Electric Power Group Presents

Maximizing Use of Synchrophasor Technology for Everyday Tasks

Welcome!
The meeting will begin at 2:00 p.m. ET / 11:00 a.m. PT Jan. 18, 2017

Today’s Topic: Synchrophasor Intelligence in EMS for Use in Operations

Registration URL: https://electricpowergroup2.webex.com/
Webinar Teleconference Number: 1-650-479-3208
Access code: 666 672 715

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Maximizing Use of Synchrophasor Technology for Everyday Tasks

Synchrophasor Intelligence in EMS for Use in Operations

Integration of Synchrophasors and EMS/SCADA through ICCP

January 18, 2017

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Frank Kopecki, NYISO
James Hiebert, CAISO
Synchrophasor & EMS Integration

Synchrophasor System

PMUs

RTU’s

ICCP Gateway

EMS/SCADA

Applications with Synchrophasors

Applications with Synchrophasors and SCADA Data e.g. PhasorNXT

Applications with SCADA

Applications with SCADA and Synchrophasors e.g. One-Line Diagram with phase angles
What Will This Do?

- Enable EMS/SCADA with Synchrophasors
  - Dynamics: Oscillations, Phase Angles, Sensitivities, etc.
  - Dynamic Alarms and Composite Alarms e.g. Low Damping, Islanding
  - Frequency Disturbance Source Location
  - Transmission MW Flow Constraints
  - Improve State Estimation
  - Improve Grid Resilience

- Data Exchange with ISO’s and Utilities
  - Raw PMU Measurements (voltages, currents, frequency, etc.)
  - Calculated Values (angle difference, system frequency, real/reactive power, mode, sensitivity, oscillation, etc.)
  - Alarms/Events (threshold violation, rate of change violation, composite alarms, global alarms etc.)
# Synchrophasor Information Available to EMS

<table>
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<tr>
<th>PMU Measurements (Telemetered)</th>
<th>Linear State Estimator (Estimated)</th>
<th>Applications (Calculated)</th>
<th>Alarms/Events (Calculated)</th>
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<td>Real &amp; Reactive Power</td>
<td>Threshold Violations (Alarm)</td>
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<td>Angle Difference</td>
<td>Global Alarms &amp; Global Events</td>
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<td>IEEE 37.118 digitals</td>
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<td>System Frequency</td>
<td>Islanding, Generation Trip, and Load Drop Events</td>
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<td>IEEE 37.118 analogs</td>
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<td>Mode Frequency, Damping Ratio, and Energy</td>
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<td>Oscillation &amp; Low Damping Alarms</td>
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<td>High voltage/Angle Sensitivity Alarms</td>
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EPG ICCP Gateway

- Designed under the Guidance of Industry Partners
- Validated and Trustworthy Data through Synchrophasor Applications (DataNXT, RTDMS, eLSE, etc.)
- Independent of EMS Proprietary Protocols
- Web-based Configuration GUI
- Real Time Monitoring of Communication & Data Flow
- Extensive Logging
- Flexible Deployment – Physical, VM; Standalone, Cluster
- High Performance & High Availability
- Provides role-based access control
- Uses Field-Proven SISCO ICCP Stack
ICCP Gateway Service-Oriented Architecture

**Gateway Service & Web App**

- **ICCP Gateway Web App**
  - General Configuration
  - ICCP Association Configuration
  - ICCP Data Set Configuration
  - ICCP Point Mapping
  - ICCP Link Monitoring
  - Access Control

- **ICCP Gateway Service**
  - SISCO ICCP Stack

- **RTDMS/DataNXT Services**
  - SDS 1
  - SDS k

- **Mode, Sensitivity, Oscillation Services**

- **eELSE Service**

- **Link Status Monitoring**

- **SCADA/EMS**
  - Measurements
  - Estimated States
  - Calculations
  - Alarms
  - Breaker Status

**SDS**: Synchrophasor Distribution Service (SDK in C/C++, C#, Python, ...)

**CIM XML File**

**RTDMS/ DataNXT Config File**

**EPG ICCP Adaptor (Gateway Service & Web App)**

**ICCP Gateway Web App (Continued)**

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ICCP Gateway Design Key Features

- Open Standards based Integration Vs. Proprietary Coupling/Bolt-on
- ICCP Gateway Service runs as Windows Service
  - Flexible Deployment
  - Decoupled from Applications (DataNXT, RTDMS, etc.) using SDS Pub/Sub interface
  - Service Oriented Architecture (SoA)
- Control Data Rate Exchange between Synchrophasor Applications and EMS/SCADA. For Example:
  - Average
  - Down-sampled
NYISO Use-Case for Using PMU data in EMS
Benefits of Providing Synchrophasor Data to EMS

- Supplying PMU data to EMS over ICCP provides additional data not available in SCADA from the member T.O.’s and other ISO’s

- Provides EMS with another source of data to use in its State Estimator and Intelligent Source Selection Application

- Pass alarms to the EMS in order to integrate RTDMS alarms into the Operator’s current Alarm Monitor

- PI Trends using PMU data provide easy comparison to SCADA data to uncover configuration and calibration issues.

