Next Generation Distribution Management Systems (DMS) and Distributed Energy Resource Management Systems (DERMS)

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Outline of Presentation

• Basics of Distribution Management Systems
• Evolution of Distribution Management Systems
• DOE Project on Integrated Smart Distribution Distribution
  – Objectives
  – Technical Scope
  – Research and Development Areas
  – Technical Approach and Results
  – Lessons Learned
• Conclusions and Summary
Basics of Distribution Management Systems

- **Objective:** Advance Distribution Automation
- **Definition:** Distribution Automation is the integration of sensing and monitoring, control and protection.
- **Goal:** To improve operator effectiveness via development of application functions which interact with each other seamlessly and effectively that too under emergency conditions.
What is Advanced Distribution Automation (ADA)?

• “ADA is revolutionary approach to managing and controlling distribution systems. It achieves a fully controllable and automated distribution system including the integration of Distributed Energy Sources (DERs) to optimize system performance.”

• Source: EPRI
Drivers for ADA

- Improved efficiency, reliability, security, power quality, safety, resilience
- Reduced operating costs
- Improved outage restoration times
- Increased customer service options
- Integration of Distributed Energy Resources (DERs)
- Integration of customer system
- Innovative customer-focused operation

Source: EPRI
Role of New Technologies in ADA and IDMS

- New technologies are essential to enhance ADA
- The design of IDMS, as second generation DMS, need to keep the advances in new technologies in mind
- New technologies facilitate IDMS to integrate OMS, DMS and SCADA and other new functions into one seamless function. This is the essence of third generation DMS or IDMS

Examples of New Technologies for ADA

• Smart meters will enhance fault location identification function

• Remote controlled switches and protective devices will allow Integration of Fault Location, Isolation and System Restoration into one function

• Microgrid (DG) integration with utility system will yield higher reliability and resiliency
Current Status of ADA

• A lot of progress is being made.

• For instance, distribution automation (DA) technologies are presently being integrated with supervisory control and data acquisition (SCADA) systems to provide more visibility and intelligence.

• Rapid reconfiguration of specific sections of the distribution system. This will minimize the impact of system faults and power quality disturbances on customers.
ADA Subsystems

- Integrated Distribution Management Systems (Advanced Distribution Control Centers)
- Substation automation
- Feeder automation
- Customer automation (AMI, smart meters)
Current Integrated Distribution Management System (IDMS)

Network Analysis
- Power Flow (RT & Study)
- State Estimation
- Limit Violation Monitor
- Fault Location
- Loss Analysis

Network Outage
- Unplanned/Planned Lifecycle
- Trouble Calls/AMI
- Customer Updates
- Crew Monitor/Assign
- Performance Indices
- Device Prediction

Network View
- Dynamic Operations Map
- Geographic/Schematic
- Persistence of Manual Entries
- Energization visualization

Network Optimizer
- FISR (self healing)
- Feeder Reconfig (proactive)
- Volt/Var Management (automatic)

Switching Operations
- Create, Simulate, Execute,
  Switch Orders and Safety
  Documents

Strong Integration/Seamless
UI
Monitor/Control
Navigation
Visualization
Tags

Distribution SCADA
Switching Operations

Crew Monitor & Assign

Outage Mgmt

Network Operations
- Connectivity visualization
- SCADA
- Network Analysis/Opt
- Geographic & Schematic
- Outage Extent & Cause
- unplanned & Planned Outage Lifecycle
- Performance Indices
- Historical Archive

CIM based Adaptor

Electrical Asset Data from GIS, Planning, Protection, etc.

Customer Notification

Planned Work Management
- Maintenance
- Repairs
- New Construction
- Seasonal Reconfigure

Call Center
(Call Handling Front End)
IVR

CIS
- Customer Data
- Electrical Address

AMI/MDM
- Customer Energization
- Consumer Characteristics

Mobile Resources
- Work Force Mgmt
- Crew Callout
- Resource Optimization

Single User Interface

Secure SOA Adaptor

Integrated Distribution Management System

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# Evolution of Distribution Management Systems

