Florida Power & Light
Smart Grid Investment Grant
Synchrophasor Update

North American Synchrophasor Project Initiative

NASPI Work Group Meeting

Oct. 12-13, 2011

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Overview

- **Utilize Phasor Measurement Units (PMUs) as part of Energy Smart Florida (ESF) project for disturbance monitoring, event analysis, verification of system models and enhanced situational awareness**
- **Install 45 PMUs at 13 Transmission stations**
  - 30 samples / seconds
  - 9 PMUs @ 500kv stations
  - 36 PMUs @ 230kv stations
- **Phasor Data Concentrators (PDCs)**
  - Several PDCs, one super PDC
- **Employ a Transmission Line Type Relay as a dedicated PMU**
  - Monitoring, no protection or control functions
- **Funded by the Smart Grid Investment Grant Program from the DOE**

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Expected Benefits of PMUs

- Provides wide-area situational awareness for system operators
- Aids in determining available system margins
- Helps determine stress points of the Transmission system by monitoring phasor quantities
- Detects and aids in restoring an islanded section of the grid after a storm or major outage disturbance
- Provides post-disturbance analysis capability
- Enables visualization of PMU data for system operations to be incorporated into the Energy Management System (EMS)
- Provides data to be added to FPL's existing participation in the North American Synchrophasor Project Initiative (NASPI)
- Improves state estimation and accuracy of EMS applications as direct data is more accurate and overcomes modeling delays

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Project Plan

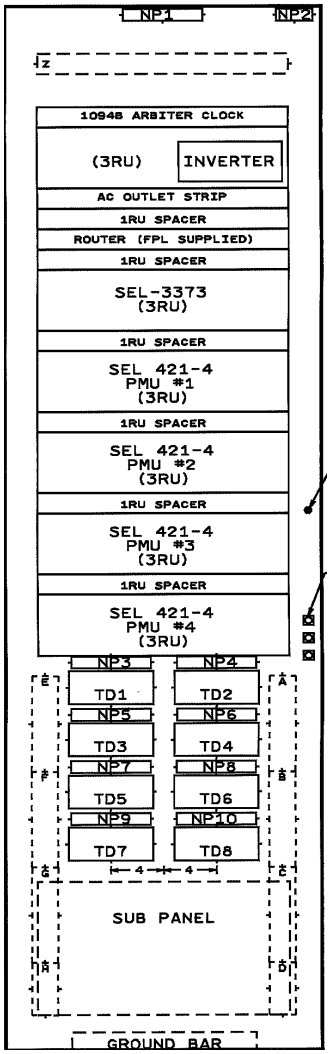
- **PMU Substation Equipment installation rate**
  - 18 PMUs installed as of 3Q 2011
  - 4 additional PMUs by EOY 2011
  - 23 remaining PMUs installed by 2Q 2012
- **Communication Network**
  - Installation beginning 4Q 2011
  - Completion by EOY 2012
- **PMU Applications**
  - Full use EOY 2012

Phasor Measurement Units (PMUs)

