems in Commercial or Industrial Sites
  - Level 3d: Actual and Virtual DER Power Plants
  - Level 3e: Military Base Microgrids with DER Systems
- Level 2: DER Management System to Manage Groups of DER Systems
- Level 1: Autonomous Cyber-Physical DER Systems in a Customer or Utility Site



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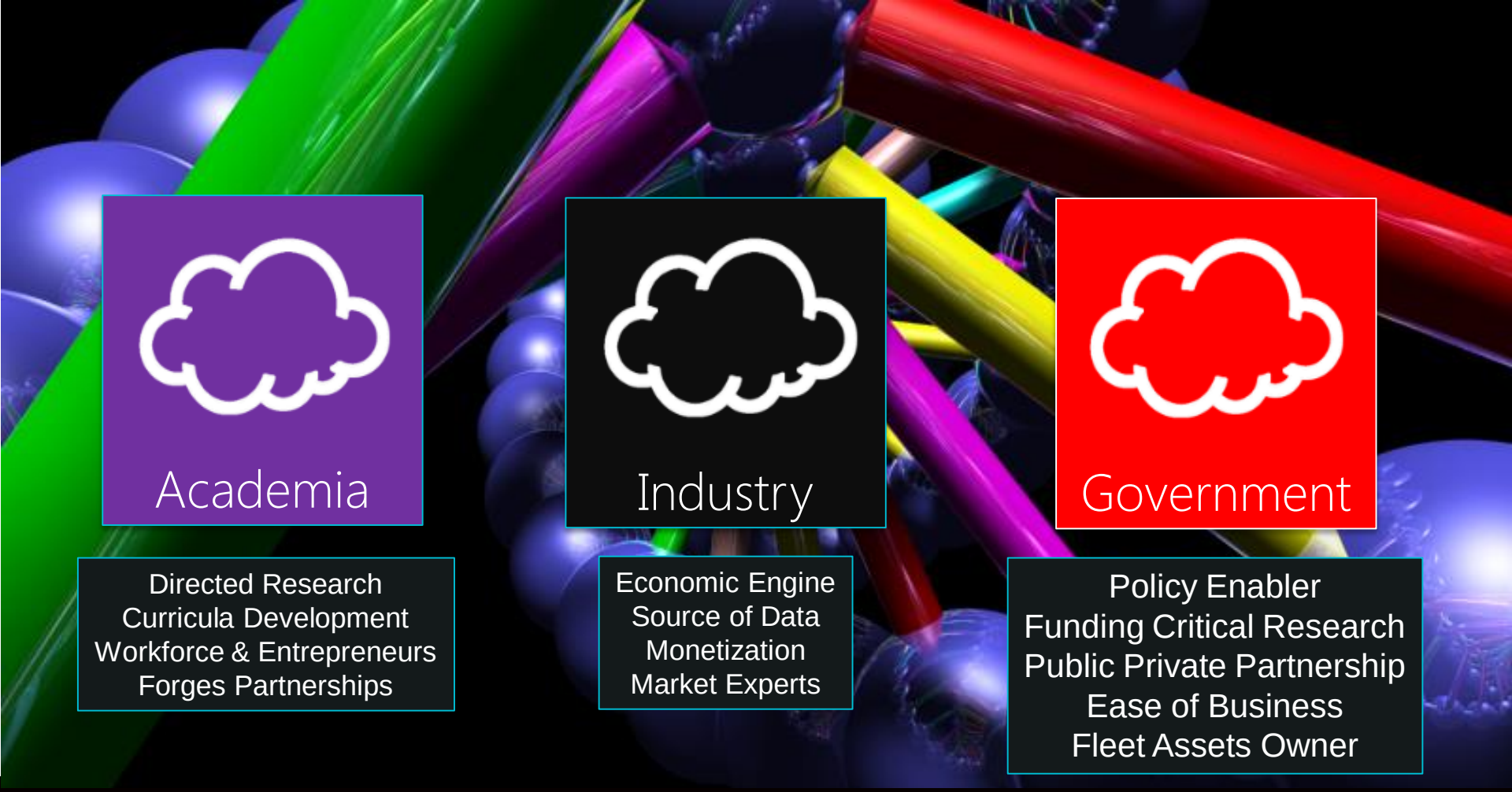

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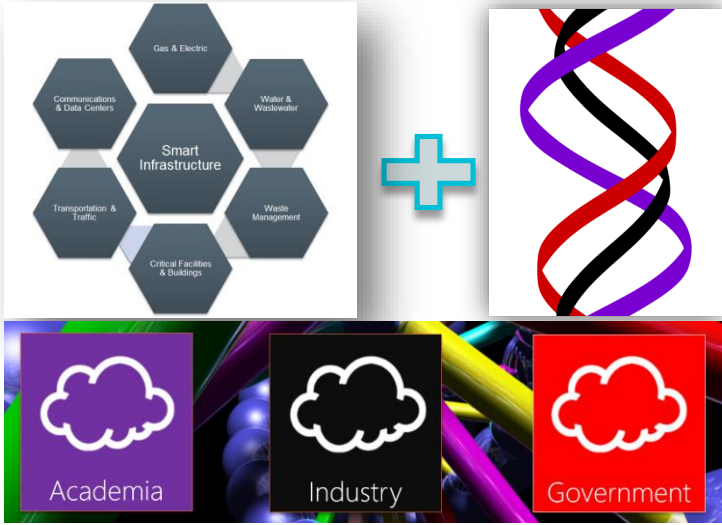
Smart Infrastructure – Binding the Triple Helix

- Enable Advanced Applications
  - End-to-end Value Chain Coverage
  - Energy Efficiency
  - Situational Awareness/Security
  - Sustainability
  - Asset Optimization
  - Microgrids/Energy Surety
  - Open Data/Innovation Programs



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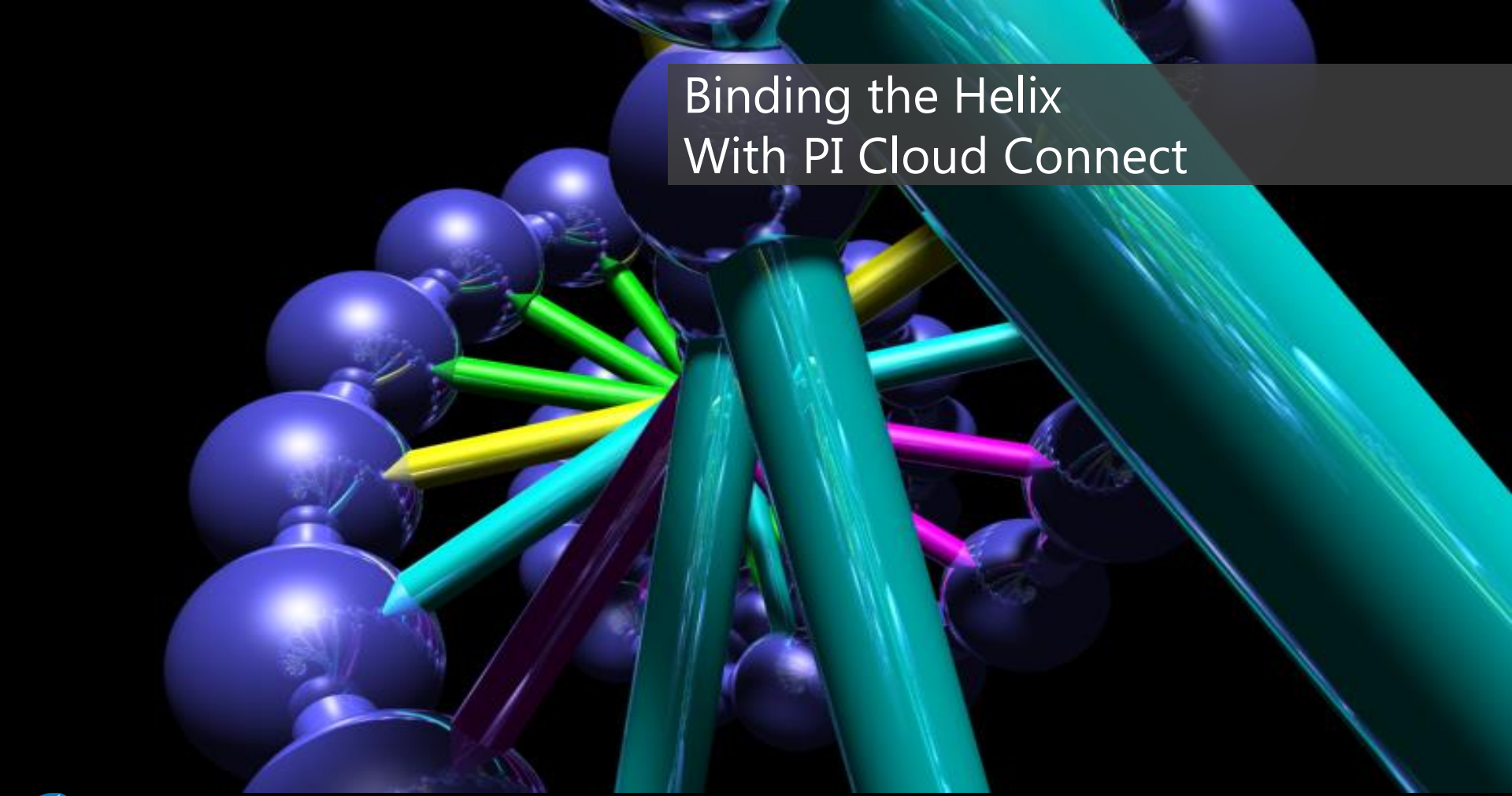

