SynchroPhasors to Enhance Control Center Capabilities
NASPI Working Group Meeting

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Presentation Outline

1. Our Vision & Partners
2. ALSTOM’s Integrated SynchroPhasor Solutions
3. Customers Successes
   1. PG&E SynchroPhasor Project
   2. ISO-NE SGIG Project
4. Our Products: PMU, PDCs, Visualization, Applications
5. Concluding Thoughts
Our Vision

Traditional EMS MODEL-BASED Analysis

New PMU Measurement-Based Analysis

EMS Generalized Security System

Traditional EMS MODEL-BASED Analysis

New PMU Measurement-Based Analysis

SCADA & Alarms

Other EMS Applications

WAMS

State Measurement

New Applications

State Estimator

Oscillation Monitoring

Small Signal Stability

Stability Monitoring & Control

Transient & Voltage Stability

Grid System- Level

EMS Generalized Security System

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Our Partners

**Our Partners**

**GRID**

**ALSTOM**

*World-wide leader in providing technology solutions for transmission & distribution of energy.*

**Psymetrix**

*Commercial provider of synchronized measurement & monitoring solutions:
- PhasorPoint (SynchroPhasor Framework)
- PMU-based applications*

**Powertech**

*Model-based dynamic analysis:
- Voltage Stability Analysis (VSAT)
- Small Signal Stability Analysis (SSAT)
- Transient Stability Analysis (TSAT)*

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ALSTOM’s Integrated SynchroPhasor Solution

- Dynamic Security Assessment
  - Transient Stability Analysis
  - Small Signal Stability Analysis
  - Voltage Stability Analysis

SynchroPhasor Applications Framework (PhasorPoint)
- Oscillatory Stability Monitoring
- Disturbance Detection
- Composite Events
- Islanding/Restoration/Blackstart
- Post-Event Analysis, Baselining

Energy Management System (EMS)
- Improved State Estimation
- Grid Security Assessment
- SynchroPhasor State Estimator

PMU Data (1 per second)
- PMU based Information/Alerts (few seconds)
- SE snapshot (1 per min)

Phasor Data Concentrator (PDC)
- FACTS
- PMUs
- IEC 61850
- PMU Data (30-60 per second)

Wide-Area Advanced Visualization

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Online Stability Solutions

An integrated measurement-based and model-based stability assessment application that runs in real time.

PMU measurement-based methods monitor grid stability in real-time:
- Track current damping levels.
- Detect & alarm on dangerous oscillations & sudden events.

Stability assessment visualization within e-terrasvision.

Model-based techniques (SSAT, TSAT, VSAT) provide the predictive component (i.e. ‘what-if’ analysis)
- Available MW transfer capability (‘distance’ to the edge)
- Assess impact of critical contingencies. (e.g. change in damping levels)
- Recommend controls based on sensitivity information.
Select Customers for SynchroPhasor Applications

- Eskom (South Africa based Power Utility)
- Svenska Kraftnät (Swedish Electricity Transmission System Operator)
- Pacific Gas & Electric (PG&E)
- Florida Power & Light (FPL)
- Duke Energy
- ISO New England (ISO-NE)

*Active proposals being submitted to others……*
PG&E SynchroPhasor Project
Vahid Madani – Project Technical Leader

Strategic Team: PG&E, ALSTOM, GE, Mississippi State Univ., Quanta
Academic & Testing Partners: GeorgiaTech, Omnicron/VirginiaTech, Washington State Univ.

EMS Visualization and Alarming Platform
(Cognitive Task Analysis & Information Processing)

- Interfaces (Data Exchange with Neighbours)
  - OSM
  - Islanding / Restoration
  - Disturbance Locator
  - Other WASA
- PMU Apps
- Grid Stability Apps
  - VSAT
  - SSAT
  - Mode Compare
  - TSAT
- EMS Apps
  - Fast Grid Topology Processor
  - Fast Grid State Estimator
  - Enhanced SE
  - Security Apps
- Simulation
  - DTS

PMU and SCADA Data
(Reudndancy/Data Synchronizaion)

SynchroPhasor Applications for the Control Center

Multi-host Redundancy (ISD Link)
Expansion of IEC 61850 outside Substation environments

IEC 61850 as communication interface with EMS
- Simplified Substation integration

IEC 61850 as single substation model
- Single IEC 61850/IEC 61850 Substation PDC used as single Substation interface
- Single access for remote control, maintenance & asset management
- Version management for Hardware, Software, Configuration and Setting

IEC61850 as a fast automation backbone to support Wide Area Automation

Support for Enterprise Level Applications
ISO-NE SIDU project scope:
- increase synchrophasor data measurements from key transmission substations within New England region and
- provide analytical tools based in part on phasor data.