<table>
<thead>
<tr>
<th>Decade of (Generation)</th>
<th>Computer Frame</th>
<th>Applications</th>
<th>Performance Goals</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980 (First Generation)</td>
<td>Mini computers</td>
<td>SCADA, VVC for individual components</td>
<td>Improve reliability and efficiency of legacy systems</td>
<td>Specialized and unique needs. No communication or coordination</td>
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<tr>
<td>1990 (Second generation)</td>
<td>Standard PCs</td>
<td>Coordinated SCADA</td>
<td>System wide enhanced efficiency and reliability</td>
<td>Integration and coordination of functions to improve operator effectiveness</td>
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<tr>
<td>2000 Dawn of Smart Grid (Third Generation)</td>
<td>Network of power PCs, Server farms</td>
<td>GIS, Model based FLISR, AFR, VVC and switch plans</td>
<td>Security, Safety, Reduced cost, Customer interface</td>
<td>Smart meters/AMI DERs, Renewable Energy Resources</td>
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<tr>
<td>2010 (Continuation of Third Generation)</td>
<td>Improved networking, Mobile and Cloud computing</td>
<td>OMS, DERMS, VVO, Microgrid operation, control and protection</td>
<td>Real-time situational awareness, enhanced customer interface, resiliency, Enhanced PQ</td>
<td>Higher penetration of solar and wind, EVs, storage, microgrids</td>
</tr>
<tr>
<td>2020 (Fourth Generation)</td>
<td>Mobile cloud computing</td>
<td>Optimization, Decision Support, ...</td>
<td>DER integration, Integrated Performance improvements, Environmental goals</td>
<td>Higher penetration of DERs, EVs, storage and retail market mechanisms into distribution domain</td>
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Pilot Projects and Lessons Learned

• **Alstom is involved in several pilot projects dealing with DERMS**
  – DOE-ISD Project with DUKE Energy
  – The Navy Yard Microgrid
  – Nice Grid in France
  – ReflexE in France
  – Two distribution projects in Scotland

• **Many more in the World**
Objectives of DOE-ISD Project

The primary objective of this project is to leverage the intelligence of, and information provided by, sensors, energy boxes and smart meters to integrate DER for developing next generation DMS to enhance optimal performance of the emerging distribution system. This builds on the DOE Vision towards an Intelligent North American Grid by 2030.
Technical Scope

- Advanced distribution modeling capability to accurately simulate/model smart grid operations.
- Accurate representation of the distribution system in real- or near real-time (capture real-time topology).
- Interoperability with and seamless communication between other management systems and data bases used by the utility.
- Simulation of distribution systems based on real-time operational planning to analyze the benefits of smart grid assets.
- Integration of network, market, and renewable resource models for next generation DMS.
- Management and forecasting of DER (DG, storage, DR)
Research and Development Areas

• Research
  • DER Modeling
  • Advanced and Adaptive Protection
  • Microgrid Protection
  • Fault Location Using PMUs
  • Optimal Real and Reactive Power (VVO) Management Using PMUs and μPMUs
  • Short Term Load Forecasting
  • Communication Architectures
  • Market Integration of DER
Research and Development Areas

- Research
  - Secondary Distribution Modelling
  - Solar Swing Mitigation
  - Grid and Microgrid Solar Penetration Investigation via Simulations
  - Robust Power Flow and Short Circuit Algorithms
  - Three-phase State Estimation
- Research and Development for Pilot System
  - Cold Load Pickup
  - DG Back feed Mitigation
Lessons Learned

- The partnership with Duke Energy has been a positive influence and the interaction with more than 30 Duke personnel via 20 workshops has been invaluable.
  - It enabled the team to concentrate on problems, with a real-world context, that needed immediate attention in the “Smart Distribution System”.
  - Our project workshops continue to be very fruitful and will continue throughout the project phases as the requirements of Integrated Smart Distribution continue to evolve.
Lessons Learned (Contd.)

• It was a challenging experience for the entire team to tackle R&D areas that were not even on the radar screen when the project was started.

• We underestimated the amount of workshops and brainstorming required.

• Duke have acquired and installed new devices to provide scarce data in sufficient quantities to facilitate research.

• Adoption of customer owned equipment slower than anticipated
Lessons Learned (Contd.)

• Demonstrated a strong partnership between a Utility, Vendor, Universities & National Labs to achieve project goals.

• The use of GridLAB-D as a planning tool is extremely useful for the project investigation along with Alstom’s Distribution Operator Training Simulator (DOTS).
What will drive the Next Generation DMS?

• The future looks very bright and exciting!

• It will depend on the developments to come in the following Key Technology Areas:
  – Communication architectures
  – IT: Real time data base management
  – Computer technologies
  – Control algorithms
  – Decision support systems
  – New materials development

• The developments will happen in an exponential fashion

• If you believe all our dreams will come true!
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Thank you

What Questions Do You Have?

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