Binding the Helix
With PI Cloud Connect

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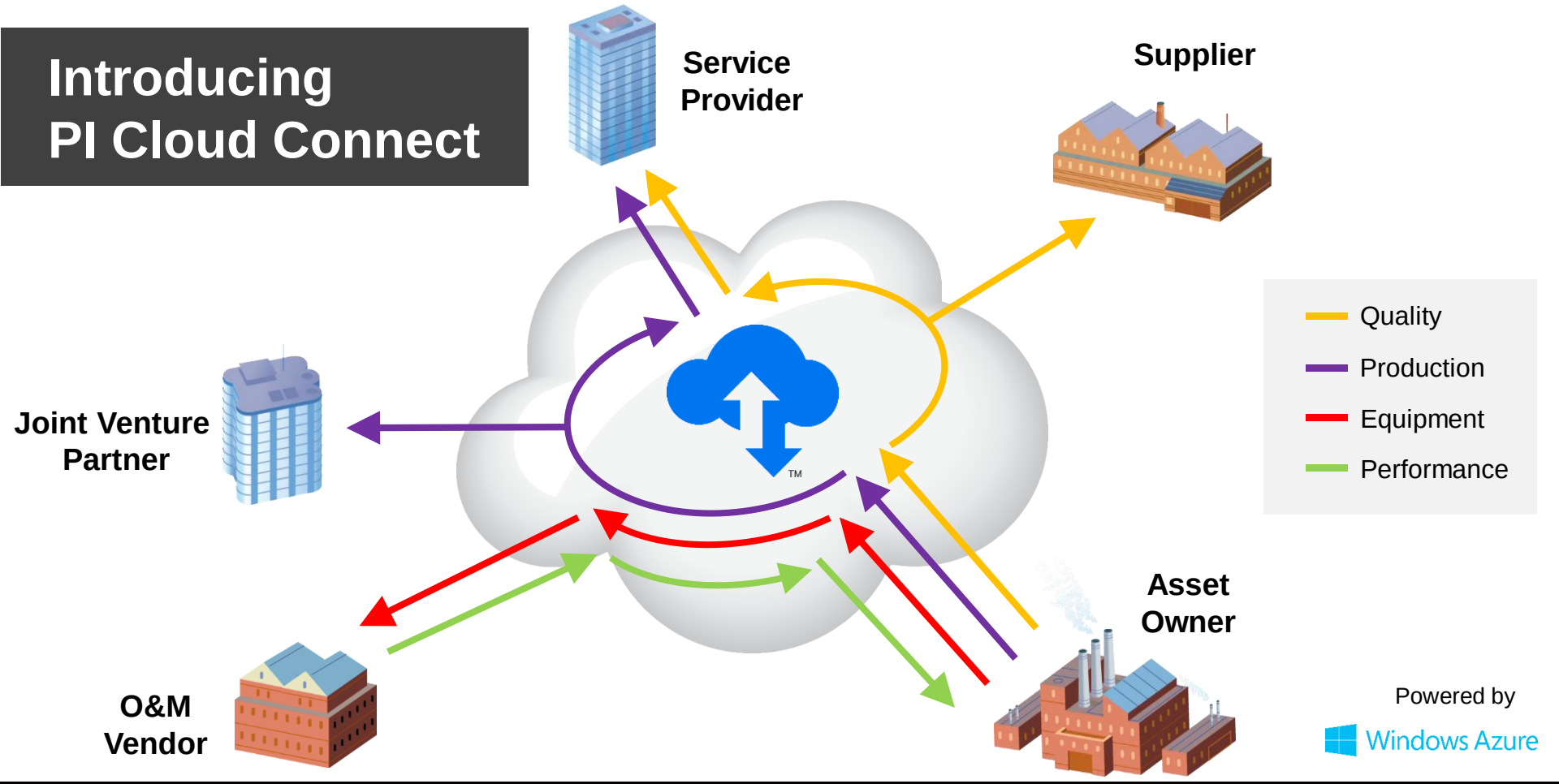
Introducing PI Cloud Connect



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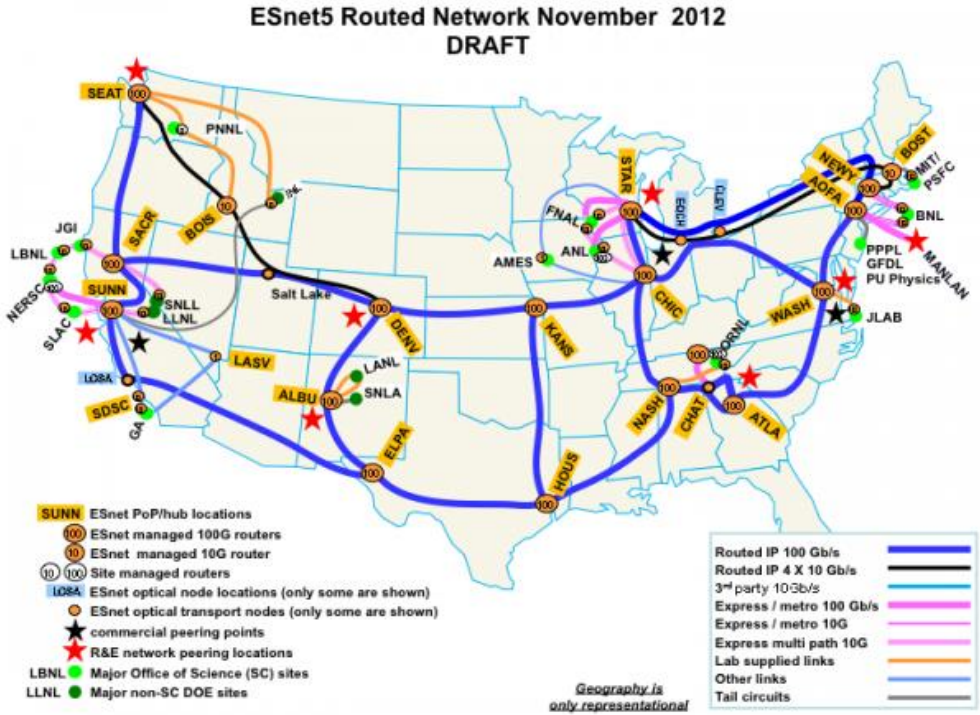
ES.NET and Cloud Connect

