DMS - "Breakthrough" Technology for the Smart Grid

The emerging smart grid is expected to address many of the current challenges in the electrical power industry. It is expected to make the electric grid more reliable, more resistant to attacks, and self healing, while at the same time reducing peak demand for electricity, optimizing networks, and facilitating greater participation from end-customers in electricity production and consumption. Taking advantage of the advancements in information technology and data communication capabilities, several utility automation vendors have developed new distribution SCADA and distribution management systems (DMS) to operate in the open distributed architecture environment of the future smart grid. This article discusses how the new DMS platforms fit into the distribution automation landscape.

What is Distribution Automation (DA)?

Distribution Automation entails real-time remote monitoring and control of distribution system assets. It also provides decision support tools and, in some cases, automated decision making to improve system performance. DA covers automation at the substation, feeder, and customer level. Key components of a typical DA system include distributed field sensors; remote controlled switches such as feeder switches, reclosers, or capacitor switches; the SCADA system; a communication system for remote data acquisition; and a suite of advanced DMS applications as decision support systems.

What is Distribution Management Systems (DMS)?

Over the years, utilities have deployed a greater number of sophisticated applications. Key utility automation vendors have responded to this trend by developing a suite of commonly used DA applications that can be relatively easily deployed and configured to meet the utility's needs. These applications run on a dedicated SCADA server that has come to be known as distribution management systems (DMS).

What are Common DMS Applications?

Several primary, high-value applications have been proven to deliver strong benefits in improving the reliability as well as the quality of power delivered to end customers. While some of these directly impact the operations of the distribution network, other secondary applications have proven to be beneficial to long-term distribution planning and maintenance groups within the utility.

The following are **primary, high-value** distribution automation applications that can be implemented through a DMS suite.

1. Substation Automation: Monitoring and control of distribution substation equipment from a SCADA master forms the primary layer of DA. Modern protective relays provide exhaustive amounts of valuable data that can be acquired, stored, and used to monitor and control the electrical distribution network, while "non-operational" data can be collected and stored as historical data. Specialized DMS applications can then access these data extracts and convert them into actionable intelligence to improve distribution network performance.

2. Feeder Automation: Feeder automation forms an important part of DA. It can be implemented either as a self-contained local configuration by teaming a small number of switches/ reclosers or as a

centralized scheme controlled by a SCADA/DMS system. The local implementation is usually suitable for addressing problems within a small portion of the distribution system and involves distributed intelligence embedded within the switches. These self-contained switches communicate through peer-to-peer networks. The centralized schemes, implemented on SCADA/DMS platforms, are more elaborate and can control large portions of the distribution network, thereby delivering more advanced DA functionalities.

3. Feeder Peak Shaving: More utilities are discovering the immense benefits of demand management using volt/VAr technologies (voltage regulator control or capacitor switching). In many instances, this can delay construction of peaking units that would otherwise require a significant capital expenditure.

4. Power Quality Management: When it comes to power quality, the stakes are always high. With more of today's consumers using sensitive electronic equipment, there is greater demand for high quality power. Voltage sags, spikes, and poor harmonic control are some of the most pressing problems that require immediate attention. While SCADA systems are capable of acquiring vast amounts of senor data on distribution feeders, DMS applications can then be deployed to analyze the data and provide insight into the sources which can then be corrected.

With the primary infrastructure in place as described above, many **secondary** applications can be deployed with incremental costs, further enhancing the value of the SCADA/DMS infrastructure. The following are secondary applications, some of which are widely used: 1) distribution system load flow analysis, 2) reliability and contingency analysis, 3) Volt/ VAR control of distribution system, 4) relay protection coordination, 5) automated fault location and restoration, 6) load management under system emergencies, 7) fault diagnosis and analysis, 8) outage management coordination, 9) power quality analysis, and 10) dispatcher training simulation.

How do the New DMS Applications Compare to Historical DA Applications?

