Success Story: Advanced Grid Monitoring Analytics at ISO-NE using PhasorPoint

NASPI Working Group Meeting

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Outline

- ISO-NE’s Synchrophasor Infrastructure and Data Utilization (SIDU) Project
- Introduction of PhasorPoint application
- Engineering process to set parameters in PhasorPoint
- Success stories in grid monitoring using PhasorPoint
- Conclusions and future plans
ISO-NE’s Synchrophasor Infrastructure and Data Utilization (SIDU)
PhasorPoint Solution Maturity

Approximately 40 PhasorPoint deployments worldwide

Europe
2013 WPD
2012 SP Manweb
2012 CEPS
2011 Svenska Krafnet
2010 CORESO
2010 Alcoa
2009 LitGrid
2009 Energinet.dk
2008 REN
2007 REE
2006 Landsnet
1999 National Grid UK
1998 Scottish Power

North America
2013 AltaLink
2013 National Grid US
2013 AESO
2013 ATC
2013 Minnesota Power
2013 Hydro Quebec
2012 Tucson
2012 Midwest ISO
2011 ISO-NE
2011 WECC
2010 CFE
2010 PG&E
2010 Manitoba Hydro

South America
2009 XM Colombia

Africa
2011 Eskom

Asia
2014 Power Grid
2013 SEC
2013 GETCO
2013 EGAT
2013 EWA
2012 GCCIA
2012 CLP

Australasia
2012 Western Power
2007 Transpower NZ
2004 AEMO
2000 Powerlink
PhasorPoint Application

Advanced Applications
- Oscillatory Stability (and Mode Power Path)
- Islanding, Resynchronization & Blackstart
- System Disturbance
- System Condition
- Dynamic Angle Reference

Base
- Voltage & Phase Angle
- Current
- Frequency & df/dt
- Active & Reactive Power
- Symmetrical Components

Interfaces
- IEC 60870-5-104
- COMTRADE/CSV Export
- e-terra Web Services
- Asynchronous Systems
- Calculated Data

Data Management
- Phasor Data Concentrator (PDC)
- Historian
- SQL JDBC/OBDC
- MyViews
- Composite Events
System Disturbance Monitoring (SDM)

- Identifies, locates and characterizes a disturbance

- Highly configurable triggering attributes
  - Rate-of-change of voltage angle
  - Rate-of-change of frequency

- Efficient and accurate disturbance monitoring depends on settings of triggering attributes

- Trade-off between sensitivity to detect significant disturbance and too many alarms for insignificant disturbances
System Disturbance Monitoring, cont.

1) Detect Disturbance
2) Locate trigger point
3) Detect Event Type
4) Estimate Impact
Oscillation Stability Monitoring (OSM)

- Extracts frequency, damping, amplitude and phase of the main electromechanical oscillations in the band 0.04 – 4.0 Hz

- Configurable triggering attributes
  - Mode frequency sub-band
  - Mode damping ratio or decaying time
  - Mode amplitude
  - Hysteresis

- Efficiency of OSM depends on settings of triggering attributes
Oscillation Stability Monitoring, cont.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.08 Hz</td>
<td>0.69 Hz</td>
<td>9.37 %</td>
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<tr>
<td>0.77 Hz</td>
<td>0.22 Hz</td>
<td>7.23 %</td>
</tr>
<tr>
<td>0.9 Hz</td>
<td>0.33 Hz</td>
<td>2.01 %</td>
</tr>
<tr>
<td>1.06 Hz</td>
<td>0.33 Hz</td>
<td>6.04 %</td>
</tr>
</tbody>
</table>

![Map of ISO-NE](image-url)
Engineering Process to configure SDM and OSM Attributes

• A representative period of ISO-NE’s PMU data was used to setup SDM and OSM attributes

• Principles
  ✓ Normal parameters variations do not trigger an alarm
  ✓ Significant disturbances (generation trips and line trips) are detected
  ✓ The generation/load loss estimates are broadly correct

• Histograms and cumulative histograms of ROCOA and ROCOF were extracted from PMU measurements

• An estimate of system inertia is used to quantify MW load/generation loss
Engineering Process to configure SDM Attributes, cont.

- Most of the ROCOA was contained within -3 to +3 °/sec
- Inflection point is selected around the 99.999% of occurrence approximately corresponding to a 5°/sec ROCOA
- Trade-off between sensitivity and too many alarms for insignificant events
Engineering Process to configure OSM Attributes

Step 1: OSM frequency band setting
Goal: capture all dominant modes

Step 2: measurement selections
Goal: observability for all dominant modes

Step 3: Alert/alarm threshold settings
Goal: alarm for important events only
• “Forced oscillation” 0.12 Hz with almost 100 MW peak-to-peak amplitude
• Never observed before from simulations or measurements
Grid Monitoring using PhasorPoint – OSM, cont.

Locus plot of the 0.12 Hz “forced oscillation”

- Results satisfying trigger threshold generated an OSM alarm event
OSM event – sustained 1.0 Hz oscillations with significant amplitude

- New capability: detection and detail characterization of oscillations
OSM event – sustained 1.0 Hz oscillations with significant amplitude, cont.

- SCADA view

- Power Plant view
Grid Monitoring using PhasorPoint – SDM

- Sandy Pond HVDC single pole tripped, lost about 800 MW
Grid Monitoring using PhasorPoint – SDM, cont.

- Location: Sandy Pond ROCOA reached triggering conditions first
Grid Monitoring using PhasorPoint – SDM, cont.

• Line trip event (Beseck – Millstone)
Grid Monitoring using PhasorPoint – SDM, cont.

- Selection of Singer as location is based on triggering conditions
- Correct location is Beseck or Milstone
- Potential area of improvement
Composite Events

- Powerful tool to build complex triggering conditions
- Goal: provide single alarm per system event
Conclusions and Future Plans

• The PhasorPoint application has been successfully deployed at ISO-NE and demonstrated high efficiency for wide area monitoring and situational awareness

• PhasorPoint has detected system dynamic behaviors which were not observed before from simulations or measurements; ISO-NE has contacted plant owners to investigate the root causes

• Engineering process to set SDM and OSM attributes has been established. The process will be repeated periodically in the future

• WAMS applications such as SDM and OSM will greatly benefit from interconnection-wide PMU data exchange

• PhasorPoint is mainly used by operation engineers today. ISO-NE has developed synchrophasor technology roadmap to migrate the technology into control room
Questions