AMI Information Support for Transmission and Distribution Management

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Background components of TnD Object/Data Models

Components of model errors

Current reference bus

Desired reference terminal
Component Errors in Voltage Modeling

• Measurements of the reference voltages
• Modeling the voltage transformation by voltage regulators (bandwidth error)
• Modeling the voltage drops in the feeder primaries
• Modeling the voltage drops in distribution transformers
• Modeling the voltage drops in the secondary (LV) circuits

➢ Of the 5 types of errors listed above, the last three are closely related to the AMI-supported information

➢ Assuming random independent component errors, the composite error is defined as follows:

\[ \Delta V_{lv} = \left[ (\Delta V_{mv})^2 + (\Delta V_{Ddt})^2 + (\Delta V_{Dsec})^2 \right]^{0.5} \]
IMPACT OF MODEL UNCERTAINTY ON BENEFITS

Examples
Load reduction due to IVVO

Realized benefits in load reduction vs accuracies of control and model

Potential benefits = 3%
Benefits of accurately determined voltage–critical nodes with DR

Initial load reduction due to VVO = 1990 kW

Total DR = 67 kW; Additional Load Reduction by VVO = 614 kW; Ratio = 9.2; 30% increase of load reduction by VVO
Lost benefits due to lack of confidence in secondary voltage models

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)

![Graph showing the impact of model errors on transfer load ratio and initial voltage drop.](graph.png)
Time of feeder upgrade

[Graph showing the relationship between years and error of voltage model and control, %]
In the most loaded segments the errors in the voltage drop calculated by DSE do not exceed 0.1% of nominal voltage.

Voltage errors due to load errors
Load error = 15%

Number of loads
Actual voltage drop, %
Voltage model error, %
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>
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</thead>
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<tr>
<td>-0.25</td>
<td>-0.43</td>
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<tr>
<td>-0.2</td>
<td>-0.39</td>
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<tr>
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<td>-0.35</td>
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<tr>
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<td>-0.31</td>
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<tr>
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<td>-0.31</td>
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<td>0.25</td>
<td>-0.28</td>
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</tbody>
</table>
Sample Secondary Circuits
Equivalent Secondary Circuit
Assessment of Achievable Accuracy of VD by Utilizing AMI

\[ \Delta VD = (0.1^2 + 0.5^2 + 0.5^2)^{0.5} = 0.7\% \]