Advanced Functionalities of an Integrated Distribution Management System (IDMS)

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The Emerging Smart Distribution Grid presents an increasingly complex system to manage

• Distribution Operators still have their hands full safely coordinating crews doing switching and restoration – keeping the lights on with no time for “advanced functions”

• Distribution Analysts may work with advanced functions to maximize system and energy efficiency, often via automated systems like FLISR and IVVO

• Still others may coordinate demand response participants, distributed energy producers, and manage AMI/MDM

• In smaller utilities, Operators may do it all!

• Increasingly mobile users need to interact remotely

• A comprehensive network management system improves efficiency of users, safety, and system support
IDMS – Distribution Control Room Cockpit

**SCADA**

**OMS**

**IDMS**

**ADMS**

**DERMS**
IDMS - A Single Network Operations Model & UI
Supports Multiple Functional Modules for Ease of Use

Network Outage Management  Network Analysis & Optimization  System Simulator (DOTS)  Switching Operations  DERMS and DR  SCADA

Network View

Network Operations User Interface  Network Operations Model

Call Center  Workforce Management  Customer Model (CIS)  Distribution Automation  Equipment Models (GIS, Graphical Editors)  Automated Metering (AMI)
Distribution Operations Training Simulator (DOTS)

• Simulation vs. Event Playback
  – Simulator uses real SCADA, ADMS, OMS to process scripted events and scenarios (fully interactive)
  – Playback tool re-enacts recorded events (not interactive, view only)

• Calculated Response to Events
  – Power Flow, SC Analysis
  – Correct System Response

• Simulated System Response
  – IVR, Call Center, Crew, AMI
  – Tagging, Alarms, Operation of Protective Devices (Relay, CB, Reclosers, Fuses, etc.)
DER Impact Studies with DOTS

• The Distribution Operations Training Simulator (DOTS) is used to analyze the Operational impacts of DG penetration

• A DG Modeler Tool can add hypothetical DG to the IDMS model

• Time series studies are performed with varying DG output and Load schedules

• Salient analysis results are captured and collated

• Detect operational limit violations and excess wear on automated equipment
Operations Department Focus

With proper evaluation tools, Operations can:

- Prepare operational mitigation procedures
- Restrict DG connection permits granted
- Request engineering design remediation
- Build regulatory cases for more operationally restrictive DG connection contracts
Study Solar Profile

Solar PV Farm Cloudy Spring Day Output

Output (kW/kVAR) vs Time of Day

- Real
- Reactive
Study Circuit Load Without Solar

Study Load Profile
4/7/2012 - 3 minute interval data

[Graph showing load profile over time with 'Real' and 'Reactive' load lines]
Study Circuit Load with 5 MW Solar Connected

Circuit Load With Solar

Time of Day

Load (kW/kVAR)

12:00:00 13:00:00 14:00:00 15:00:00 16:00:00

Real

Reactive
### Study Regulator Tap Movement (Local Control)

Over a 4 hour study period

<table>
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<th>Solar Ops</th>
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Smart Meters as Sensors for IDMS: Near Real-time ADMS/AMI Functionality

- **Meter PowerOn / PowerOff Events**
  - Outage and restoration visualization on geographic displays

- **Meter Ping**
  - For verification of outage and restoration

- **Meter Low / High Voltage Event Processing (i.e. brown-out events)**
  - Visualization of AMI voltage events on geographic displays
  - Utilization of AMI voltage events in Integrated Volt/Var Optimization (IVVO)

- **IDMS Initiated Voltage Scan**
  - Automatic voltage scan of dynamically selected bellwether meters
  - Utilization of AMI voltage scans in IVVO

- **Meter kW / kVAR measurements used in Distribution State Estimation**
  - Initially for customers with large solar DG installations or difficult to model loads
  - Telemetered load at service point overrides modeled load/generator
  - Eventually the normal source of load values for Distribution State Estimation
Meter PowerOn / PowerOff Events Visualization

Connected customers shown as ovals, PowerOn = Green, PowerOff = Red
Meter Pings Invoked Automatically or with Right-Click Menu
Meter Low and High Voltage Event Visualization
• Solar DER and nonconforming loads are difficult to model
  – Smart Meters provide IDMS with the last 5-minute averaged data for power flow calculation improvements
IDMS and Smart Inverters: The National Renewable Energy Laboratory
IDMS and Smart Inverters

- Ongoing DOE sponsored project with Duke Energy and NREL leveraging the ESIF
- Evaluate capabilities of commercially available “Smart” Inverters and their impact on distribution operations
- Add Smart Inverter set points as a control type within IVVO to complement taps and capacitors
- Controlling Smart Inverters is key for a DER enabled ADMS - DER voltage rise, backfeed, power factor control
Evaluation of DER Smart Inverters as a control type for IDMS
The Evolving Sophistication of Emergency Load Reduction

Utility customers are asking for a stepped approach to load reduction orchestrated through IDMS. Generally:

- **Demand Minimization with IVVO**
  - No customer impact – voltages moved to low end of normal ANSI range
- **Demand Response program calls**
  - Commercial and residential DR participants
- **Emergency Demand Minimization with IVVO**
  - Voltages moved to the next lower ANSI range
- **Surgical Load Reduction by network optimization function**
  - Selective load curtailment via AMI disconnects with customer type and DG awareness
- **Educated Load Reduction through circuit switching by network optimization function**
  - Based upon As-Operated network model with critical customer awareness
- **Rotational Load Shed through classic SCADA-style function**
  - With abnormal configuration and critical customer awareness
- **Traditional Block Load Shed**
IDMS
Complete Ecosystem Management

- Grid Reliability
- Power Quality
- Field Crew Safety
- Operational Costs
- Environment Sustainability
- End-Customer Satisfaction