- Put highly granular data into Publishers PI System inside firewall
- Put up DMzB PI System outside Firewall .
- Connect the Publisher PI Infrastructure to ES.NET
- Publish/Subscribe high-resolution data fover ES.NET
- Cloud Connect makes data available to relevant data subscribers (SDGE, Sandia, CAISO, other researchers etc.) per Publisher data sharing objectives – including participants on ES.NET
- Inverse data flows back to Publisher, from Cloud could include:
  - SDGE, NASPI etc re: PMU data in WECC to UCSD
  - CIEE Distribution Data
  - Solar/Weather Data
  - CAISO Pricing Data
  - Vehicle Data



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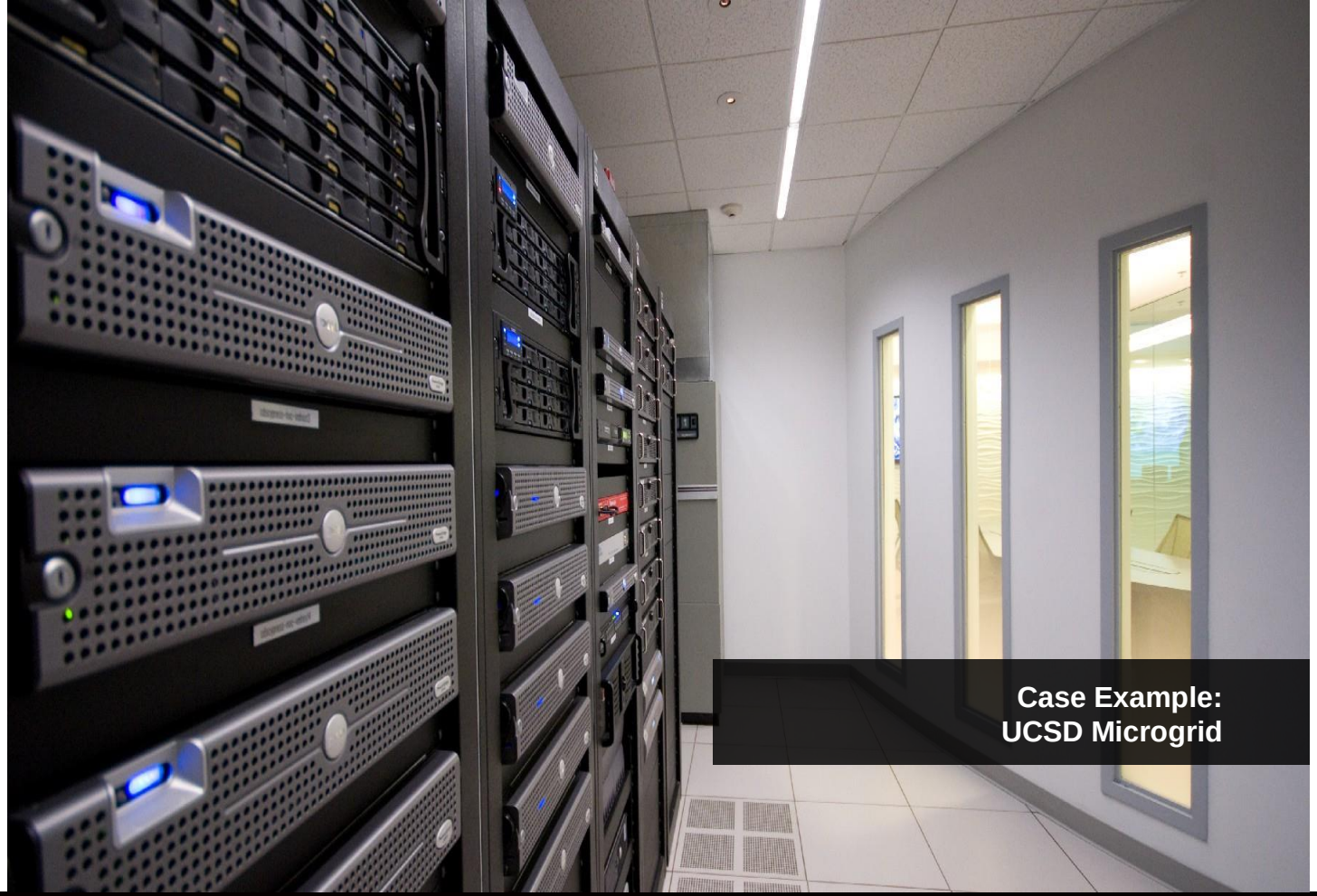

Case Example: UCSD Microgrid

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Overview of UCSD Microgrid

With a daily population of over 45,000, UC San Diego is the size and complexity of a small

As a research and medical institution, we have **TWO** times the energy density of commercial buildings

12 million sq. ft. of buildings, $200M/yr of building growth

Self generate 92% of annual demand

- 30 MW natural gas Cogen plant
- 2.8 MW of Fuel Cells contracted
- 1.5 MW of Solar PV installed, with another .8 MW planned in 2012