- Other purposes for PMU data in the EMS

- Currently, 1800+ ICCP points for synchrophasor data & alarm from RTDMS to EMS
**PMU Data Stale Monitor**

- A Monitor in EMS used by Operations Control to notify T.O.’s and ISO’s when there are issues with PMU’s

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**EMS Use-Case** for using PMU data at NYISO
### PMU Data Used by State Estimator Application

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EMS Use-Case for using PMU data at NYISO
### EMS Use-Case for using PMU data at NYISO

#### PMU Data Used in Voltage Intelligent Source Selection (Custom NYISO Application)

PMU source has been selected as best choice.

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Synchrophasor Global Alarms

Alarm Types

EMS Alarm Message

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EMS Use-Case for using PMU data at NYISO
PI Trends to Compare SCADA Data to Synchrophasor Data

EMS Use-Case for using PMU data at NYISO
Angle Difference Used to Determine 345 KV Line Reclosures

EMS Use-Case for using PMU data at NYISO
Example of Incorporating PMU Measurements in the CAISO EMS/Control Room
CAISO Use-Case for Using PMU data in EMS

- Angle Difference Monitoring & Operation Procedure for Reclosure – Displayed on EMS One-Line
- MW Flow for Major Tie Lines used in AGC Calculation (Resiliency), e.g. COI
- Frequency Measurements for Redundant Inputs (Resiliency)
  - AGC Calculation
  - Islanding Detection
  - Black Start
- Frequency Disturbance Source Location
- Local Oscillation Detection
  - Electro-mechanical or
  - Control Issues at Power Plant
- Share Data with TOs through ICCP, e.g., Line Angle Difference Limits
CAISO Synchrophasor Activities

• CAISO will have the following capabilities
  – predict the potential phase angle difference *before* the line trip (State Estimator and contingency analysis).
  – show the actual observed phase angle difference *after* the line trip

• These functionalities will allow the system operators
  – to be prepared before the contingency
  – to know the actual system conditions after the contingency
CAISO Line Closure Procedure with Phase Angle

Phase Angle Difference

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<td>Substation C - Substation D</td>
<td>9.2 DEG</td>
<td>9.3 DEG</td>
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Redispatch Rule of Thumb:
Curtail 100 MW of PVWEST Schedule and increase 100 MW of generation for every 5 DEG
CAISO Synchrophasor Project Overview
Future Activities

- dynamic phase angle difference limit – study the usefulness of combining real-time PMU measurements with model-based programs (OMS, DSA, RTCA, etc)
- additional studies on oscillation mode detection and analysis – combined efforts with adjacent balancing authorities to write operating procedures
- linear State Estimator and hybrid solutions
  - looking at LSE to help improve data quality
- joint efforts with the Western Utilities and United States Department of Energy
Demonstration & Key Take-aways

ICCP Gateway & ICCP Web App
Demo Setup

- ePDS
- RTDMS
- ICCP Gateway
- ICCP Web App (Config & Monitor)
- ICCP Test Server (to EMS)
Summary

- Bridges the Gap between Synchrophasors and EMS
- Enables companies to realize value from Synchrophasors via integration with EMS and Data Exchange
- ICCP Gateway Provides
  - Production Grade Solution
  - Commercial Off-The-Shelf
  - One ICCP Gateway with Many End-Point Connections
  - Two-way data transfer (i.e. import breaker status & limits into Synchrophasor applications)
  - Designed to meet Redundancy and High Availability Requirements
  - Easy to Configure & Monitor ICCP Links through Web Browsers Locally or Remotely
  - Built on Industry Standard SISCO Stack
  - Security Management Features for IT Administration
Q&A, Discussion

Your Practice, Use Cases, Suggestions
Q&A, Discussion

- Q&A

- Synchrophasor Application & EMS Integration
  - Your Practices
  - Use Cases
  - Pain Points
  - Suggestions

- Next Webinar Focus
  - Priority
  - Other topics
Extracting large amounts of synchrophasor data efficiently for offline analysis. (August 2016)

Quickly creating an event report that could be distributed to operators, engineers and managers. (Sept. 2016)

System Model Validation for MOD-33 Requirement (Oct. 12)

Configuring alarms and validate parameters to provide meaningful results for operators. (Dec 14)

Synchrophasor Intelligence in EMS for Use in Operations (Jan 2017)

Use Cases of Linear State Estimator Technology for Grid Resiliency (Feb 2017)

Providing secure remote access to users in real-time for monitoring and diagnostics during normal times and emergencies.

Using alarms & events for proactive actions

Mining large data archives for events of different types, e.g. oscillations, generator trips etc.

Other topics?
Thank you for participating!

If you have any questions regarding any part of the course, please contact us at Contact@electricpowergroup.com

http://electricpowergroup.com/webinars.html