The Integrated Distribution Management System (IDMS)
What are Utilities looking for in a DMS/OMS

- The key applications are the User Interface and the Trouble Call / Outage Management System.

- Many utilities develop their own OMS because it is “core business”. It is a major change to move to a “product”.

- Priority order is OMS, SCADA, DMS

- Reliability

- Performance under worst-case conditions

- Ability to support the changing regulatory environment
“IDMS” Functional Components

Network Analysis
- Power Flow (RT & Study)
- Limit Monitor
- Fault Location

Network Optimizer
- FISR
- Feeder Reconfiguration
- VoltVar Management

Network View
- Dynamic Operations Map
- Geographic/Schematic
- Persistence of Dressings

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

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

SCADA
IDMS - Typical Business Drivers

- Provide SCADA automation to distribution networks
- Improve operational efficiency through user interface consolidation (DMS/SCADA/OMS)
- Improve reliability and safety through better visualization of distribution network status and use of switching plan tools
- Improve reliability indices and customer satisfaction through faster and more predictable outage restoration
- Reduce peak demand and longer term energy consumption with coordinated Load and Volt/Var management (green initiatives)
- An operational platform from which to manage distributed generation
- Reduce energy losses and network operational costs with coordinated Load and Volt/Var management
- Reconfigure control center operations dynamically
- Reduce penalty payments through faster outage restoration
A suite of applications for distribution utility operational needs - providing a comprehensive real-time network management solution

A Control Room presentation of information to better comprehend and improve the state of the distribution system – geographic, schematic, tabular, real-time and analytics

Seamless integration of systems (SCADA/DMS/OMS = IDMS) into the Control Room user interface based upon the e-terrabrowser product

Builds upon, and complements, GIS/Asset Management, SCADA, AMI, and field automation investments

Provides virtual and dynamic control center configurability

Performance in high activity storm situations as well as blue sky days
Outage is confirmed for all devices downstream of Recloser.
The Key Elements

- Outage Management
- Distribution Management
- Switching Operations
- Network Optimization
- SCADA Integration
- Study Tools
- Training / Simulation Tools
- Model Management
Planned Work Management
- Maintenance Planning
- New Construction
- Return to Normal
- Seasonal Reconfigure

Customer Notification

Switching Operations

Outage Mgmt

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

Asset Data (GIS etc.)

CIM Adaptor

Crew Monitor & Assign

Resource Management
- Mobile Data System
- Crew Callout
- Crew Optimization

Call Center
(Call Handling Front End)
- IVR

CIS
(Customer Data and Electrical Address)

AMR/AMI
(Customer Energization and Consumption)

Integrated Distribution Management System

e-terra browser
Typical IDMS Configuration

Client PCs running e-terra browser

Main Viewport

SCADA Standby

User Int Server

SCADA

ALARM

IDMS/OMS Application Primary

User Int Server

SCADA

ALARM

PERMIT

IDMS Apps Server

IDMS Application Standby

SCADA Primary

User Int Server

SCADA

ALARM
Key Features and Value Proposition

Integrated Distribution Network Management

- Transparent integration of DMS, OMS and SCADA activity in one graphical user interface - increase efficiency and safety and reduce inadvertent outages

- Physical realism - based upon dynamic network operations connectivity model with detail of all phases - improve situational awareness and field coordination

- Asset model updates go on-line transparently without failover, while persisting temporary changes made online – maintain business continuity across updates

- Online Network Analysis Tools for balanced and unbalanced systems – reactive and proactive operational recommendations to speed outage restoration, maintain operational limits, and reduce demand/losses

- Leverage GIS investment for asset model source – avoid redundant modeling

- CIM based interfaces to other enterprise applications – facilitate integration

- Integration of automated observations like AMI

Performance and Scalability (Storms vs. “Blue Sky” DMS/OMS)

- Distribution Network Object Model supports connectivity of >5M customers and >25M electrical objects

- Hurricane level outage performance >1M customers, 200K calls/hr

- Supports 1000’s of users with smart clients
Network View

Network Operations User Interface
- Geographic Network Display
- Topology Analysis (Loop Detection)
- Energization Status
- Operator Annotations
- Network Tracing
- Tagging

Network Operations Model
- Static Data Model (entire network in its normal state)
- Dynamic Data Model (switching changes & temporary network modifications)
- Supports on-line updates
The Southern Company Case for IDMS
Serve 4.4 Million Retail Customers
Generating Capacity : 42,000 MW
120,000 Square Miles
Alabama Power Company
Site of the first IDMS implementation

- APCo serves over 1.4M Customers
- 10,163 Miles Transmission
- 76,137 Miles Distribution
- 44,500 Square Mile Service Territory
- Six Geographic Divisions
Present Distribution Operations

Applications integration on-the-fly by operator across multiple disparate User Interfaces and paper

- Distribution SCADA
- Switching Management
- Outage Management
- Crew Call Out System
- Work Force Management
Separate and Disparate Systems
840,000 peak customers out
1,831 feeders affected
Why Change?