UC San Diego Operates a 42 MW_{peak} Microgrid

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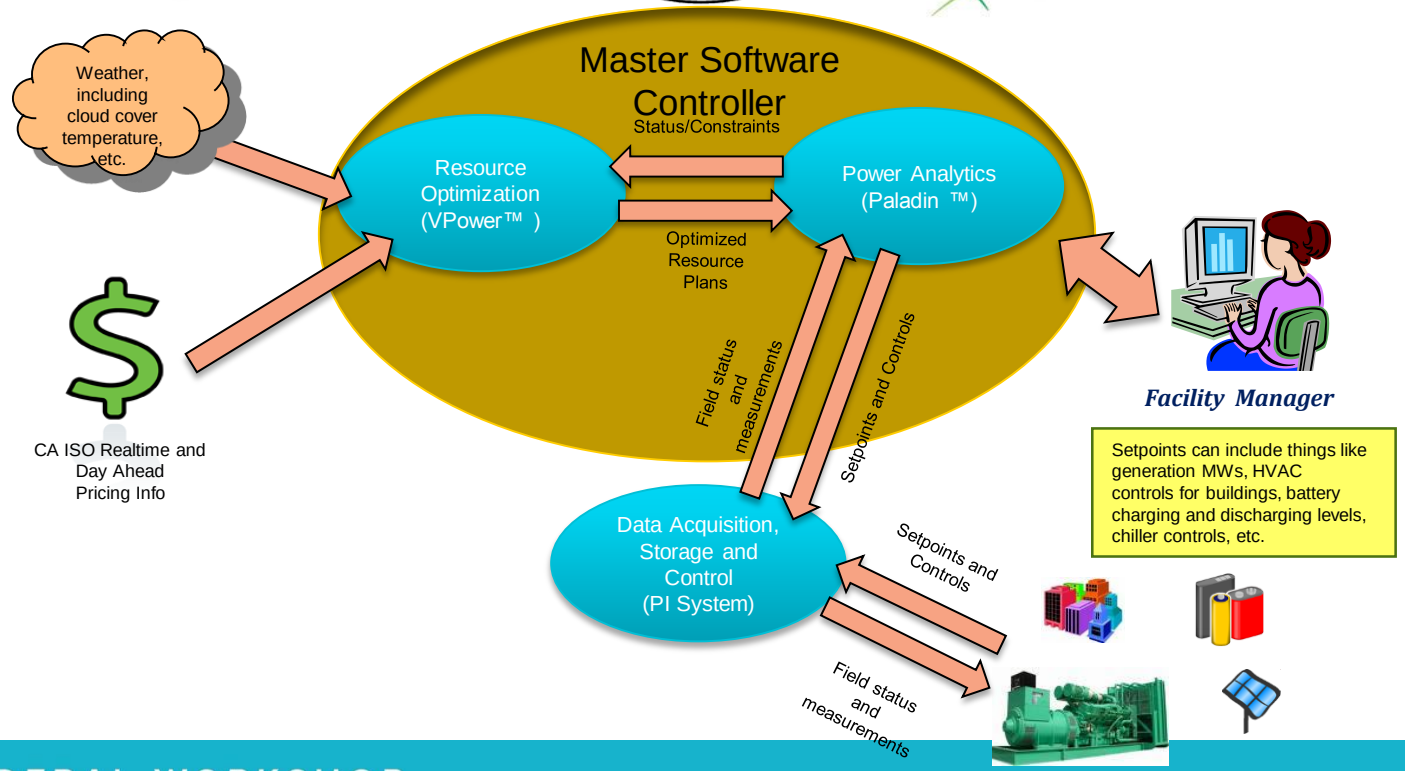
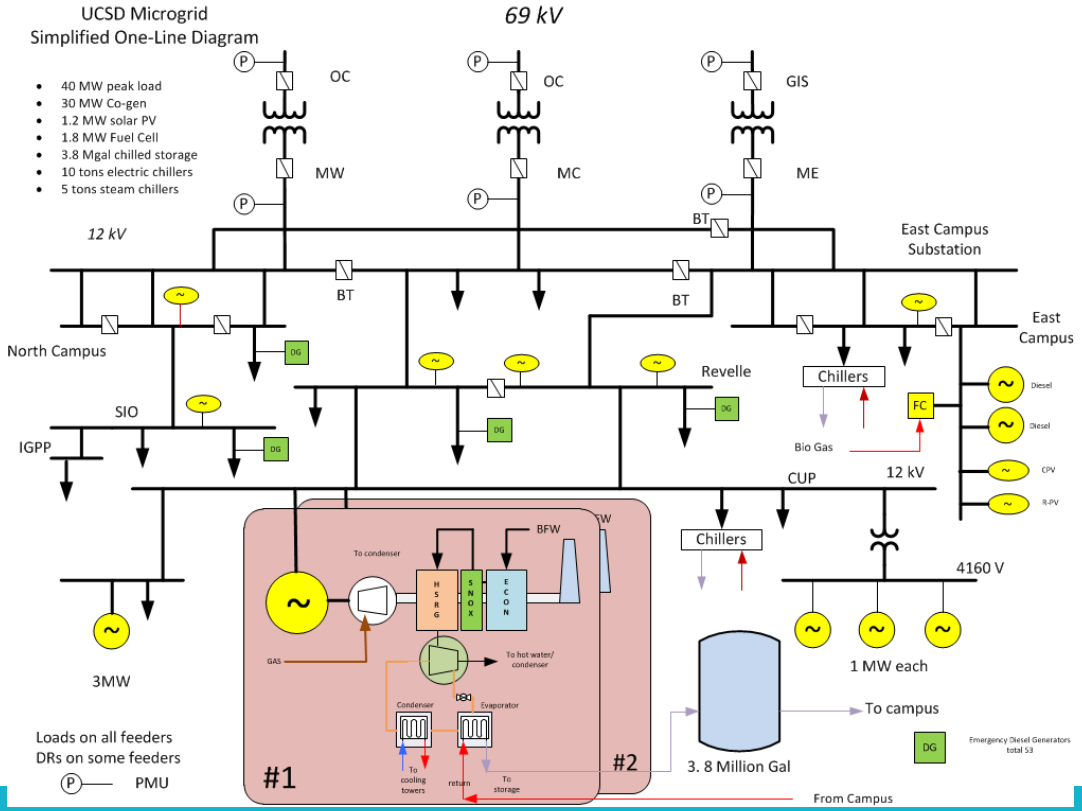
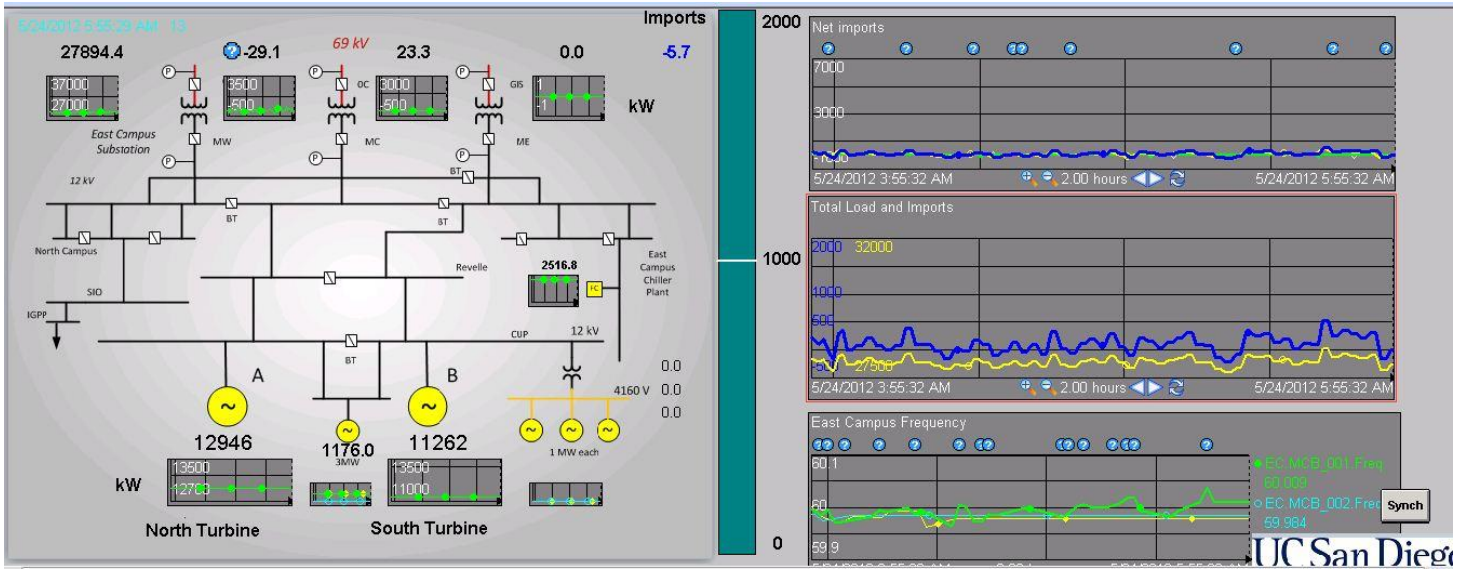

Weather, including cloud cover temperature, etc.
Master Software Controller
Status/Constraints
Resource Optimization (VPower™)
Power Analytics (Paladin ™)
Optimized Resource Plans
Field status and measurements
Setpoints and Controls
CA ISO Realtime and Day Ahead Pricing Info
Facility Manager
Setpoints can include things like generation MWs, HVAC controls for buildings, battery charging and discharging levels, chiller controls, etc.
Data Acquisition, Storage and Control (PI System)
Setpoints and Controls
Field status and measurements
Distributed Resources