Synchrophasor Panel

Phasor Data Concentrator

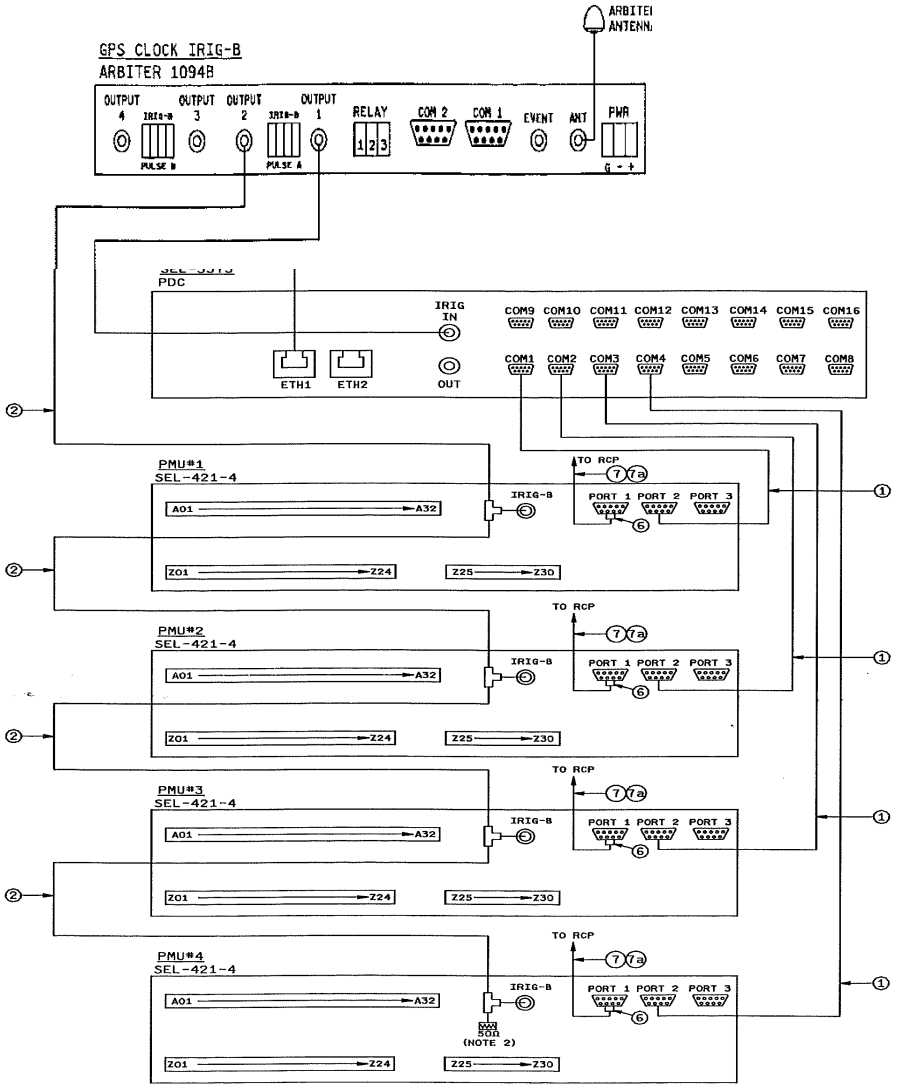
PMU Relay



Design Features

- 4 PMUs and 1 PDC
- Local archiving capability 60/120MB
- High-accuracy clock
- Inverter
- Router
- T1 CSU/DSU card
- Analogs V1(M,A), I1(M,A), F, dF
- Va, Vb, Vc, Ia, Ib, Ic (M,A)

Substation System Architecture



Open PDC

- **Connects individual PMUs and PDCs**
- **Substation PDCs feed the OPDC**
- **Central location at EMS**
- **Data-archiving**
  - Three Month input capability
  - Longer storage for Significant Event
- **Redundant server**

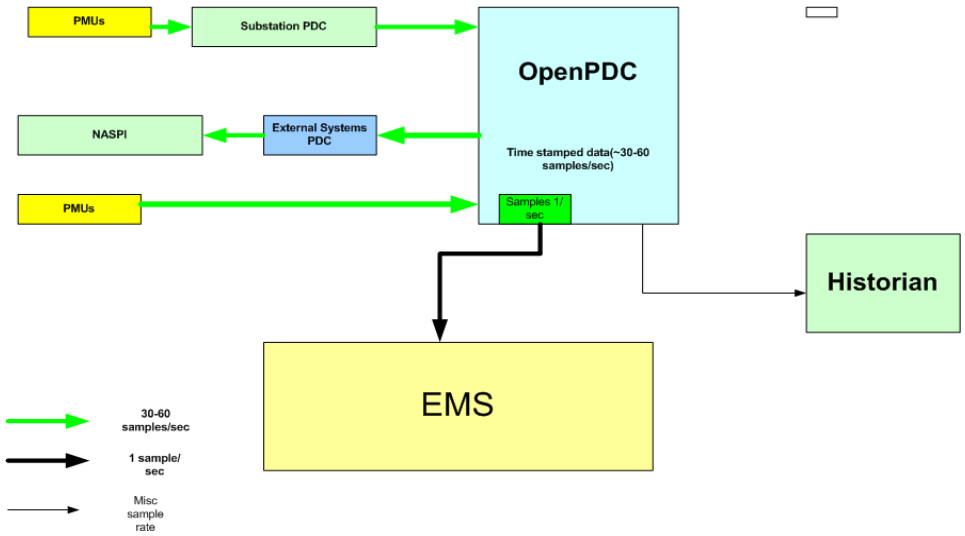
Open PDCs Communication to EMS

- Open PDC is located at FPL EMS
- The Reliability Coordinator for FPL is FRCC
- Both Balancing Authority & Transmission Operator is Florida Power &Light
- The PMU Applications will run on the Energy Management System purchased from ALSTOM

Open Phasor Data Collection

Objectives:

1. Provide a flexible framework for the collection, processing, concentration and archiving of PMU data
2. Develop integration of PMU data to interface with EMS state estimator, NASPI project and historian



PMU/PDC Network Diagram

Benefits:
- Improves State Estimation in Energy Management System
- Enables System Health Check for small perturbations
- Enables post-event data analysis
- Provides select PMU data to NASPI project

Security Approach

- Dedicated and isolated from any control and tripping functions
- On its own network
- Within electronic security perimeter
- Within physical security perimeter
- Multiple layers of encryption

