Oscillation Detection and Analysis

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I. Introduction

• In power systems, changes in load, generation, topology, and control may initiate oscillations that could lead to instability if not well damped.

• Synchrophasor technology makes it possible to detect oscillations.

• **Visualization** provides operators with an intuitive understanding of what is happening.
II. FNET/GridEye Overview
II. Application Architecture

- FDR
- PMU
- FDR
- PMU

Internet

Oscillation Detection

Oscillation Analysis

Oscillation Amplitude

Oscillation Frequency & Damping Ratio

Oscillation Plots

Automatic Oscillation Report

Subscribers

Phase Angle Data

2015 NASPI Work Group Meeting
II. Detection Algorithm

Step 1

\[
\sigma - 0 > \text{Threshold}_1
\]

Step 2

\[
\alpha - \beta > \text{Threshold}_2
\]
III. Case Studies:

1. Oscillation caused by an incident in EI on 500kV network (03/14/2013 11:15:33 UTC)
III. Case Studies:

Modal Analysis Result

<table>
<thead>
<tr>
<th>Modes(Hz)</th>
<th>Leroy</th>
<th>Boston</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominate</td>
<td>Frequency(Hz)</td>
<td>0.6880</td>
</tr>
<tr>
<td></td>
<td>Damping Ratio(%)</td>
<td>3.2711</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modes(Hz)</th>
<th>RPI</th>
<th>Bangor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominate</td>
<td>Frequency(Hz)</td>
<td>0.6910</td>
</tr>
<tr>
<td></td>
<td>Damping Ratio(%)</td>
<td>3.9281</td>
</tr>
</tbody>
</table>
III. Case Studies:

2. Oscillation case in WECC (06/30/2013 07:35:47 UTC)
III. Case Studies:

3. Oscillation case in EI (04/05/2013 23:31:01 UTC)
III. Case Studies:

4. Oscillation case occurred due to HVDC event (07/03/2013 20:33 UTC)

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Time(UTC)</th>
<th>Interconnections</th>
<th>Amount (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20:35:44</td>
<td>Phase II, pole 1</td>
<td>1775</td>
</tr>
<tr>
<td>2</td>
<td>20:37:20</td>
<td>Phase II, pole 2</td>
<td>2775</td>
</tr>
<tr>
<td>3</td>
<td>20:38:51</td>
<td>Madawaska</td>
<td>280</td>
</tr>
<tr>
<td>4</td>
<td>20:38:51</td>
<td>Eel River</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>20:36:05</td>
<td>Outaouais</td>
<td>500</td>
</tr>
<tr>
<td>6</td>
<td>20:39:08</td>
<td>Chateauguay</td>
<td>700</td>
</tr>
<tr>
<td>7</td>
<td>20:39:13</td>
<td>Highgate</td>
<td>200</td>
</tr>
</tbody>
</table>
III. Case Studies:
Relative phase angle in EI
III. Case Studies:
Frequency excursion in Quebec Interconnection
IV. Movie Playback
V. Conclusion

• Visualization of synchrophasors provide insight into power system phenomenon not available through traditional SCADA measurements.