CUSTOMER-SITE INFORMATION SUPPORT FOR TRANSMISSION AND DISTRIBUTION OPERATIONS
Introduction

- Advanced Distribution Automation applications are based on near real-time computer-aided models of distribution operations.
- The models for advanced DA applications must reflect not only the current state of the object but also support the look-ahead states dependent on changing conditions. Hence the models shall be **predictive and adaptable**.
- The fundamental model for the advanced DA applications is the power flow/state estimation model down to the equivalents of the low voltage circuits. 1
- The critical results of the power flow are the loading of the circuit elements and **the voltages at the designated buses**, predominantly at the customer terminals.
Impact of Accuracy of Models on Operations

**Benefits**

*Without Smart Grid Applications*

- "Typical" Load Model; Default Secondary circuit models
- DOMA
- High standard voltage limit
- Tolerance for optimization
- Margins due to inaccurate models
- Low standard voltage limit

*With Smart Grid Applications*

- Accurate Load Model; Accurate Secondary circuit models
- DOMA
- High standard voltage limit
- Tolerance for optimization
- Margins due to inaccurate models
- Low standard voltage limit

Smart Grid Data Management Systems

Greater benefits with Smart Grid Applications
Background components of TnD Object/Data Models

Components of model errors

Currently monitored bus

Desired monitor terminal
In the most loaded segments the errors in the voltage drop calculated by DSE do not exceed 0.1% of nominal voltage.
Voltage Drop Error in Three-phase Distribution Transformer Vs Load Model Accuracy

<table>
<thead>
<tr>
<th>KW errors, p.u. kVA</th>
<th>kvar errors, p.u. of kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.25</td>
<td>-0.43 -0.20 0.02 0.25 0.476</td>
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<tr>
<td>-0.2</td>
<td>-0.39 -0.16 0.07 0.29</td>
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<td>-0.15</td>
<td>-0.35 -0.12 0.11 0.34</td>
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<tr>
<td>-0.1</td>
<td>-0.31 -0.08 0.15 0.38</td>
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<tr>
<td>-0.05</td>
<td>-0.50 -0.27 -0.04 0.19 0.42</td>
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<tr>
<td>0</td>
<td>-0.46 -0.23 0.00 0.23 0.46</td>
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</tr>
</tbody>
</table>
Equivalent Secondary Circuit

\[ V_{dt} \]

\[ V_{dt} \]

\[ V_{critical} \]

\[ \sum L(1-3) \]

\[ V_{critical} \]

\[ V_{mv} \]

\[ V_{Ddt} \]

\[ V_{Dcritical} \]
Example histogram of voltage modeling error mostly due to the error in LV equivalent.
Examples
Load Reduction due to IVVO

Benefits in load reduction vs accuracies of control and model
Potential benefits = 3%

Percent load reduction
Initial accuracy of model
Initial accuracy of control
Benefits of accurately determined voltage–critical nodes with DR

Total DR = 67 kW; Additional Load Reduction by VVO = 614 kW; Ratio = 9.2; 30% increase of load reduction by VVO

Initial load reduction due to VVO = 1990 kW
Lost benefits due to lack of confidence in secondary voltage models

Impact of conservative bus voltage limit on energy conservation benefits

- Bus voltage
- Customer voltage
- Optimal bus voltage
- Substation load
- Operator's bus voltage limit
- Customer-side limit

Time of day

Voltages, p.u.

Substation load, MW

[Graph showing the impact of conservative bus voltage limit on energy conservation benefits]
FLIR Benefits due to AMI
(fault detection by bellwether meters)
Impact of model errors on models of transfer capacity limited by voltage (5% limit)

Ratio of transfer load over load of backup feeder after reconfiguration,
Available emergency voltage drop in primary 5%

Load ratio

Initial voltage drop in feeder primary, %

Voltage model and control error in critical points, %
Interfaces between major actors involved in ADA
Conclusions

- Customer-site supported data and control capabilities may provide significant added benefits of advanced DA applications.

- The extent of the added values due to involvement of customer-site information support of TnD depends on:
  - the design of the DMS/EMS applications,
  - the contents of data gathered from the customer sites,
  - the accuracy of information support by all information sources
  - the accuracy of control actions.

- Most of the information support needed by DMS from the customer systems does not require direct information exchange between the DMS applications and Smart Meters in near real time.

- Advanced procedures for creating adequate adaptive and predictive models should be developed.

- To develop these models, combinations of customer-site data with data obtained from other information systems are needed.
Thank you!

Questions, Comments?