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Integrated SCADA/DMS/OMS: Increasing Distribution Operations Efficiency

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Many electric distribution organizations are presently evaluating their approach to integrating three key operational systems – SCADA (Supervisory Control and Data Acquisition), OMS (Outage Management System) and DMS (Distribution Management System). SCADA, which has long been prevalent throughout transmission systems, is finding increased applications on distribution systems.

Modern OMS, utilizing GIS-based connectivity models, is now well established and a key component of many organizations' outage management business processes. The implementation of DMS functionality is a relatively recent trend. While a DMS can include and improve the traditional outage management functions, a DMS also typically includes applications that assist in the improved operation of the electric distribution system, as well as functionality for improving planned work on the system.

This article first reviews SCADA, OMS, and DMS systems. Considering that both OMS and DMS require a connectivity model of the distribution system, the benefits of integrating OMS and DMS are presented. Next, the integration of SCADA with DMS/OMS is discussed, including the functionality of the integration and the resulting benefits. Finally, a proposed architecture for an integrated distribution operations center is presented.

SCADA

SCADA systems are globally accepted as a means of real-time monitoring and control of electric power systems, particularly generation and transmission systems. RTUs (Remote Terminal Units) are used to collect analog and status telemetry data from field devices, as well as communicate control commands to the field devices. Installed at a centralized location, such as the utility control center, are front-end data acquisition equipment, SCADA software, operator GUI (graphical user interface), engineering applications that act on the data, historian software, and other components.

Recent trends in SCADA include providing increased situational awareness through improved GUIs and presentation of data and information; intelligent alarm processing; the utilization of thin clients and web-based clients; improved integration with other engineering and business systems; and enhanced security features.

Outage Management Systems

Modern computer-based OMS, utilizing connectivity models and graphical user interfaces, has been in operation for some time now. OMS typically includes functions such as trouble-call handling, outage analysis and prediction, crew management, and reliability reporting. Connectivity maps of the distribution system assist operators with outage management, including partial restorations and detection of nested outages.

In recent years, OMS has become more automated. Outage prediction – the process of analyzing outage events such as trouble calls, AMI outage notifications, and SCADA-reported status changes – has improved. Interfaces to Interactive Voice Response systems (IVR) permit trouble call entry into an OMS without call-taker interaction and also permits the OMS to provide outage status information to customers and provide restoration verification call-backs to customers who request them.

OMS systems have also become more integrated with other operational systems such as Geographic Information Systems (GIS), Customer Information Systems (CIS), Work Management Systems (WMS), Mobile Workforce Management (MWM), SCADA, and AMI. Integration of OMS with these systems results in improved workflow efficiency and enhanced customer service.

Today's OMS is a mission-critical system. At some utilities, it can be utilized simultaneously by hundreds of users. It integrates information about customers, system status, and resources such as crews, providing a platform for operational decision support.



Figure 1 - Outage Management Systems Improve Reliability Through Enhanced Outage Analysis, Fault Location, and Crew Management

Distribution Management Systems

In comparison to OMS, DMS functionality is relatively new. While DMS applications are utilized in outage management processes, DMS also extends to the efficient management of planned work and normal electrical operations. DMS is also typically associated with receiving real-time status and analog points from the distribution system, and the generation of supervisory control commands to distribution breakers, switches and reclosers, switched capacitor banks, voltage regulators, and load tap changers (LTCs). The importance of DMS will increase as additional amounts of customer generation, energy storage, and demand response are placed on distribution systems.

DMS is receiving a lot of attention because it can provide solutions to many challenges distribution organizations face today. **Table 1** below contains a listing of DMS applications, functionality and benefits.

Integration of OMS and DMS

Integrated DMS/OMS provides a number of benefits to the distribution organization, as discussed below.

1. Integrated DMS/OMS Improves Operator Efficiency

An integrated DMS/OMS assists operators in performing their responsibilities better, compared to separate DMS and OMS systems. Displays have the same appearance and can provide a single intuitive interface for navigation. Additional displays for separate systems are not required in already-crowded operator workspaces. Operator training is minimized, since operators only need to learn the features of one GUI.

DMS Application	Functionality	Benefits
Unbalanced Load Flow Analysis	Determination of the line currents and node voltages per phase for the entire distribution system, either on-line or off-line in simulation mode	<ul style="list-style-type: none"> • Improved system awareness • Higher asset utilization • Improved contingency planning
Load Allocation & State Estimation	Intelligent allocation of telemetered or historical measurements over the network to calculate estimated power flows, voltages, and limit violations based on real-time conditions	<ul style="list-style-type: none"> • Improved load flow & state estimation calculations • Improved notification of overloaded equipment and voltage violations
Fault Location	Identification of possible fault locations on system	<ul style="list-style-type: none"> • Improved crew efficiencies in managing outages • Reduced CAIDI and SAIDI
Restoration Switching Analysis	Evaluation of isolation and restoration switching schemes	<ul style="list-style-type: none"> • Improved operator efficiencies during outages • Increased reliability
Distribution Volt/VAR Control	Monitoring and control of line capacitors, voltage regulators, and LTC's to reduce peak load and system losses	<ul style="list-style-type: none"> • Reduced customer demand at system peaks • Lower system losses • Improved voltage profiles
Line Unloading	Computation and analysis of load transfer options, including overload reduction	<ul style="list-style-type: none"> • Reduced thermal-mode failures • Longer equipment life due to reduced overloads • Higher asset utilization
Remote Switching & Restoration	Automatic feeder reconfiguration considering network operating conditions	<ul style="list-style-type: none"> • Reduced CAIDI and SAIDI • Lower system losses

