Eastern Interconnection Situational Awareness Monitoring System (ESAMS) Prototype Demonstration Project

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Motivation

• Reliability events can affect the behavior of an entire interconnection
• Yet, while operators have excellent visibility within their footprints.... .... improving visibility outside their footprints is always desirable

“RCs should improve communication with neighboring RCs in the event of widespread oscillation disturbances on the BPS”
Eastern Interconnection Situational Awareness Monitoring System (ESAMS) Prototype Demonstration

Overall Project Objectives:

To demonstrate how a common, high-level, synchrophasor-based view of the Eastern Interconnection can:

*Facilitate discussions* among Reliability Coordinators; and

*Support information sharing* among operating entities

Key Elements:

- Identification of the Reliability Coordinator footprint that is the source of a forced oscillation
- Monitoring and tracking trends in oscillatory modes and damping
- Monitoring and tracking trends in wide-area phase angle pairs

Information Delivery:

Daily emailed reports

Near real-time information on source location of forced oscillations - *forthcoming*
Locations of PMU signals currently streaming into ESAMS

(note: locations approximate)
Location of signals currently supporting Phase Angle Analyses
Location of signals currently supporting Forced Oscillation Source Location
**Daily Report Summary**

Summary (Eastern Daylight Time, 24-Hour Format)

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Event Time (EDT)</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interconnection Oscillatory Behavior &amp; Phenomenon</strong></td>
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</tbody>
</table>
| Forced Oscillation Detection & Source Location | 15:33-15:45      | 3 forced oscillation event(s) detected<br>Key info for event with highest energy:<br>  
  - Signal: SUB_A, Signal 1<br>  
  - Type: Real Power<br>  
  - Frequency: 0.962 Hz<br>  
  - Value: 11,732 MW<br>  
  - Source Area: RC_1 |
| Dominant Natural Oscillation Baselining |                  | Daily Report on Natural Oscillations                                      |
| Ringdown Detection            | 06:42-06:50      | 1 ringdown event detected<br>List of angle pair(s) for event with earliest time:<br>  
  SUB_A – SUB_B<br>  
  SUB_B – SUB_C |
| **Wide Area Phase Angles**    |                  |                                                                             |
| Rapid Step Changes           | 20:50            | 4 events with rapid step changes detected<br>Key info for event with the most angle pairs participating:<br>  
  - Number of Angle Pairs participating: 5<br>  
  - Most sensitive angle pair during the event: SUB_A – SUB_B |
| Very Large Angles Compared to Recent Observations | 10:00-10:04      | 2 events with large angles detected<br>Angle pair with the longest time under stress:<br>  
  SUB_C – SUB_D |
| Atypical Combinations of Rapid Step Changes and Large Angles | 09:40            | 5 Atypical Combinations detected<br>List of angle pair(s) with highest contribution to the event with most angle pairs:<br>  
  SUB_E – SUB_F<br>  
  SUB_F – SUB_G |
| **PMU Data Quality**          |                  |                                                                             |
|                               |                  | Daily Report on PMU Data Quality                                           |
Forced Oscillation RC Source Location

1) Forced Oscillation event was detected by signal SUB_A_Signal51 on 09/02/2021 15:45, Source Area: RC_1

Forced Oscillation Detection & Source Location

Time (EDT): 10:31 - 10:44; Frequency: 0.36 Hz; Oscillation Type: Inter-area Oscillations

<table>
<thead>
<tr>
<th>Rank</th>
<th>Oscillation Detected at</th>
<th>Peak to Peak Amplitude</th>
<th>Oscillation Band RMS Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SUB_A_Signal51</td>
<td>12 MW</td>
<td>7 MW</td>
</tr>
<tr>
<td>2</td>
<td>SUB_B_Signal52</td>
<td>7 MW</td>
<td>4 MW</td>
</tr>
<tr>
<td>3</td>
<td>SUB_C_Signal53</td>
<td>9 MW</td>
<td>6 MW</td>
</tr>
<tr>
<td>4</td>
<td>SUB_D_Signal54</td>
<td>6 MW</td>
<td>5 MW</td>
</tr>
<tr>
<td>5</td>
<td>SUB_E_Signal55</td>
<td>4 MW</td>
<td>3 MW</td>
</tr>
</tbody>
</table>
## Project Milestones and Schedule

<table>
<thead>
<tr>
<th>Description</th>
<th>Date</th>
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<tbody>
<tr>
<td>Initiation of field demonstration (ISO-NE, MISO, NYISO, PJM)</td>
<td>June 2021</td>
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<tr>
<td>Bi-weekly review of events</td>
<td>Ongoing</td>
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<tr>
<td>Incorporate signals from TVA, SPP, Southern Co</td>
<td>September 2021</td>
</tr>
<tr>
<td>Near real-time notifications (RC footprint location of a forced oscillation)</td>
<td>November 2021</td>
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<tr>
<td>Conclusion of field demonstration</td>
<td>December 2021</td>
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<td>EIDSN Advisory Committee evaluation*</td>
<td>Proposed to begin in Winter 2021-22</td>
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*Note that DOE, LBNL, EPG, and PNNL are not participants in this evaluation*
ESAMS Demonstration Partners

**ISO-NE** – Frankie Zhang, Slava Maslennikov, Xiaochuan Liu  
**MISO** – Keith Mitchell  
**NYISO** – Emily Fernandez, Shubhrajit Bhattacharajee  
**Southern Co** – Clifton Black, Chris Wakefield, Mark Newman, Michael Breuhl  
**SPP** – Cody Parker  
**TVA** – Tim Fritch, Gary Kobet, Phillip Crittenden
ESAMS Project Team

**PJM** – Ryan Nice, David Hislop, Eric Hsia, Christopher Callaghan, Hamed Golestani, (formerly, also Shaun Murphy)

**EPG** – Neeraj Nayak, Simon Mo, Ken Martin, Horacio Silva-Saravia, Song Xue

**PNNL** – Jim Follum, Nick Betzsold

**LBNL** – Joe Eto