San Diego Gas & Electric
Transmission Synchrophasor Project

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SDG&E Overview

- Subsidiary of Sempra Energy
- Regulated public utility
- Provides safe and reliable energy service to 3.4 million consumers
  - 1.4 million electric meters
  - 868,000 natural gas meters
- 4,100 square mile service territory in San Diego and southern Orange Counties (27 cities)

- 1,800 miles of electric transmission lines and 21,600 miles of electric distribution lines
- Two compressor stations, 160 miles of natural gas transmission pipelines, 8,100 miles of distribution pipelines and 6,200 miles of service lines
- 4,500 employees
Key Implementation Facts

- 103 PMUs Installed
- Leveraged existing protection relays
- > 99.9% Availability
- < 100ms average latency
Complete 230kV & 500kV Coverage
Current Architecture

Substation

- Relay
- PDC
- Local Archive

Serial

Data Center

Operations

- Web-client

Engineering

- Web-client

PDC

SynchroWAVe

Archive

WECC & CAISO
Future Architecture

Substation:
- Relay → PDC
- PDC → Local Archive

Data Center:
- SynchroWAVE → Archive
- SynchroWAVE → PDC

Operations:
- Web-client
- SynchroWAVE
- Archive

Engineering:
- Web-client
- WECC, CAISO, & Others
Challenges Facing SDG&E
Effect of Renewables on Grid Operation

Real Power

Combined Cycle Generation

Solar Generation

Wind Generation
Detected Oscillation - Generator

Voltage Magnitude
Detected Oscillation

Frequency

Voltage Magnitude

\( \frac{df}{dt} \)

Invisible to EMS
Phase Angle Measurement Across Inter-tie Breakers

SYNCHRONIZING INDICATION

IV-NG CLOSING PHS. ANGLE +9 DEG

NOTE: MEASUREMENT IS FROM CABLE TCP FT 5260045592
Correlate Relay Event Data

Synchrophasor Data

Voltage Magnitude

Relay Event Reports
Correlate Relay Event Data

Frequency

Voltage Magnitude

Line Trip

Relay Event Report
### Event Summary for Operations

<table>
<thead>
<tr>
<th>TL #1 – SEL-311L</th>
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</thead>
<tbody>
<tr>
<td><strong>Event Summary</strong></td>
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</table>

<table>
<thead>
<tr>
<th><strong>Voltage Magnitude</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>135.77 kV</td>
</tr>
<tr>
<td>135.0 kV</td>
</tr>
<tr>
<td>125.9 kV</td>
</tr>
<tr>
<td>115.0 kV</td>
</tr>
</tbody>
</table>

**Frequency**

- Frequency Chart
- Voltage Magnitude Chart
Integrated Event Analysis

Relay Oscillography
Event Report Integration Architecture

Substation
- Relay
- PDC
- Local Archive

Operations
- Web-client

Engineering
- Web-client

Data Center
- PDC
- SynchroWAVe
- TEAM
- Event Report Archive
- Archive
Next Steps for Project

1. Develop operational procedures for specific use cases
2. Work with SEL to further develop operations applications
3. Integrate V&R application for enhanced voltage stability
4. Develop Ethernet communication network
Thank you!