Enhancing Utility Outage Management System (OMS) Performance

by John Dirkman, P.E.

Executive summary

Traditional grid outage management systems suffer from two fundamental flaws: they lack an accurate, current representation of the grid network model and they typically don't integrate with the systems that monitor and control the actual grid. These shortcomings result in longer outages, higher costs, and in lower levels of customer service. This white paper outlines the evolution of utility outage management and describes how new Advanced Distribution Management System (ADMS) tools address these two gaps.

998-2095-08-01-14BR0

Introduction

An Outage Management System (OMS) is a tool that utilities deploy to manage the grid and restore power during service interruptions. The tool is designed to reduce the economic impact of power outages. Estimates now put the annual cost of outages between $10-75 Billion in the United States alone (see **Figure 1**)[1]. An OMS can significantly cut the cost of an interruption for the utility and its rate payers, improve the quality of service for consumers, and enhance safety for everyone who uses or operates the grid.

The OMS analyzes the location and extent of an outage and has outage prediction capabilities enabled by a detailed representation of the distribution network. This helps dispatchers and crews determine trouble locations.

But maintaining an accurate, up-to-date model of the operational grid is not simple. Distribution systems that appear to be unchanging to the casual observer are often quite dynamic, undergoing daily changes due to operational configuration, growth and network additions, and routine switching for maintenance. Integrating real-time tools, such as a Supervisory Control and Data Acquisition (SCADA) system or a Distribution Management System (DMS) is challenge. This is because a utility's command-and-control backbone system is usually isolated and operates within closed-loop networks to ensure performance and security.

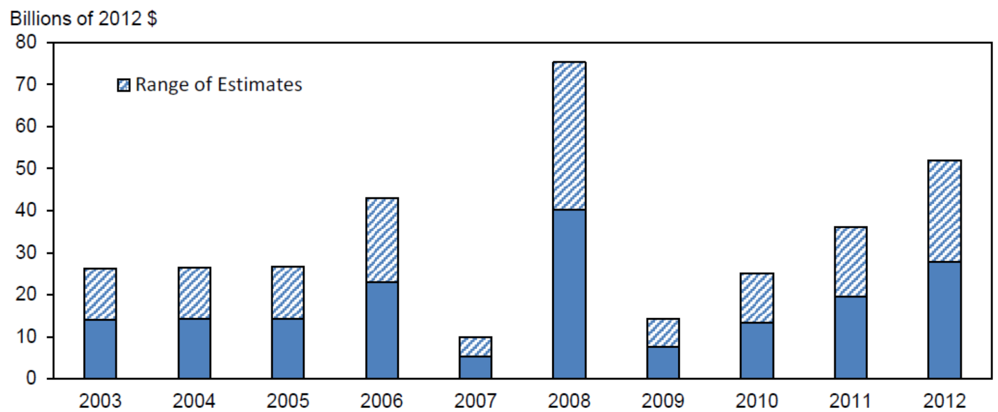

Figure 1
Estimated annual cost range of weather-related power outages (Courtesy of the US Dept of Energy)

The functionality and effectiveness of an OMS varies from one implementation to the next. These systems range from home-grown architectures to complete off-the-shelf packages. Functions can vary from basic prediction services to sophisticated restoration time estimation, crew management, and reporting. The OMS at most utilities has most likely grown and evolved over time. The most advanced systems have been credited with reductions in outage time of up to 25% percent or more, with corresponding cost savings.

However, nearly every OMS suffers from two significant shortcomings:

- Lack of an accurate, up-to-the-second model of the distribution system.
- Lack of integration with the systems that monitor and control the actual grid.

These gaps leave system operators with a fragmented view of the situation, leading to human error, unnecessary complexity, and sub-optimal workflows.

[1] President's Council of Economic Advisers, U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, White House Office of Science and Technology, "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages", August 2013

Newer systems called Advanced Distribution Management Systems (ADMS) address these gaps. By combining OMS, DMS, and SCADA systems, the ADMS harmonizes data and function (see **Figure 2**). ADMS delivers a single environment and user experience. This enables the streamlining of decision making and enhances emergency response performance. It resolves the critical barrier issues of real-time integration and enables the creation of high-performance network models. By providing a unified environment for control and dispatch, ADMS also allows for a more comprehensive view of the distribution system during an outage. This white paper describes the evolution of utility outage management and explains how ADMS tools are enabling a more advanced smart grid.