Table 1 - DMS – Improving the Management of Distribution Systems

2. Integrated DMS Applications Improve the Outage Management Process

The integration of DMS applications in the OMS has proven to improve outage performance. For example, a fault location algorithm uses the as-operated electric network model, including the location of open switches, along with an electrical model of the distribution system with lengths and impedances of conductor segments, to estimate fault location. The DMS Fault Location functionality therefore uses the electrical DMS model, but ultimately improves the OMS process. The experience of Progress Energy Carolinas with the ABB Fault Location application shows a significant reduction in SAIDI over the 6 years since the application has been in operation.

Similarly, a Restoration Switching Analysis application evaluates the possible isolation and restoration switching actions that can be done upon occurrence of a permanent fault. The application executes an unbalanced load flow to determine overloaded lines and low-voltage violations for each switching action, and the operator is provided with a listing of recommended switching actions. Again, the functionality utilizes the DMS model of the system, but improves the Outage Management process and reduces CAIDI and SAIDI.

3. DMS/OMS Integration Improves Coordination of Planned and Unplanned Work

Distribution systems are dynamic in nature, with changes occurring on a daily basis due to both planned work and outage restoration. If a safe and efficient operation of the system is to be achieved, then it is critical to ensure that the current state of the network is continuously maintained and made available to those working on planned and unplanned work. This includes operators, dispatchers, persons responsible for switching requests and switching plans, field crews, engineering, and others who require an accurate representation of the system state.

Temporary network changes such as line cuts and jumpers, phase jumpers, switch operations, protective device operations, grounding tags, safety, warning, and information tags, and temporary generators should be represented. This is easiest if a single model is used for the DMS and OMS.

With DMS and OMS working with the same operational model of the distribution system, circuit analysis can be fully functional considering temporary changes. This includes circuit tracing, trouble call and outage analysis, safety interlocks, loop and parallel source detection, fault location and load flow. The result is a more comprehensive and accurate understanding of system conditions at any moment in time.

4. DMS/OMS Integration Reduces Data Maintenance Efforts

Many distribution organizations maintain and make planned updates to the network model in their Geographic Information System (GIS). Since DMS and OMS both require a connectivity model of the distribution system, data maintenance processes are simplified if the DMS and OMS are operating from the same model. The result is one set of processes for managing the network model, and one process for the incremental update to the DMS/OMS model instead of two.

Integration of SCADA and DMS/OMS

Integration of DMS/OMS with SCADA is an increasing trend. While the inclusion of SCADA “breaker-open” operations in OMS have long been used for outage detection, recent business challenges have driven a more comprehensive integration between the two systems. Available functionality now includes the transfer of status/analog points from SCADA to the DMS/OMS; the sending of supervisory control and manual override commands from the DMS/OMS to the SCADA; an integrated user interface running on the same operator console, and integrated single sign-on for users.

The benefits of integrating SCADA with DMS/OMS include:

- Improved operations by close integration of DMS applications with distribution SCADA
- Increased operator efficiency with one system, eliminating the need to go to multiple systems with potentially different data
- Integrated security analysis for substation and circuit operations to check for tags in one area affecting operations in the other
- Streamlined login and authority management within one system
- One network model for OMS and DMS analysis
- Consolidated system support for DMS/OMS and Distribution SCADA
- Simplified data engineering via coordination of SCADA point and GIS data changes

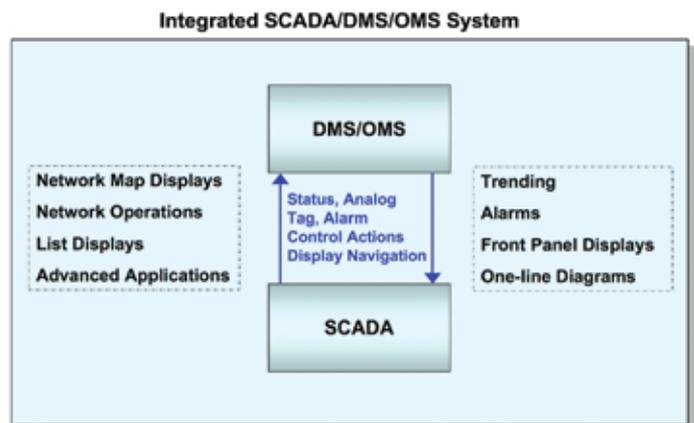


Figure 2 - DMS – Integrated SCADA/DMS/OMS Architecture

Integration of SCADA and DMS/OMS can be between systems of the same vendor, or between different vendors, using a protocol such as ICCP (Inter-Control Center Communications Protocol). Using systems from the same vendor typically results in increased functionality and can reduce the need for data engineering in the systems.