- Improve distribution operation capabilities to address:
  - System loading, maximize assets utilizing connected model
  - Predicting, locating, isolating, and analyzing faults with or without operator intervention – self-healing systems
  - Autonomous application systems
  - Reliability and asset maintenance – Condition Based
  - Demand Management – system losses and demand reduction programs
  - Distributed generation
  - Operator Training
  - Enable active customer participation through AMI
IDMS Benefits

► IDMS assumption of .5% loss reduction will contribute to a greener environment by less required generation
  • Industry accepted recoverable loss estimates range from .5% to 4.1% of the distribution kWh sold at a typical utility

► A 33% reduction in outage duration would be the largest incremental gain of any system reliability project
  • Utilizing FISR within the IDMS system will reduce SAIDI to our customers
Integrated Single User Environment
  • An integrated view of the power system increases operation efficiency

Power flow analysis
  • Real time information leads to improved asset utilization

Fault location
  • Saves time and expense of crews searching for faults when they occur / less customer outage time

Power quality
  • Identify harmonic problems

Maximized return on SCADA and GIS investment with automatic interface and transparent database change management to on-line distribution network model
Future Distribution Operations

Integrated Distribution Management System (IDMS) Project

**SCOPE of IDMS PROJECT**

- To achieve a seamless integration of operating applications – combining OMS, SCADA, Distribution Analysis applications, and integration with AMI into a single user interface to improve operator Situational Awareness (efficiency, accuracy, safety gains)

- Utilizes GIS as the major source of electrical asset data and applies real-time dynamics for a connected and “intelligent” model

- GIS topology and attribution facilitates the use of advanced network analysis applications to enhance operational decisions

- Improve distribution system electrical efficiency and expand demand management programs

- Distribution Operator Training Simulator with Storm mode
IDMS Facilitates Smart Grid Operations

Advanced IDMS Applications enabled by the integration of static asset data, real-time observations, historical data, and manual dressings

- Unbalanced power flow analysis for real-time Operations and study mode switching planning
- AFISR (Automatic Fault Isolation and Service Restoration)
  - De-centralized
  - Centralized
- Pro-Active as well as reactive mode Feeder Reconfiguration
- Fault detection and location
- Volt/Var Control for demand management and minimizing distribution losses
- Integrated system coordination and protection analysis
- Distribution Contingency analysis
- Switching Management
- Advanced Crew Management
- Dynamic Deration of Power Equipment (Harmonic loading)
IDMS Facilitates Smart Grid Operations

DOE and EPRI Support

- IDMS project being co-funded by US Department of Energy’s GridWise Program and the Electric Power Research Institute (EPRI)
- Demonstration project completed in June 2008
- Complete Implementation at Alabama Power Company in 2010
IDMS Advanced Functions
Switching Operations

- Creation, Validation and Execution of Switching Orders.
  - A detailed set of instructions used to plan and coordinate switching actions that are performed on the network.

- Creation and Management of Safety Documents.
  - The formal documents that transfer jurisdiction of a defined section of the network between operations staff and maintenance staff.
Advanced DMS Function Values

- Cross functional geographic displays provide a physical map alternative for visualization of the distribution network
  - More intuitive assimilation of outage information (customer call patterns and outage island extents)
  - More intuitive viewing of crew locations and subsequent crew dispatching as well as navigation

- Improvement of system reliability and reduced outage times through automatically generated restoration switching plans with the option of closed loop execution through SCADA.

- Real-time and planning power flow calculation for precise intervention. Power flow calculation takes into account physical equipment, cables, switches, transformer and metered data on the circuit. Can detect if a circuit is overloaded or if there is an excessive power consumption compared to the expected load.

- Optimization calculations take into account short term load trends observed in real-time and cold load pickup models to provide more useful switching recommendations.

- Advanced tools for optimal switching result in estimated 33% reduction in restoration times for complicated outages as well as fewer mistakes in heavily loaded situations (ALABAMA POWER a Southern Company).