Development Phase

- **Dashboard display for system operators**
- **Aid in determining System Margins**
- **Visualization is the Key/Start - e-terra vision**
  - Apply applications as experience is gained
    - -- Interface with EMS
      - Enhance State Estimator
      - Strengthen contingency analysis
- **Monitoring**
  - Server sets flag for non-report of data and QoS
- **Wide area view application is "off the shelf"**
  - Vendor-supported training

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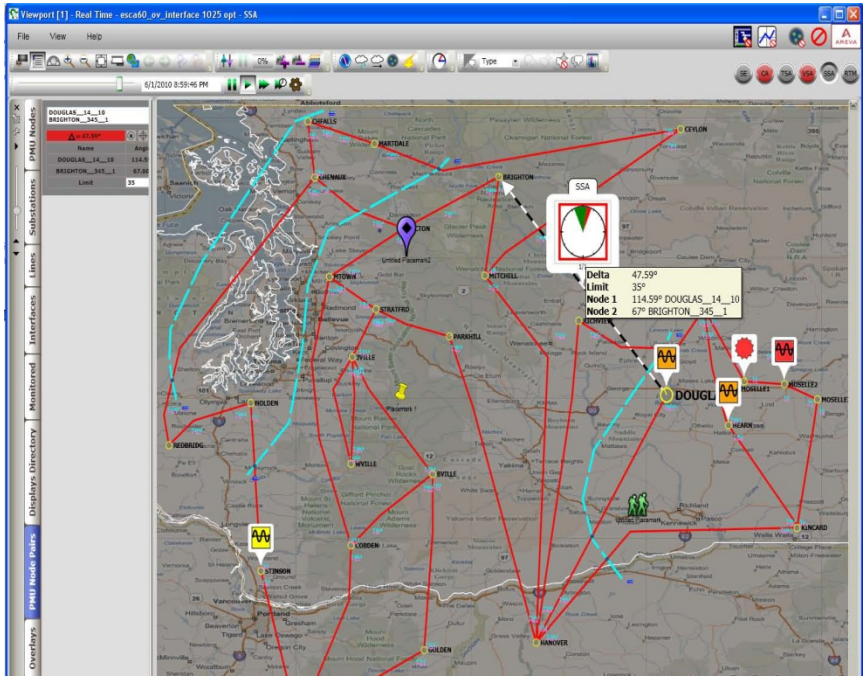
Wide Area Monitoring Tool

Objectives:

1. Improved capability for wide-area monitoring
2. More comprehensive view of grid conditions that provide alarming and GIS-based visualization
3. Allow system operators to monitor abnormal grid conditions utilizing PMU data in conjunction with other applications for a GIS-based visualization



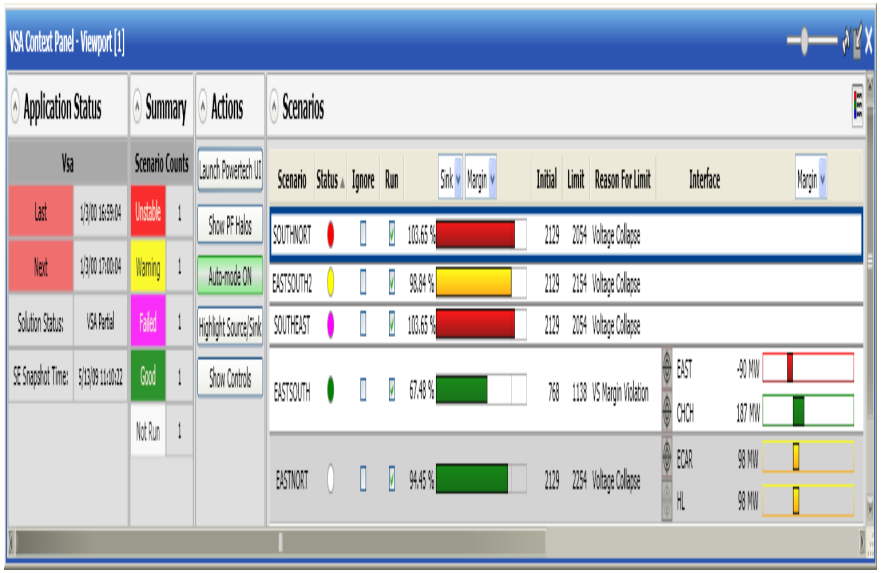
Monitoring Phase Angle Differences

Benefit: Improved situational awareness and system monitoring

Voltage Stability Analysis Solutions

Objectives:

1. Integration of model-based dynamic security assessment applications
2. Anticipate instability (e.g. how close the system is to voltage based on the level of congestion and contingencies)
3. Allow the operators to issue preventive or corrective controls to mitigate instability



Voltage Monitoring

Benefits:
- Improved visualization of system's voltage profile
- Improved analysis of voltage conditions across system

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Challenges

- Pathway to other operating entities
- Network installation coordination
- Coordinating equipment outages for PMU installation

Project Participants

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Acknowledgement and Disclaimer

- **Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-OE0000211.**

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Questions?