UCSD Microgrid Electrical One Lines



Zero Imports



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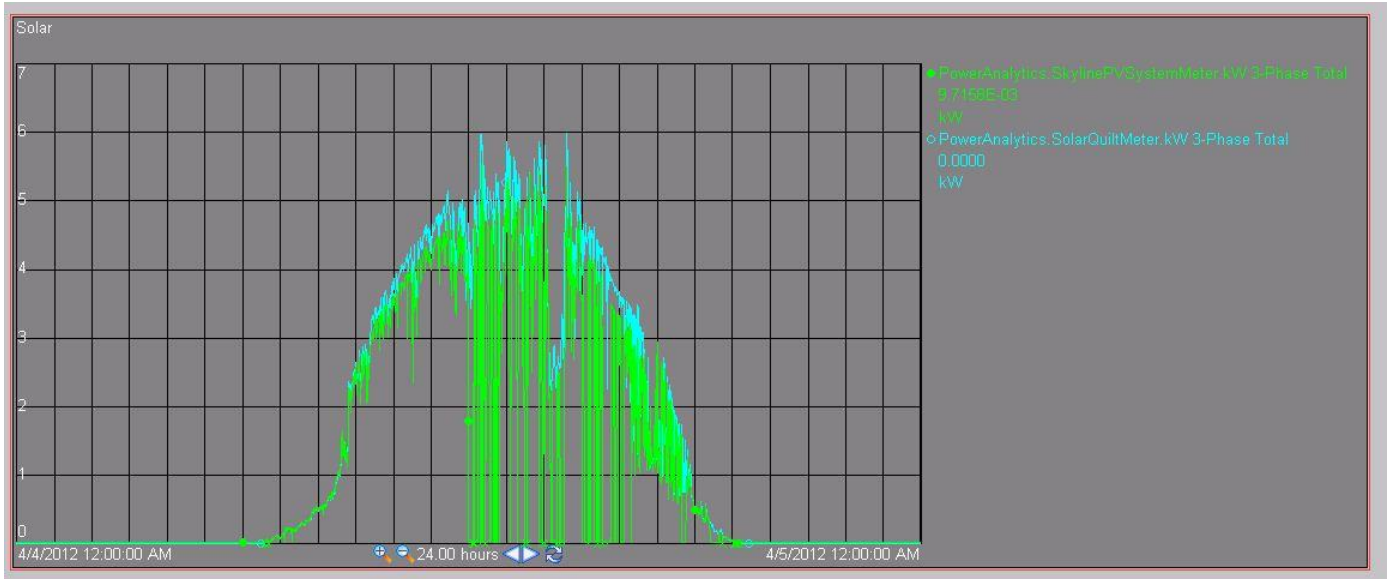
Solar output from Rady



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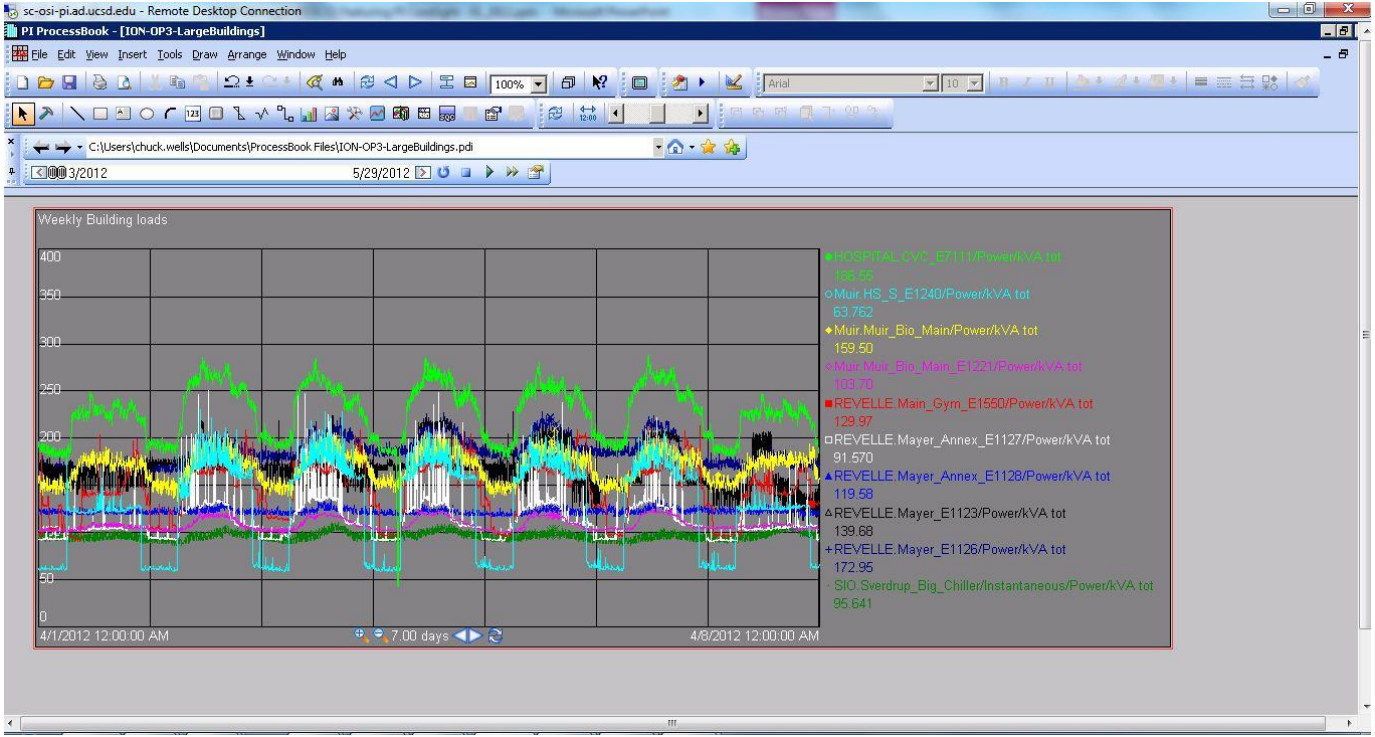
Weekly pattern large buildings



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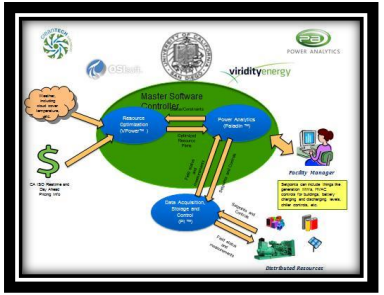
OSIsoft PI Software



- Key Successes
  - Integration
    - >84,000 data streams across campus (Buildings, DER, CUP)
    - Microgrid Controller Integration (PA Paladin)
    - Grid Event Detection and Notification
  - Projects launched as a result
    - ESTCP for San Diego Navy Bases
    - Student Intern Projects
      - PMU Research – Advanced Warning
      - Buildings – KPIs, Visualization
    - CIEE – DMRI
  - Demonstration/Scaling
    - Site visits
    - Industry Events
    - Exposing RESCO data to UCSD/JSOE Faculty/Students for Open Innovation

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R&D: PMUs and Event Detection

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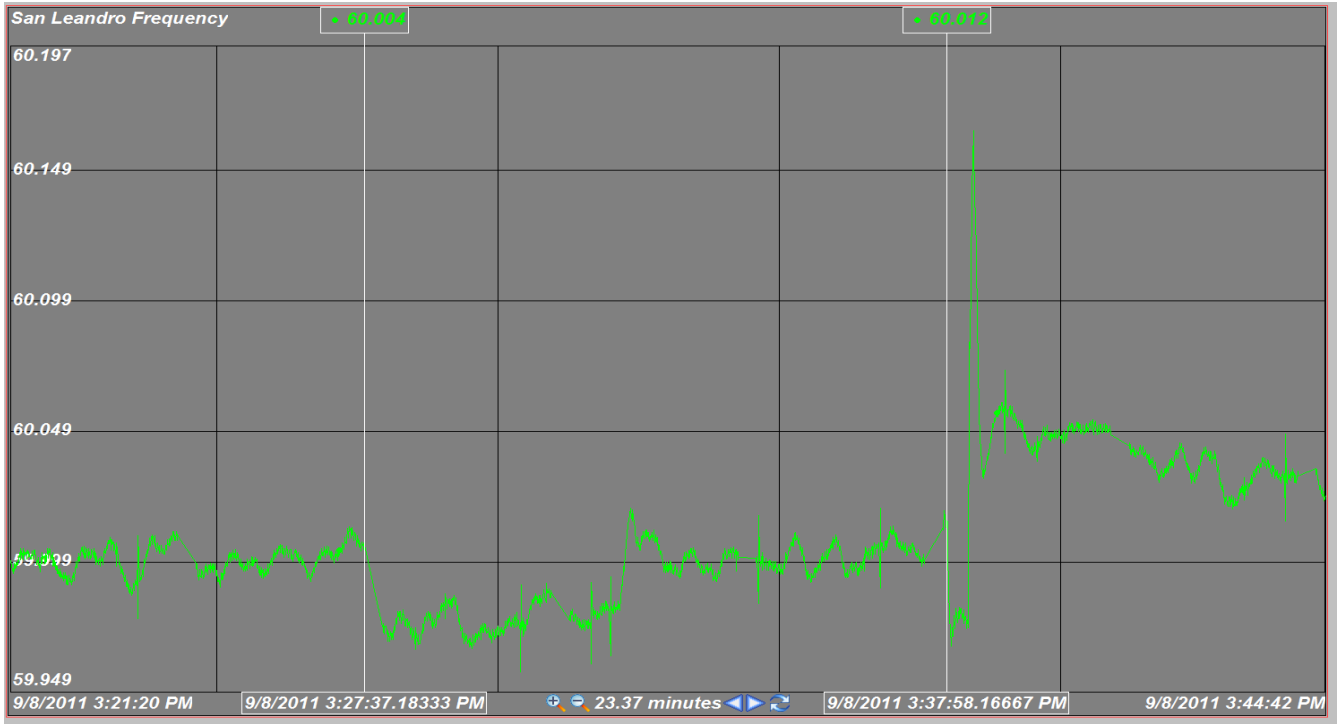
Improved PMU Monitoring Would Have Provided 10-Minute Warning on the September 8, 2011 Outage



