Leveraging AMI for Outage Management

Executive summary

Only 8–12% of customers report a power outage to their utility. Utilities that integrate Automated Metering Systems (AMI) data into outage management systems receive faster and more accurate reports about power outages, can better predict the extent of the outage, and more reliably verify service restoration. This paper discusses practical considerations when integrating AMI for outage management, including compliance testing, data quantity and quality, analysis issues, and best practices learned from experience.
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Executive summary

The Smart Grid uses network data — from real-time to historical — to improve operational and business processes across the utility. The Advanced Metering Infrastructure (AMI) that is integrated with the Outage Management System (OMS) can provide valuable data that enables much faster and more reliable reporting of power outage events than from customers calls.

Further, the robust OMS can leverage AMI data to predict the extent of the outage, and identify downstream nested outages, as well as verify restoration and save costs associated with field crews and truck rolls.

To achieve simplified deployment, maintenance, and upgrades, compliance with interoperability standards is necessary. Performance testing will demonstrate whether the AMI communication system meets expected data management performance and if the OMS can consistently process the high throughput of data associated with large-scale outages. The OMS needs an accurate network model and enhanced analysis capabilities to determine missing or delayed data, predict outage extent and discern partial power and power quality events.

Utilities targeting such an interactive and powerful AMI/OMS integrated solution must consider a system that can accommodate AMI upgrades and component updates and replacement. They will want to consider a staged implementation and vendor experience, both of which contribute to successful deployment of the AMI/OMS solution.

The interoperable OMS can put AMI data to work, to visualize, analyze, validate and report. The utility realizes faster, more accurate incident location, faster job completion, and improved customer service and satisfaction — and maximized return on its AMI investment.
Introduction

As utilities deploy Automated Metering Infrastructure (AMI) systems, they are looking to extend the value of their investment through integration with other Smart Grid information systems. This approach delivers business benefits throughout the enterprise, including the mission-essential activity of network operations. One such integration that is gaining popularity is linking AMI with Outage Management Systems (OMS), exemplifying how system interoperability helps utilities leverage the most from their distribution system projects. AMI and OMS integration can create operational intelligence that significantly increases the accuracy and efficiency of outage detection and restoration verification.

This paper details the tangible benefits realized by extending AMI to the control room; such benefits include reduced outage times, efficient crew management, nested outage detection and more accurate reliability reporting. This paper also identifies the issues a utility must consider to achieve successful AMI/OMS interoperability: system performance, standards-based messaging, event validation, network analysis and visual awareness. It will become clear that outage management augmented with AMI represents a unity that enhances all of the benefits utilities have come to expect from successfully deployed OMS solutions.
Leveraging AMI for Outage Management
Integration enables faster response and restoration

Let’s take a look at the anticipated returns from integrating AMI and OMS. Seamless interoperability between the AMI and OMS allows the OMS to put better information to work — faster, to enhance overall response and restoration.

Identify incident locations faster, more accurately

Automatic meter notification is more reliable than customer notifications. For many utilities, an average of only eight to 12 percent of customers will call to report a power problem. While this low call-in rate is often due to customers not being present at the affected location, customers quite commonly do not report electric outages because they presume the utility is aware of the issue. Historically, depending on the location and size of the affected area, utilities have not had direct awareness of customer network problems.

Enter the era of AMI systems that offer last gasp — the ability to automatically communicate ‘no power’ events, which makes event reporting more immediate, reliable and available. This is certainly welcome data for system operators and dispatchers, and reflects one more step towards a smarter grid.

But AMI technology and communication infrastructures have limitations. Communication network bandwidth constraints can limit a percentage of ‘no power’ messages from reaching the enterprise in a timely manner — or at all. While AMI is SCADA-like in some ways, communication of data is not as rapid or reliable — thus the need for enhanced processing. An OMS with an AMI event validation engine and advanced prediction algorithms can maximize the value from an increase in data that varies in reliability.

The ability to identify, validate and properly correlate event data that is duplicate, delayed, missing or out of order significantly aids in the efficiency and accuracy of managing network-related issues. An OMS testing/training tool that allows the utility to simulate the irregularities and inconsistencies that can occur in meter communications can best prepare system operators, dispatchers and administrative staff — see Figure 1.

Figure 1. OMS simulates AMI event data for testing and training

An OMS should be able to utilize all relevant outage and non-outage information for tracing and prediction analysis of a near-real-time distribution
network model. AMI systems cannot do this on their own, since the topologies of AMI communication networks have limited knowledge of the power distribution network, let alone the current state of network devices and power sources. Leveraging the utility’s geographic information system (GIS) as a representation of the as-built state of the network, the OMS maintains the as-operated state, providing utility staff with a geospatial view of network activity — see Figure 2.

A robust OMS also can take advantage of AMI solutions that also provide event notification from devices higher on the network. The OMS can prioritize these events to identify incident locations more rapidly. Prioritization of upstream events allows the OMS to simply associate related downstream events, reducing the amount of processing required. The OMS also can process information from AMI solutions that report partial power and power quality-related events.