- VoltVar Management can achieve 1.5 – 4% demand reduction in energy conservation mode
Network Analysis and Optimization
Functional Groups

Distribution Power Flow and derivatives
- Real-time state estimation and study modes
- Detailed Dynamic Models – phase domain
- Limit monitoring and exception/Alarm reporting

Distribution System Optimizer
- Switching Reconfiguration – fault isolation and restoration as well as optimization of circuits
- Load & Volt/Var Management – loss minimization and demand management
- Closed-loop and advisory modes
Distribution Management System (DMS)
Network Analysis Functions

- Power Flow Analysis
- Load Allocation – real-time modelling of loads
- Limit Monitor - overloads
- Power Quality – Voltage Violations
- Short Circuit Analysis for Protection Validation
- Loss Analysis
- Load Model&Forecast
- Fault Location – uses Smart Relays and Fault Indicators
A means of developing optimal switching plans for the distribution network to achieve the desired outcome

Can be used to reduce demand through intelligent load shed – a component of Demand Management

Can be used to address reliability issues on network by relocating as many customers as possible from inherently unreliable line sections

Primarily works by shifting open points on feeders

Run in real-time in response to overload events and as a study mode operation

Can be used to generate return-to-normal plans after network has been large disturbances
Network Optimizer - Fault Isolation and Service Restoration (FISR)

► Analyze faults based upon input from real-time SCADA (Fault Detectors and Fault Currents) and crew reports.

► Generate recommended switching for isolation of a nominated fault and restoration of unaffected customers.

► Isolate the fault based upon current state of distribution network.

► Propose multiple restoration plans based upon network status, topology, equipment limits and desired objectives.

► Alabama Power expects FISR could speed up restoration activity by up to 25% when entire feeders have to be analyzed.

► Configure switches to serve the load with:
  ♦ minimal switching operations
  ♦ maximization of margins and/or reliability
  ♦ minimization of losses and/or voltage drop

► Study mode simulates contingencies and summarizes non-restorable switchable line sections.
Automation of voltage and Var control can achieve the following objectives and cost justifications:

- Reduce losses by minimizing the transport of reactive power
- Maximize existing distribution capacity and defer capital outlay
- Reduce distribution transformer excitation losses
- Actively manage voltage dependent loads to:
  - Shave peak system loads
  - Implement energy conservation – a component of Demand Management
  - Improve economics during light load periods
- Enhance transmission grid reliability:
  - Minimize reactive power impacts from the distribution network
  - Provide reactive power support when needed for voltage stability
  - Reduce demand during peak load conditions
- Better maintain distribution circuit voltage profiles to meet customer quality limits
Smart Grid Energy Conservation Mode of Demand Management with VVC (Substation KW by hour)

VVO - Minimize Demand

Time (Hours)

Original
VVO
Local
Advanced Function Demonstrations

- Power Flow
- Fault Location
- Fault Isolation and Service Restoration (FISR)
- Volt/Var Control
Distribution Network Management of the Future

- Further demand for distribution network situational awareness and improved performance indices
  - Visualization of automation!
  - More severe penalties for reliability transgressions
  - More physical network reconfiguration capability
  - Dynamic model always showing current state of network

- Progression towards AMI becoming the primary tool for observation and a key component of supervisory control of the distribution network including the consumer premises -> real-time state observation and demand response enabler
Distribution Network Management of the Future

- Complementary interaction with, and supervisory control of, field deployed automation (automated feeder/substation reconfiguration schemes like IntelliTeam)
  - closed loop reconfiguration – this is a key part of the “self-healing” bit in SmartGrid
  - implies providing broader, and dynamic, network connectivity knowledge to fast field deployed automation schemes

- Further requirements for automated loss minimization, reliability, and demand management means increased control at the distribution level
Distribution Network Management of the Future

- Utility interface to Distributed Generation (monitor and control)
- Precise fault location determination to speed dispatch/repair
- Predictive and pro-active reconfiguration plans
- Analytical predictions of network tampering/power theft
Outage Management System

- Unplanned / Planned Outage Management – tracking and coordination of outages, recording of statistics.

- Trouble Call Management (Customer Calls, Automated Meter observations, SCADA information), Prediction of interruption device.