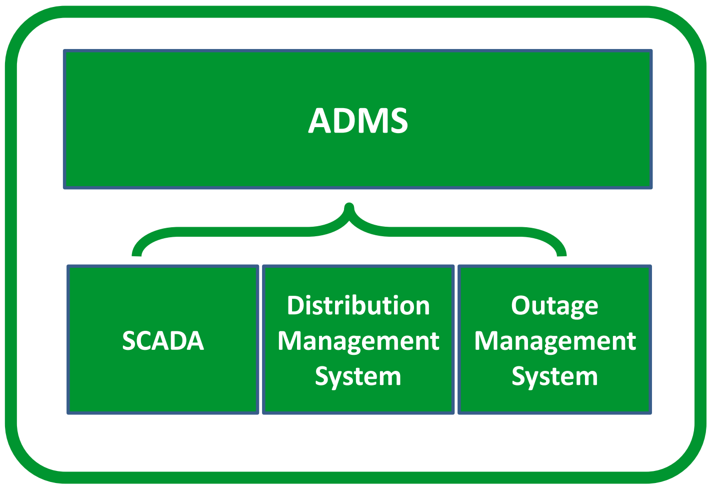

Figure 2
Insight from disparate utility power distribution systems can be consolidated under one view for more accurate network control

Evolution of the OMS

An OMS was originally put into place to enable a utility to identify and predict potential grid outages. Prediction engines within the system used a variety of algorithms to analyze the pattern of calls from out-of-power consumers to derive the extent of the outage. The goal of the system was to identify, isolate, and then fix the fault for a particular incident.

Over time, the heuristics or experience-based techniques that a dispatcher would use to narrow down a fault within the network and to determine the best location to send a crew during an outage were codified. The intelligence and behavior of dispatchers that enabled diagnosis of the network during outages was automated. Some of the prediction algorithms evolved to a high level of accuracy when determining the extent of outages but only if the appropriate number of no-power calls was received from consumers.

As the grid became smarter, more and more interconnected devices became capable of sending intelligence about the status of the system to a control room, making consumer outage calls less vital. Advanced Metering Infrastructure (AMI) offered the potential for individual smart meters to notify the grid of a local power loss, as well as to measure end-point power quality. Line devices, such as reclosers and switches, voltage regulators, and capacitor controls, all added to the perspective of enhanced grid performance and more accurate OMS prediction.

AMI communication networks are not designed to be as reliable as a dedicated SCADA network, however. AMI event messages can be delayed, duplicated, or dropped. The power quality data that is available, however, can provide important clues in both predictive and post-incident analysis. Ultimately, even if AMI events were more reliable, some analysis had to be performed to identify likely upstream incident devices.

Mature OMS tools now go far beyond predicting outage location and extent. Utilities that cover large geographic areas impacted by severe weather manage large numbers of crews. Under such scenarios, optimal logistics and resource management can make all the difference in handling a large-scale outage. Since switching is often required in the service restoration process, many modern OMS solutions include switch scheduling and switch management functions, including tagging. History and post-incident analysis tools, including regulatory and non-regulatory reporting, play a key role. Dispatcher training, simulation, and playback of major outages also add to the business value of the OMS.

Challenge #1: Network Model Changes

The foundational concept of every OMS is its ability to understand the relationship between customers and the network, in order to analyze the location and extent of an outage. Outage prediction capabilities are enabled by a detailed representation of the distribution network. A model that represents the network's current topology and connection to the end consumer is essential to determine the location of the problem.

Distribution systems undergo daily changes due to operational configuration, growth, and network additions, as well as routine switching for maintenance. Adding to this complexity, changes to the network can originate from many different sources including control center operations, design and construction crews, or service / trouble personnel. Managing network changes from such a wide variety of sources in a timely and accurate way is a key challenge for every OMS implementation.

At the operational level, an obsolete network model presents many problems. The potential for misdiagnosing an outage is the obvious high risk. Faulty outage prediction can lead to crews being dispatched to the wrong location, a waste of time and resources when they are the most needed. In addition, when utility personnel begin to have doubts about the accuracy of the network model, they can become reluctant to rely on the OMS and may discount or even ignore the information it provides.

An OMS requires network data that is complete, correct, and current. To learn more about how a utility can best prepare and maintain an accurate and up-to-date network model, see Schneider Electric white paper "*Best Practices for Creating your Smart Grid Network Model*".

Challenge #2: Integration of disparate tools

The second critical challenge for OMS, integration with real-time tools such SCADA and DMS, is also a cause for concern for utilities. The command-and-control backbone systems at a utility are often isolated, operating within closed-loop networks to ensure performance and security. These SCADA and DMS systems are regarded as mission-critical, and, in most cases, are not under the purview of corporate IT. Instead, they are usually managed by the business unit responsible for operations. As a result, standards and integration architecture are often not emphasized, since the intention of the owners of these real-time systems is to have them stand alone, isolated from everything else.

This lack of integration poses a number of issues during an outage. The ability to obtain a complete picture of the system, from substation to end customer, is lost when multiple views and user interfaces are required. Many utilities have designed workflows to compensate for the back-and-forth. This human-intensive process moves knowledge from the SCADA/DMS to the OMS and back again. The fractured workflow can lead to delays in dispatching, or worse, mistakes and sub-optimal decisions during outages.

Unique ADMS capabilities

Electrical distribution management systems aren't new. Utilities have used computers to model their networks for four decades, employing load flow algorithms to calculate voltages and power flows at nodes throughout the grid. Over the past 25 years, SCADA systems have been deployed to monitor and control the grid at key locations, such as substations, in real time. More recently, Distribution Management Systems (DMS) have combined load flow analysis data with real-time data points to enhance the picture of the grid.