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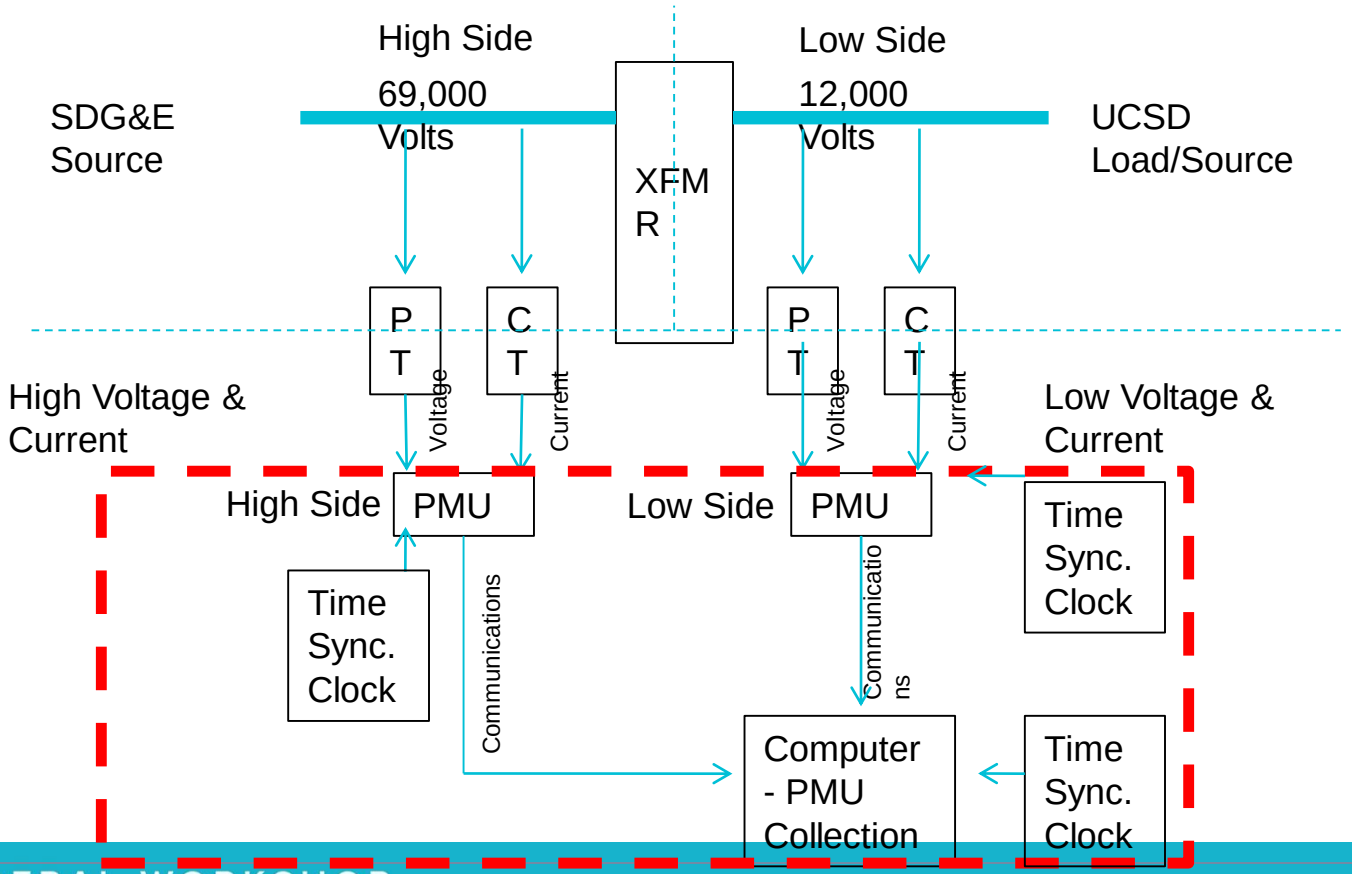
PMU Project



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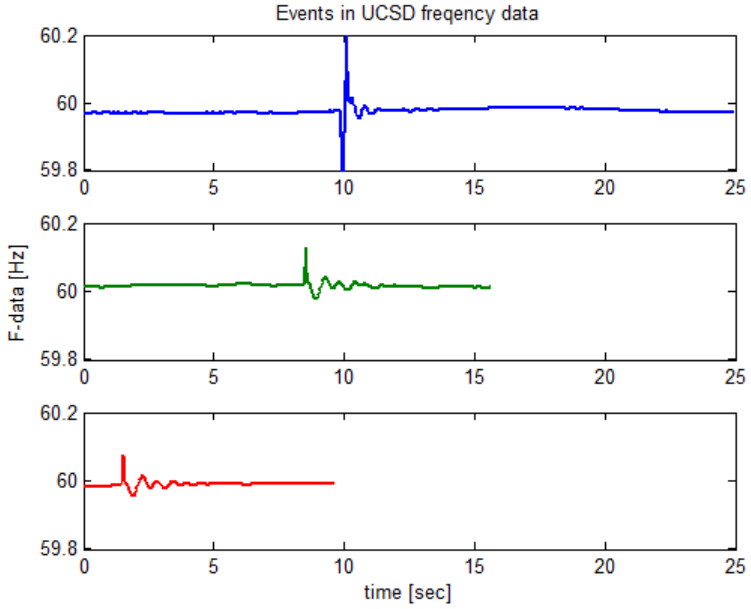
Automatic detection of events

Typical events/oscillations we currently measure in the UCSD microgrid:



- How do we detect these events?
- How can we quantify these events?
- What do these events tell us about our (micro)grid?