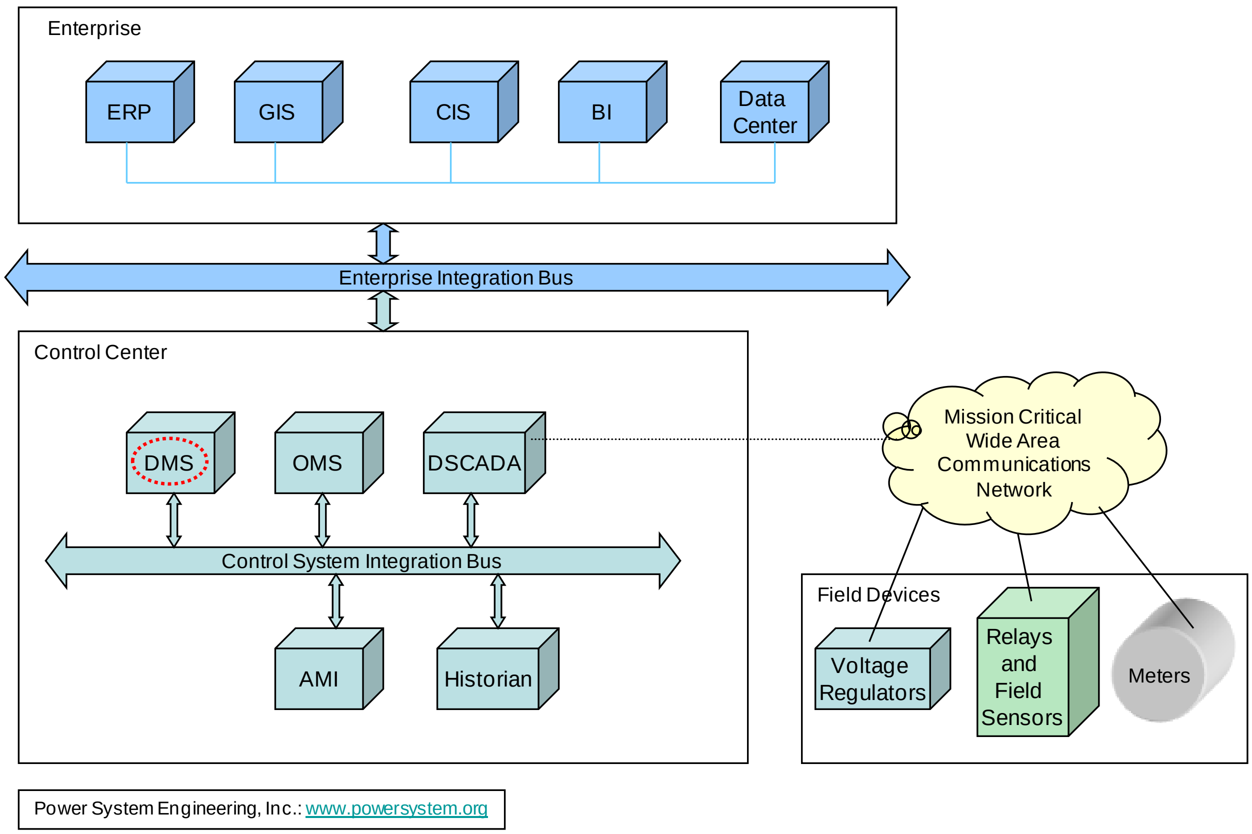
The table below illustrates functionality of various applications delivered over historical, present, and new DMS systems. Functionality is either available (Yes), not available (No), available on a limited basis (Limited), or only available as a custom feature (Custom). In the new DA landscape (the right-hand column), you will notice that *all* functionality becomes available.

Application	Historical DA	Present DA	DA for Smart Grid (DMS based)
Basic Monitoring and Control	Yes	Yes	Yes
Monitor Equipment on Feeder	Limited	Yes	Yes
Network Switching Management/ Analysis/ Optimization	No	Limited	Yes
Relay Protection Coordination	Custom	Custom	Yes
Integrated Volt VAR Control	Custom	Custom	Yes
Direct Customer Load Control	Yes	Yes	Yes
Interface with AMI/ OMS/ GIS Systems	No	Custom	Yes
Distribution System Real-time Analysis Tools	No	Limited	Yes
Multi-level Feeder Reconfiguration	Limited	Limited	Yes
Emergency System Restoration Support	Limited	Yes	Yes
Dispatcher Training and Simulation	No	Yes	Yes
Power Quality Assessments	No	Limited	Yes
Demand Response Analysis	No	No	Yes
Load Forecasting	Custom	Custom	Yes
Predictive Equipment Maintenance/ Asset Management	No	Limited	Yes
Source: Power System Engineering, Inc. www.powersystem.org			

In summary, the chart above reflects that the new DMS-based suites provide extensive functionality compared to some of the older DA product offerings. While the new DMS-based suites do come with a high software cost, the testing and integrations functionality is more advanced "out of the box." This is compared to custom approaches, which require the utility to provide the integration, testing, and ongoing maintenance of many of the existing DA product lines (which can significantly increase lifecycle costs).

How does DMS Fit into the Smart Grid Architecture?

The diagram below illustrates where DMS fits into the overall smart grid architecture.