These first-generation DMS solutions, unfortunately, don't meet the requirements of a smarter grid. With thousands or even millions of data points in the network, and with the need to integrate a variety of distributed energy resources (DERs), the scope and scale of information required to properly manage a smart grid makes it difficult for a traditional DMS to digest and analyze the high volumes of data. In addition, the requirements to automate switching and bring OMS functions into a coherent user experience make it difficult for traditional DMS technology to add value.

In the world of operational grid control, the new ADMS tools offer the following unique capabilities:

"A single, high-performing network model for SCADA, DMS, and OMS improves accuracy and performance, and eliminates the need for data synchronization among disparate models."

- **Convergence of SCADA, DMS, and OMS functionality** - In addition to real-time network analysis, the ADMS allows the user to operate all SCADA monitoring and control functions. In addition, access is provided to OMS functions for managing outages and dispatching crews. The integrated flow of information is presented in a single, straight-forward user experience, simplifying analysis and operations.
- **Increased scale of data management and analysis -** To manage the smarter grid, ADMS must account for hundreds of thousands, or even millions of real-time data points. The ADMS accounts for a variety of new devices and end point types and adapts as new kinds of distribution and customer devices come online.
- **Increased scope of feature function** - Closed loop control allows for the ability to analyze, execute commands, and then re-analyze the network to automatically manage the impact of changes. These tools also optimize volts / VARs to increase efficiency and reduce peak load, enabling distributed generation, energy storage, microgrids, and other forms of distributed energy resources. The tools also provide support for demand response analysis and execution, and automate the distribution switching process.

Impact on the industry

An ADMS platform provides a new future for grid and outage management by providing a single environment and user experience for SCADA, DMS and OMS. This key construct resolves the critical barrier issues of real-time integration and high-performance network models. By providing a unified environment for control and dispatch, ADMS allows for a more comprehensive view of the distribution system during an outage. Placing the tools for outage analysis and crew dispatch alongside those for control, load flow, and grid optimization enables a workflow that is more responsive and less error-prone.

ADMS also eliminates the network modeling problem, enabling OMS functionality against the memory-resident, real-time model of SCADA / DMS. A single, high-performing network model for SCADA, DMS, and OMS improves accuracy and performance, and eliminates the need for data synchronization among disparate models. The concept, also known as 'The Single Version of the Truth,' is a huge step forward in both OMS performance and enterprise data integrity.

ADMS provides the user access to a robust variety of network analytics to assist in outage management and service restoration. Decision support functions, such as fault location, can reduce patrol time — limiting unnecessary truck travel and shortening outage times. Large area load restoration functions can provide dispatchers with simplified scenarios for bringing back online large sections of the network in the event of a wide-spread grid failure. Switch management functionality along with a fast load flow solution lets operators quickly analyze pre-defined switching scenarios in the context of current conditions. This avoids overloads and repeated re-energizing of lines that shorten the lifecycle of cables and oil-filled equipment.

Operations control center employees are under pressure to make decisions quickly. Too much information undermines workflow as much as not enough information. ADMS presents data and function in a simple yet thorough way which allows operators to perform advanced outage management.

ADMS is a key enabler for implementing Smart Grid strategies. For more information on how ADMS capabilities can transform distributed generation into an efficient asset see the Schneider Electric white paper "*Preparing for Distributed Energy Resources*".

Conclusion

A smarter grid will require robust tools to manage both normal operations and emergencies. Outage costs are too high and both business and home consumers demand a higher level of grid uptime. Traditional OMS that is poorly integrated with the real-time environment and based on a less-than-current network model will struggle to fulfill the need. By providing a single environment and user experience for SCADA, DMS, and OMS, ADMS tools and applications can enhance outage performance with better decision support and workflow. This elevates the development of the grid and simplifies the work of people who are tasked with grid operation.

Utilities and concerned stakeholders who wish to initiate a migration to an ADMS approach should consider the following short and long term steps:

Within the next few weeks: Begin to plan a migration roadmap. Assess what steps need to be taken in order to evaluate current outage management weaknesses. Conduct an assessment of requirements.

Within the next 6 months: Determine how much work needs to be done to implement a cutover to ADMS, what the cost savings will be, and what the impact will be on both operators and customers. Consider how existing systems can complement the new network control engine.

Within the next year: Enlist a trusted partner with expertise in both grid management systems and operational efficiency to help maximize modernization benefits via ADMS.

About the author

John Dirkman, P.E., is a Senior Product Manager, Smart Grid Global, with Schneider Electric. He provides product and program management for advanced integrated Smart Grid systems, from concept through sales, design, development, implementation, and maintenance. John has served as product and program manager for a wide variety of Smart Grid implementations and currently is responsible for driving technical Smart Grid vision and strategy. He is an active member of the Institute of Electrical & Electronics Engineers (IEEE) and the IEEE Power & Energy Society.