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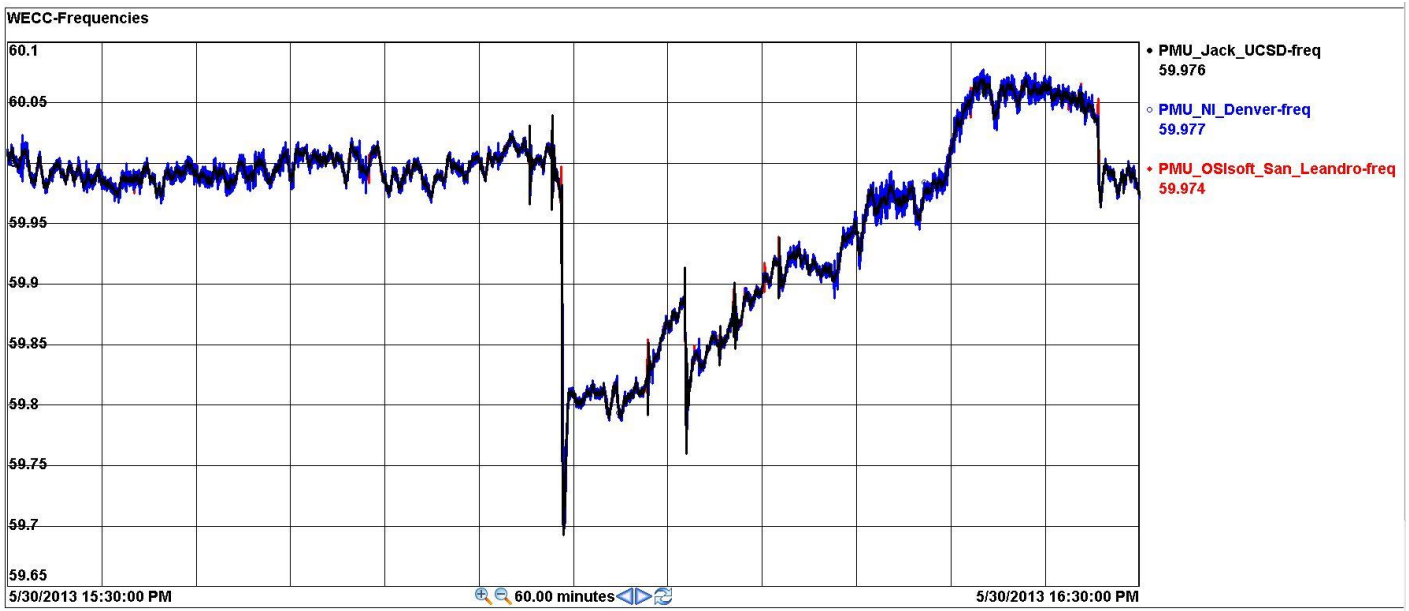
Automatic Event Detection



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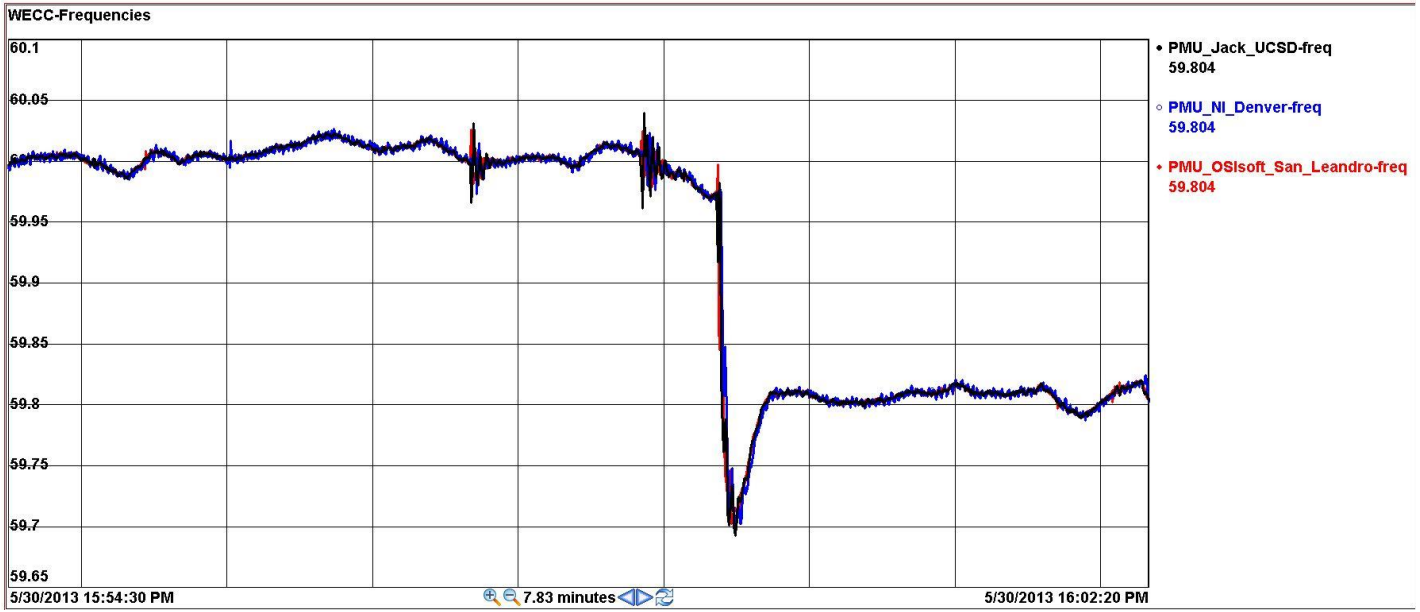
Pacific DC Intertie RAS trip



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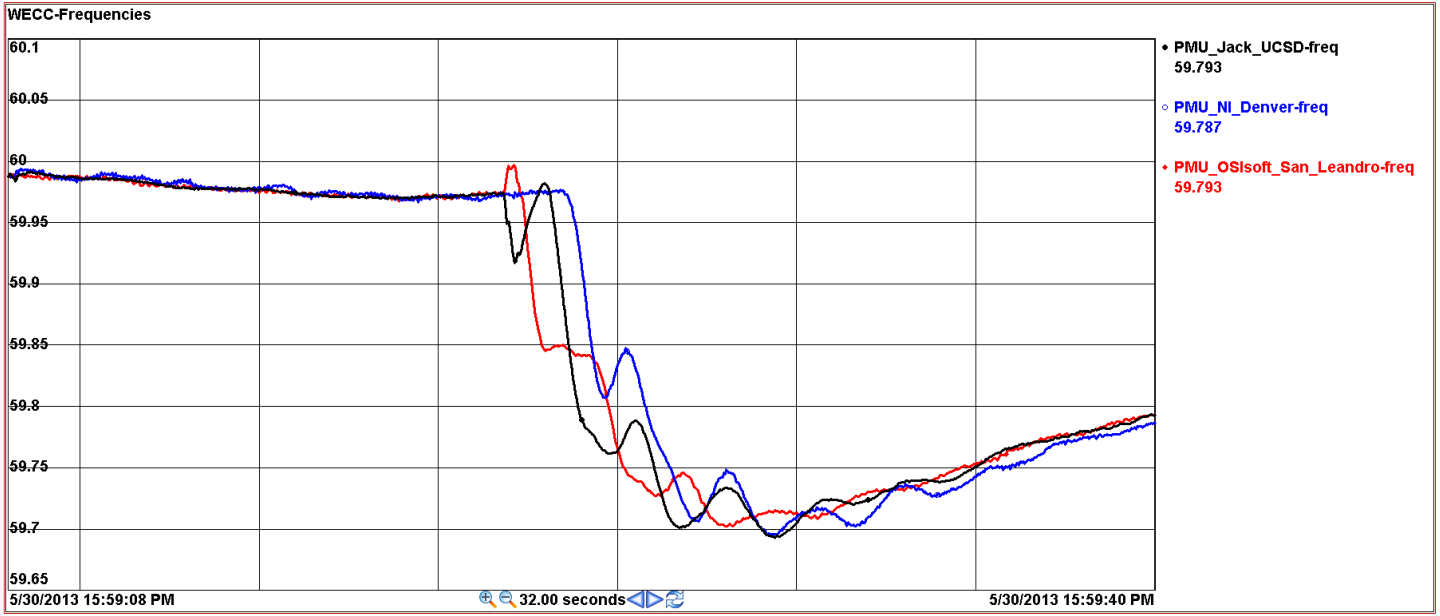
PDCI RAS trip