- Crew Monitor / Assign
Faults on Distribution Network
## OMS “Geobular” Incident Summary

### Outage Summary

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<tr>
<th>Feeder</th>
<th>Outage Time</th>
<th>#Cnf</th>
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### Customer list (select an incident to see the affected customer)

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Distribution Reliability Summary

SAIFI

SAIDI

MAIFIe

Distribution Reliability Goals

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Distribution Operations Training Simulator

- Overview

- Demonstration of Storm Scenarios and Outage Management Functionality
Overview

- Provide a controlled environment for training operators prior to the real-world events
- Train new employees in existing procedures
- Develop and test new operational procedures
- Identical User Interface and Applications as on-line environment
- Create and store event scenarios from individual faults to entire storm systems
Network Analysis
- Power Flow
- Load Allocation

Network Optimizer
- Fault Isolation and Service Restoration

Network View
- Control Room Operations User Interface
- Network Operations Model
- Network Switching Operations

Asset Model
- Static model CIM exports
- Sub-trans & distribution
- 150,000 buses
- 400,000 customers

Distribution SCADA

Distribution Simulator
- Network Operations Model, Event simulation, Call/AMI simulation, Crew simulation

DOTS Functional Architecture
Pre-Fault View of Overhead Circuits
Multiple Fault Scenario Created in the Simulator Instance
# OMS “Geobular” Thematic Map and Tabular Incident Summary

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<td>280003617</td>
<td>MARS</td>
<td>10/6 9:17:33 AM</td>
<td>10/6 11:30:00 AM</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>280005805</td>
<td>MARS</td>
<td>10/6 9:18:03 AM</td>
<td>10/6 11:30:00 AM</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>280010443</td>
<td>ROYAL TROON 11218863</td>
<td>10/6 9:18:34 AM</td>
<td>10/6 11:30:00 AM</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>280006090</td>
<td>VAIL</td>
<td>10/6 9:18:34 AM</td>
<td>10/6 11:30:00 AM</td>
<td>24</td>
<td>17</td>
</tr>
</tbody>
</table>

## Customer List

<table>
<thead>
<tr>
<th>CRT</th>
<th>Name</th>
<th>Phone #</th>
<th>Address</th>
</tr>
</thead>
</table>

### Map Section

- **OMS**: OMS Geobular Thematic Map and Tabular Incident Summary
- **Legend**: Various colored areas and lines indicating outages and areas affected by incidents.
- **Feeder**: ROYAL TROON, WINGED FOOT, BETHPAGE, MARS, SATURN, VAIL, MARS, PARK HILL, and PARK HILL.
- **Symbols**: Different symbols representing different types of incidents.

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**Note**: The map and table data are placeholders and are not real data. The layout and design are for demonstration purposes only.
Crews Dispatched and Faults Located
Repairs Made and Circuits Re-energized
Demonstration of Storm Scenarios and Outage Management Functionality
Functional Integration of Systems

- IDMS (SCADA, DMS, OMS)
- EMS
- AMI
- Work Force Management
- Locally Controlled Field Automation
Planned Work Management
- Maintenance Planning
- New Construction
- Return to Normal
- Seasonal Reconfigure

Customer Notification

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

Switching Operations

Outage Mgmt

CIM Adaptor

Crew Monitor & Assign

Resource Management
- Mobile Data System
- Crew Callout
- Crew Optimization

AMR/AMI
(Customer Energization and Consumption)

CIS
(Customer Data and Electrical Address)

Call Center
(Call Handling Front End)

IVR

Integrated Distribution Management System

e-terrabrowser

e-terra distribution

Asset Data (GIS etc.)

CIM Adaptor

CIM Adaptor

CIM Adaptor
e-terra distribution – integration with the EMS

- Integrates seamlessly with, and leverages, the AREVA NMS products (e-terra scada, e-terra platform)

- Uses e-terra browser (WebFG) viewer to provide consistency between applications in the e-terra product range

- EMS State Estimator results are incorporated into the real-time distribution network analysis function, in particular to provide phase angle separation analysis for switching plans.

- Fully integrated system (IDMS + EMS)
  - Increased operational awareness across the boundaries of the transmission and distribution electrical networks improves switching safety as well as efficiency and effectiveness of activities (manual switching status changes and tagging are entered just once and used globally across the system)
  - Consolidation means reduction in network management system maintenance work (modeling, hardware, OS patching, user & permissions administration…)
  - Consolidation means reduction in manual error-prone data synchronization activities by online users
IDMS Interfaces to AMI -
Added Value Smart Grid Functionality

- Outage Management with AMI
- Network Analysis with AMI
- Demand Management with AMI
- Meter Management with IDMS
Smart Grid Benefits of AMI Integration for Outage Management

- Unsolicited Automated Energization Messages from Smart Meters (reduce SAIDI and CAIDI)
  - Power Off messages – Last Gasp
  - Power On messages
  - Know the extent of an outage before customers call

- Verification and Tracking of Restoration Activity (reduce SAIDI and CAIDI)
  - Selective interrogation of Smart Meters to know extent of outages
  - Selective interrogation of Smart Meters to verify completeness of restoration activity

- Avoid crew deployment for false internal premise issues (reduce OpEx)