ISO-NE using OpenPDC as foundation

Alstom Grid selected as the prime vendor for integration services of OpenPDC at ISO-NE as well as seven Transmission Owners (TO). These services include:
- Installation/configuration/testing at ISO-NE and TO sites;
  TO PMU(s) → TO OpenPDC → ISO-NE OpenPDC
- Coordination of OpenPDC releases with ISO-NE;
- Management of OpenPDC releases as GPA releases new versions;
- Creation of OpenPDC installation, testing, administration and user documentation;
- Training;
- As needed support for maintenance and troubleshooting;
- Consulting services.
MiCOM P847 Series PMU Functionality

Analog Channels
- $V_a, V_b, V_c, V_1, V_2, V_0$
- $I_1, I_2, I_0, I_a, I_b, I_c$
- Frequency & Rate of Change of Frequency

Digital Channels
- Any 8 status signals available

MiCOM Substation PDC Functionality

- Concentrates up to 15 phasor data sources (e.g PMUs)
- Based on solid-state ruggedized PC rated for substation applications
- C37.118 data archiving
- Remote configuration, license and archive management
- Supports multiple simultaneous input and output reporting rates
- State-of-the-art graphic user interface
Wide Area Situational Awareness Visualization

Grid Security Monitor

UI Navigation

WAMS Alerts

Wide Area Security

Steady State Security

Dynamic Security

Correlation

PMU-based Apps

Network Model-based Apps

Non-operational Data

Condition monitoring Weather information

PMU angles & Oscillation Monitoring

EMS RT Network Analysis

Small signal Voltage Transient

Local UI & Storage

Power system Grid

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Wide-Area Situational Awareness with PMUs

Monitor ‘angular separation’ as an indicator of increased grid stress due to:

- increased transmission path loading between ‘Sources’ & ‘Sinks’ of power
- sudden events such as line outages (i.e. weakening of the grid)

Identify low voltage areas
Detailed summary of existing resources within chosen region
OSM Visualization within e-terrawision
Modes shapes, amplitudes, damping, frequency, etc

Real-time alerts on poorly damped oscillations

Track oscillatory stability in real-time.

Identify regions where inter-area oscillations are observable
Voltage Security Analysis in e-terravision
Voltage Contours, MW Margins, Weak Elements, Remedial Actions

MW Transfer Margins

Identify weak elements (i.e. regions most prone to voltage instability)

Control Recommendations
SynchroPhasors in EMS
Enhanced State Estimator with PMU data at the 1 sample/sec rate

Utilization of PMU data (voltage & Current Phasors) in SE to improve round-the-clock reliability & robustness.

- Increase the number of ‘Valid Solutions’ ⇒ improved reliability
- Reduce dependency on ‘Critical Measurements’ ⇒ better observability
- Improved SE solution quality to minimize ‘Variance of State’ ⇒ higher accuracy
- Fewer SE iterations ⇒ faster performance

Compare PMU with SE Results

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ALSTOM’s Product Offerings Today!

**PMU Functionality** *(MiCOM P847)*: Multi-function device with PMU capability.

**Substation PDC** *(MiCOM S800)*: Ruggedized PDC for substation environment.

**Control Center PDC**: Processing and Synchronizing time series data.

**Wide Area Situational Awareness & Visualization** *(e-terra vision)*:
- Monitoring angle differences for instability
- Identifying low voltage areas & available voltage support sources
- User-created, on-the-fly, dynamic dashboards

**Synchrophasor Applications**:
- Oscillatory stability monitoring *(OSM)*
- Fast detection & alarming of unexpected disturbances; Composite events.
- Islanding, restoration, blackstart.
- Post Disturbance Analysis & Baselining.

**Improved State Estimation using Voltage and Current PMU data**

**Online Stability Solutions** *(OSS)*: Comprehensive dynamic security assessment
- VSAT/SSAT/TSAT integration with Visualization platform

**Engineering Services**– PMU Placement Studies, PSS Tuning, Baselining Analysis
Alstom - Concluding Remarks

- Ready & committed to providing synchrophasor solutions for a control center environment.
- Well-defined vision & roadmap for deployment of synchrophasor technology.
- Offer a complete suite of synchrophasor products: PMU, substation PDC, control center PDC, synchrophasor applications, visualization.
- Utilize standard technologies and protocols: web-services, C37.118, IEC 61850
- Range of solution choices for the customer:
  - “Plug & play” with applications with other vendors’ solutions: PDCs, non-ALSTOM EMS, Historians, visualization, etc
  - Open framework for “plugging-in” 3rd party solution engines.
  - Full suite of solutions from PMUs…to Operator Visualization.
Specific Design and Functionality Questions – 1 hr

- Scalability
- Communication
- Logging
- Remote Configuration
- Configuration Management
- Standards Compliance
- Security
- Handling redundant data streams
- Failover / Disaster Recovery
- Local storage / buffering
- Platform requirements
- Visualization customization
- Interoperability

• Design for interoperability
• Integration (APIs) with other systems (EMS/SCADA, power analysis apps, etc)

Questions/Comments?