Integrated Distribution Operations Center

Figure 3 depicts the architecture for a fully integrated distribution operations center. The integrated DMS/OMS system model is initially created using a one-time data load from the GIS. Periodic updates to the DMS/OMS model is then performed using an incremental update process from the GIS. Since the DMS and OMS use the same network model, it is only necessary to have a single update process.

As shown in **Figure 3**, the DMS applications and OMS applications utilize a common network model. The OMS applications are used primarily in outage response. The DMS applications typically relate to the electrical operation of the network and utilize electrical data from the integrated DMS/OMS model, such as line and cable impedances, equipment ratings, and customer load characteristics. The DMS/OMS can utilize data from other distribution IT systems that collect system data from field devices. This includes SCADA, as discussed above. SCADA continues to expand past the distribution substation and onto the feeders, providing improved situational awareness and control.

The increasing presence of AMI has many organizations asking how the AMI data can be utilized for operational purposes. Interfaces between AMI/MDM (Advanced Metering Infrastructure/Meter Data Management) and the OMS have been provided for metering pingging, outage notifications, and restoration notifications. The use of other AMI data in DMS applications, such as interval demand data and voltage violations, is being explored.

In addition, many organizations are increasing the amount of substation automation and substation computers on their systems. This provides increased access to the data in intelligent electronic devices (IEDs) that are being installed in substations and distribution system, many of which have communications capabilities. These include “more intelligent” recloser controls, switch controls, and voltage regulator controls.

The architecture of how data is transmitted between field devices and the integrated operations center will vary among distribution organizations, and there may be several approaches with a company itself. Whatever the approach, the data can assist in increasing operational awareness on the system.

Summary

Distribution organizations are increasingly turning to integrated distribution operations centers, including integrated SCADA/DMS/ OMS systems and associated decision support tools, to improve their operational processes. An integrated DMS/OMS solution eliminates redundant processes for maintaining the network model and also improves operational efficiencies. Integration of SCADA and the DMS/OMS permits advanced DMS applications to access data from SCADA, analyze the real-time DMS/OMS network model, and provide increased operator efficiencies. Integration with other systems, such as AMI and substation automation systems, provide additional means to leverage the available data throughout an organization. ■

About the Authors

Tim Taylor is the Business Development Manager - DMS for ABB Network Management. Tim has been with ABB for almost 14 years in a number of engineering, consulting, and business development roles. Tim has performed distribution planning studies for companies around the world and has developed and taught courses on distribution planning and engineering. Tim is a Senior Member of IEEE and holds an MS in Electrical Engineering from NC State University and an MBA from UNC-Chapel Hill.

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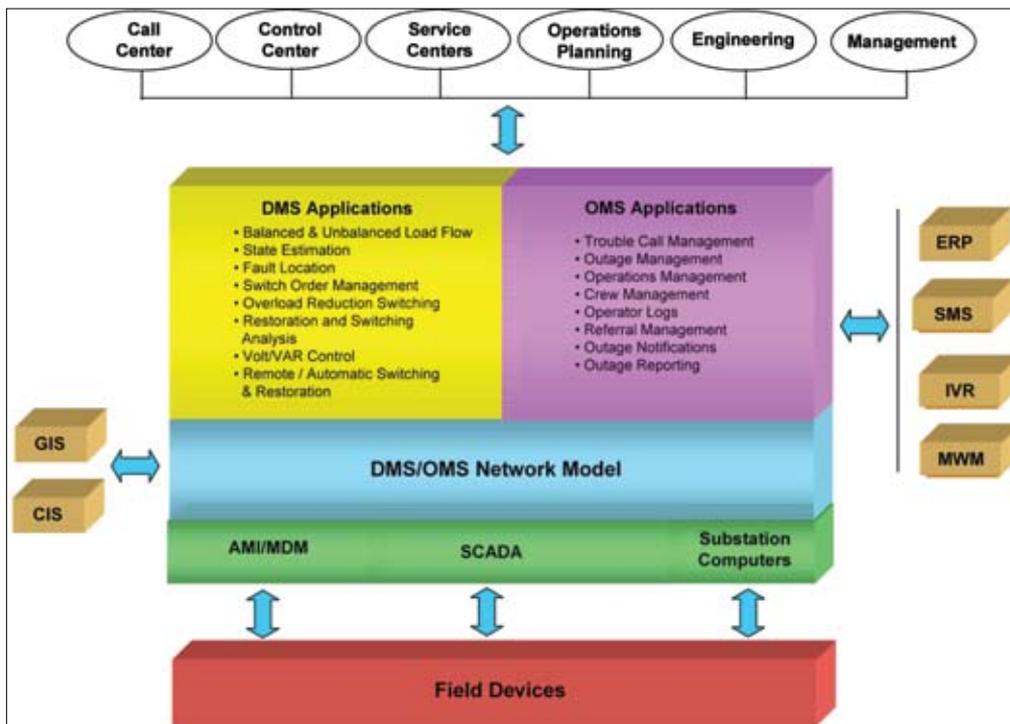


Figure 3 - Architecture for a Fully Integrated Distribution Operations Center