- Opportunity to detect customer connection model errors
Smart Meter Responses to Feeder-wide Ping
AMI Visualization in OMS to Improve Restoration and Performance Indices
Smart Grid Benefits of AMI Integration for Distribution Network Analysis

- Improved detail and timeliness of customer load profiles
  - Automated and regular adaptation of stored load profiles based upon AMI interval readings rather than single monthly billing data values

- Real-time and short-term planning operations
  - Recent premise load information will enhance the accuracy of distributing SCADA monitored circuit flow measurements in the real-time distribution power flow
  - As the ability to retrieve data from AMI eventually approaches real-time, it will provide the opportunity to include load measurements directly into the real-time distribution load flow. The load measurements may represent the consolidation of multiple customers
  - As the ability to retrieve data from AMI eventually approaches real-time, it will provide the opportunity to validate and improve modeling of load-voltage response and cold load pickup characteristics

- Longer term planning
  - Continuously adapted load models based upon AMI readings will provide an enhanced basis for planning longer term switching activities
Demand Management Levels of Control

- Individual customer control through AMI
  - Entire customer load disconnect/reconnect
  - Selective load management within the customer premise
  - Smart Meter interaction with home area networks

- Manipulate feeder voltage profile to impact voltage sensitive loads through SCADA
  - Feeder and substation capacitors
  - Transformer and regulator taps

- Conventional load shedding of entire feeders or primary substations through SCADA
Network View presents geographic and tabular visualization of AMI status

Data model populated from GIS and other enterprise systems via IEC CIM based interfaces

- Meter/customer model exists independent from any electrical distribution equipment model, but is linked through “connection points” to maximize metering asset use

Situational awareness of AMI exceptions and alarms

AMI maintenance crew assignments, locations, and annotations
Work Force Management

- View current Crew locations in the network operations view via AVL
- Assign Crews to incidents and coordinate with WFM system
- Receive updated ETRs and other status information from WFM and make available to customers
- Receive and annotate follow-up work requests from WFM
Functional Integration with Locally Controlled Field Automation

- An IDMS will provide Visualization of automation!
- Complementary interaction with, and supervisory control of, field deployed automation (automated feeder/substation reconfiguration schemes like IntelliTeam)
  - closed loop reconfiguration – this is a key part of the “self-healing” aspect of SmartGrid
  - implies providing broader, and dynamic, network connectivity knowledge to fast field deployed automation schemes
Distribution Model Management
Customers 4.52M
Generation Capacity 19.05GW
Maximum Demand 22.4GW
Transmission lines 64,000 miles

Distribution Zone Substations 550
Distribution Feeders 3,850
Circuit Segments 1,500,000
Distribution Transformers 1,000,000
Distribution Loads 4,000,000
Managed Feeder Capacitors >6,000

User Interface Positions 500
Current Analogs/Points >150K of 400K

The DMS system is deployed and operational throughout FPL.
Control centers have been consolidated. Operator training is ongoing for network optimization functions (FISR & VVC).
The Distribution Network Model Problems

- Extremely large models compared to the typical transmission system – 25 million objects in the FPL case.

- Visualization of the Network Data Model – it is not reasonable to build/maintain displays specifically for DMS – leverage the GIS

- The model changes everyday – updates must be supported which do not impact users, no restarts or failovers

- There are several data sources from which the online network model database is created
GIS and Network View
Classic SCADA System Data
(e-terra scada data models created with e-terramodeler, “FG Modeling displays”, Graphical Modeler, customer developed tools, or e-terrasource)

- Substation Editor
  (Model exported as CIM Data Files)
- Asset Management Database (GIS)
  (Model exported as CIM Data Files)

- CIM Data
  (Substation Internals Model in XML Format, One File per Station)
- CIM Data
  (Distribution Network Model in XML file format, One file per Station)

- CONVERTER
  (Converts data Files to Network Operations Model)
- Binary
  Station MOD File
- Station.xml
- Station_internals.xml
- Global data
- DMS_Defaults data

- Review with Study Environment

- Network Operations Model
  (Data structure optimized for functionality and performance)

- Station.mod

Model Management Environment for e-terradistribution 2.5x
(and until e-terrasource supports station.mod files)
CIM Data in XML format
Model Management Process

![Diagram showing the Model Management Process]

- **Field Crews** -> **DOC** -> **DMC GIS**
  - Object change
  - Connectivity Change
  - Multi-station unit of work

- **Change Triggered Extracts (90sec)**
- **Validation**
  - Simple Attribute changes:
    - RNMS Model
    - Operational Review using Study mode of NMS

- **Station Equipment Files**
  - 30sec
  - Corrections

- **Failed**