The distribution SCADA system in the utility control center acquires and manages data in real time from several field devices and sensors on the distribution network. The real-time integration bus provides for data exchange between the components of SCADA, DMS, and other systems within a utility control center. Recognizing the importance of streamlined interoperability between disparate systems and technologies, the Gridwise Architectural Council has introduced comprehensive interoperability guidelines for utilities to follow as they start building their smart grids. These guidelines (summarized below) take into consideration various types of interoperability contexts and their associated security needs.

- **Organizational Interoperability:** Defines how the individual sub systems (such as CIS, ERP etc) will utilize a standards-based information exchange method with external systems such as business networks, market operators, links to external utilities, RTO's, and other regulatory compliance requirements.
- **Information Interoperability**: Defines requirements for mission-critical data and information exchange within a utility control center required to operate the electrical network.
- **Technical Interoperability**: Defines the integration of remote field devices with the distribution SCADA platform at the utility control center. Standards-based protocols such as DNP 3.0 and the

IEC 61850 provide adequate interoperability with recent enhancements to include advanced security features.

Key DMS Products and a Sampling of Vendors

The table below lists some of the leading DMS vendors and their software tools for integrating both analytical and control features. The technologies consist of the end equipment (capacitor control, recloser, voltage regulator), communication system, centralized SCADA system, and application software. A description of the platform and software features is also included.

Vendor, Product	Platform	Software Features
Areva, E-Terra Distribution SCADA www.areva-td.com	The base system for all the e-terra distribution solutions is Network View, a Web-deployed Environment.	Complete Suite of Distribution Management Solutions includes Monitoring, Visualization, Dispatching, Emergency Management, Network Analysis & Optimization, Training & Simulation tools.
OSI, Open DNA www.osii.com	Network application, integrated with OSI SCADA platform.	Complete Suite of Distribution Management Solutions includes Monitoring, Visualization, Dispatching, Emergency Management, Network Analysis & Optimization, Training & Simulation tools.
Televent, DMS www.telvent.com	Network application, integrated with OASyS SCADA.	Complete Suite of Distribution Management Solutions includes Monitoring, Visualization, Dispatching, Emergency Management, Network Analysis & Optimization, Training & Simulation tools.
ABB, Network Manager DMS www.abb.com	Network Application integrated with Network Manager SCADA	Complete Suite of Distribution Management Solutions includes Monitoring, Visualization, Dispatching, Emergency Management, Network Analysis & Optimization, Training & Simulation tools.
Siemens, Spectrum Power CC Distribution Management System www.energy.siemens.com	PC network platform, open interface with Microsoft or Oracle databases. Supports a variety of protocols.	Complete Suite of Distribution Management Solutions includes Monitoring, Visualization, Dispatching, Emergency Management, Network Analysis & Optimization, Training & Simulation tools.

DMS: Backbone and Last-mile Communication Requirements

DMS and traditional DA require an extensive backhaul communications network. DMS/DA systems involve linking devices outside substations located on feeders. Distribution poles can provide suitable methods for mounting radio antennas, with the goal of communicating from these sites to a central control center. Most extensive DA/DMS systems will route the "last-mile" media to the nearest backbone point of presence, which could be a substation, tower site, office location, etc. The last-mile infrastructure serves as the foundation that connects end equipment to an integrated communications system (a crucial step to successful DA deployment), and should thus be included in the overall DMS strategic plan.

For utilities that have implemented an AMI system with a two-way fixed communications network, this could possibly be shared for the DA/DMS applications. Care should be taken to leverage utility communications infrastructure for both present and future applications.

Electric distribution utilities experience communications challenges due to large geographic territories, the need for extremely reliable communications (especially at the most inopportune times such as during and after major storms/disasters), and idiosyncratic challenges based on local terrain and other factors such as frequency availability.

Many utilities are able to justify a dynamic communications infrastructure (and associated process improvements) because they are able to spread the communication capital expenditure across multiple applications. Similarly, utilities may be able to reduce overall recurring communications costs by combining multiple applications on the same communications medium.

Conclusions

Significant reliability improvements, efficiencies, and costs savings can be gained with a properly deployed DMS system. Designing a technology roadmap toward the future smart grid is the first step. Developing a business case for various applications would reveal the order of most beneficial applications, which could then guide the implementation schedule. For many utilities, the transition to the smart grid can be an exciting journey, involving selecting several smart technologies and pooling innovative ideas, resulting in a single integrated smart system. Once implemented, the benefits of the smart grid could far exceed our expectations.

Contact Information:

Jim Weikert at Power System Engineering, Inc. (PSE), an automation, integration, and communications professional services firm. You can contact Mr. Weikert for work on projects involving SCADA, substation automation, DA, DMS, and communication at weikertj@powersystem.org, or 608-268-3556; more information is available at: www.powersystem.org.