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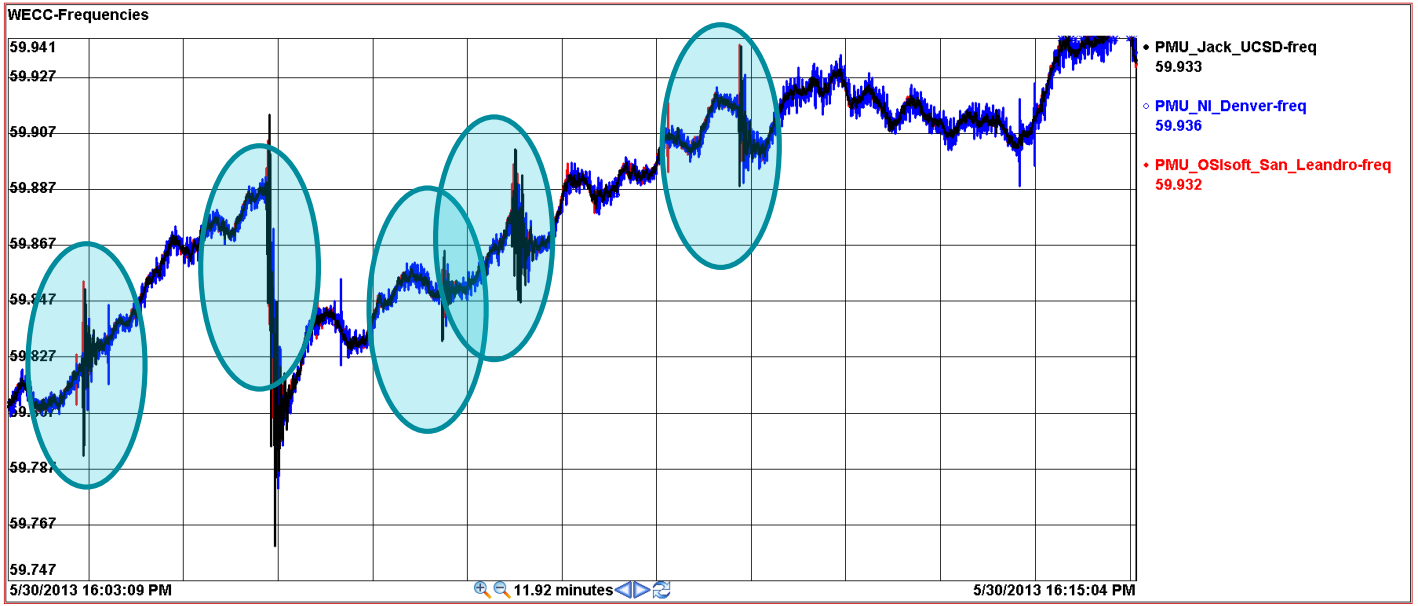
Subsequent Oscillations



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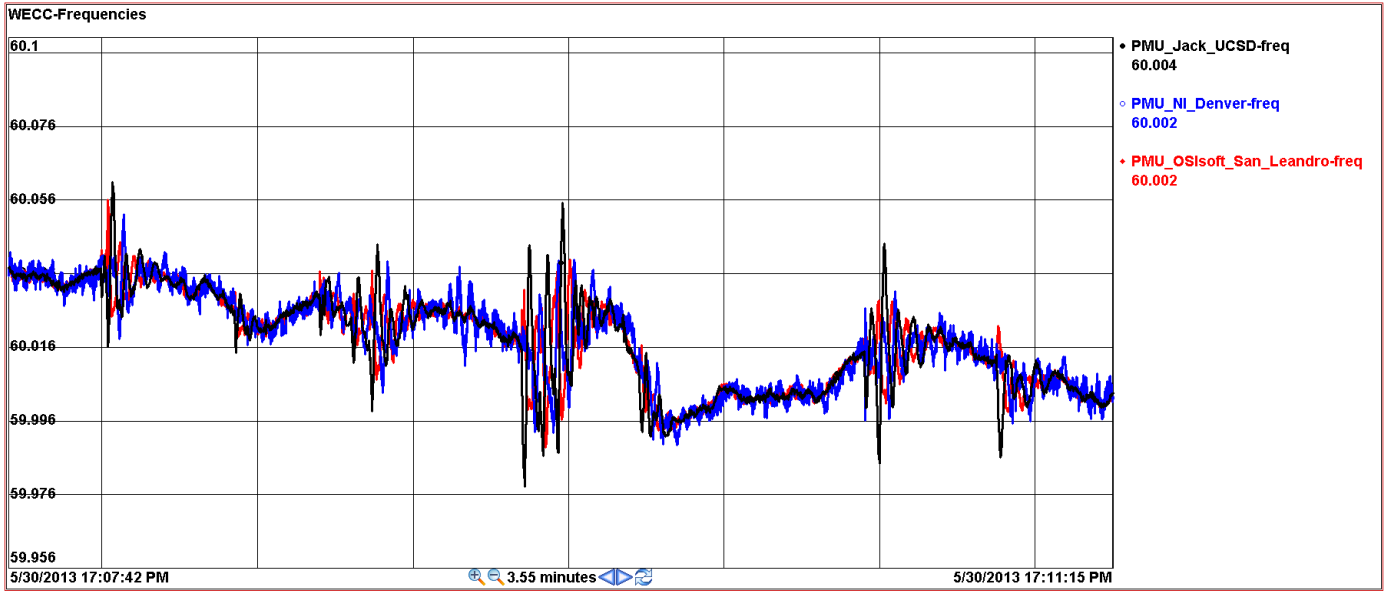
Oscillations one hour later



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Detection Mechanism

- Automatically detect when a disturbance/transient event occurs
- Automatically estimate Frequency, Damping and Dynamic Model from disturbance event.

Main Features:

- Automatically detect:
  - Predict ambient Frequency signal “one-sample” ahead
  - Observe when prediction deviates for event detection
- Automatically estimate:
  - # of modes of oscillations in measured disturbance
  - Estimate frequency and damping of the modes
  - Put results in dynamic mode
- All done in real-time!

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Hardware Photo

Closing Thoughts

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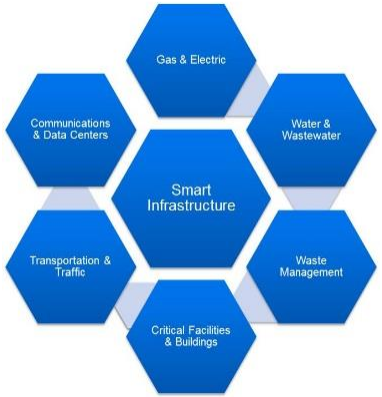
Closing Thoughts

- Islands of data everywhere
- PI Data Infrastructure goes in “thin and wide” connecting all of the islands and their operational data
- Use the same data infrastructure to drive other uses:
  - Situational Awareness/Security
  - Sustainability
  - Asset Optimization
  - Microgrids/Energy Surety
  - Open Data/Innovation Programs



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Saudi Aramco Command and Control Room

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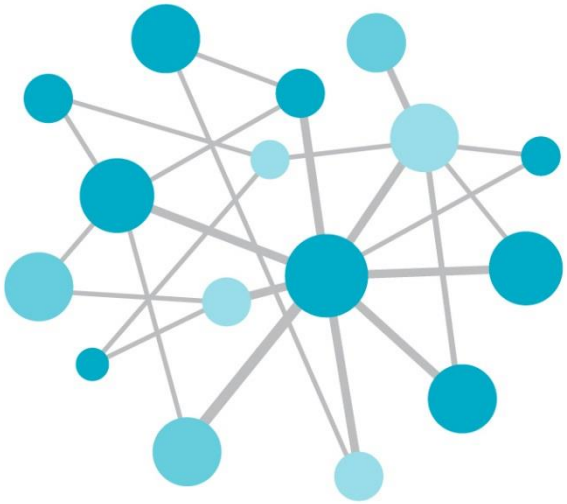

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