Verify outages and restorations

Automatic or manual pinging of unreported meters can be used to help validate results of restoration activity, as well as prediction analysis. Pinging meters following a restoration event can aid in identifying nested outages that might exist downstream from field crew activity. The OMS can create a new incident for the nested outage while crews are on site, helping to reduce outage duration, customer calls, customer service costs and additional trips to the field.

Pinging of meters for outage status also can be beneficial for validating predicted incident locations in advance of assigning crews. The utility can prevent over-prediction by acquiring AMI confirmation of power status. Pinging is only appropriate for those meters that have not reported activity, yet are predicted as part of an incident.

There is a strong business benefit in these validation activities: utilities have reported significant financial savings associated with improved efficiency of truck rolls due to AMI and OMS integration.

Figure 2. The OMS map view displays AMI meter event status
Increase customer support

In addition to getting customers’ power restored faster, many utilities consider it a significant benefit to be able to proactively communicate power problems, crew status and estimated time to restoration (ETR) to their customers. Regardless of the medium of communication, a customer can be notified that the utility is aware of a power problem at their location, based on an AMI-reported event. Even without this proactive communication, the enhanced visual awareness provided by the OMS lets the user confirm knowledge of a power problem to a customer at the time they call in to report it — see Figure 3. And with quicker identification of incident locations, utilities can more rapidly and accurately assign crews and specify ETRs.

Improve reliability reporting

The utility’s performance indexes are more accurate. OMS can leverage the reported outage and restoration times from AMI to improve reliability reporting and other forms of statistical analysis. The most common reliability reports require outage and restoration times for both customer-level and system-level analysis:

- Customer Average Interruption Duration Index (CAIDI)
- System Average Interruption Duration Index (SAIDI)
- Customer Average Interruption Frequency Index (CAIFI)
- System Average Interruption Frequency Index (SAIFI)
- Momentary Average Interruption Frequency Index (MAIFI)

Better current and historical data enables improved analyses to help mitigate future events and optimize information shared with regulators, customers, media and other stakeholders.
Achieving full-function AMI/OMS interoperability

Integration standards and compliance testing

Utilities, vendors and consultants have worked together for several years to create the IEC 61968 Common Information Model (CIM). Most recently, there has been increased momentum to support the growth in Smart Grid projects, and AMI interoperability has been receiving extra attention as more and more utilities deploy solutions. The AMI Enterprise Task Force (OpenSG) and other working groups are focusing on improving standardization that will enable the use of relevant AMI data throughout the utility enterprise.

Interfacing AMI with an OMS that meets open-standards interoperability is the best way to facilitate deployment and ongoing maintenance and avoid the risk of future incompatibility. Further, an OMS with a services-oriented architecture (SOA), making software components available via methods such as Web services, enables scalability and extensibility as the use and functionality of AMI technology evolves.

Defining data management goals

While adherence to interoperability standards aids in AMI solutions successfully integrating with external systems, there are many other important considerations for integration deployment. AMI solutions implement varying means of communications, such as RF, WiFi, WiMAX, cellular, PLC and fiber; consequently, they cannot be expected to operate or perform the same. Each form of communication will have a unique effect on AMI system performance that may further vary depending on device concentration and location. The utility will want to establish clear thresholds or criteria for the system’s data handling capabilities, and test the integrated system before deployment.

Recent milestones in interoperability testing

• 2011 – IEC 61968 part three testing demonstrated interoperability for network operations, including many systems such as AMI, OMS, and DMS
• 2010 – IEC 61968 part nine testing demonstrated interoperability specific for meter outage and restoration events, while CIM interoperability testing verified harmonization of the latest updates to the AMI Enterprise Reference Model
• 2009 – Inaugural testing for adherence to the AMI Enterprise (OpenSG User Group) Reference Model based on IEC 61968 – the CIM standard for utility distribution modeling and message exchange

Utilities are encouraged to participate in working groups focused on interoperability, to help ensure development of practical and effective standards.

Data quantity

Unlike a traditional OMS deployment, which typically only receives calls from approximately 10 percent of affected customers, the AMI-integrated OMS must be able to handle communication from all affected customer meters. The utility will want to know the system can receive high message bursts and process high-sustained rates of meter event messages, particularly for large-scale events. Performance testing, to demonstrate that the OMS can consistently process a relatively high number of messages.
of events per hour, ensures an environment that can manage large-scale outage situations without impairing the workflow of dispatcher and operators. For a large utility, this rate could be hundreds of thousands of events in a very short time frame.

Instead of finding ways to limit the quantity of AMI events that are sent to the OMS solution, an ideal approach is to ensure that the OMS has an abstracted AMI event-processing engine that will limit the performance impacts to the core OMS engine. This design will allow a utility to send all relevant AMI data to the OMS for pre- and post-event processing, while not jeopardizing the stability and usability of the system. It will also allow the operational system of record — the OMS — to track and manage all network event data as desired.

Data quality

While AMI is like a network supervisory control and data acquisition (SCADA) system that collects data from remote devices, it is not nearly as reliable or efficient. Natural filtering in the AMI network will result in somewhat delayed and inconsistent data delivered to the OMS, which must be able to accurately define events from duplicate, missing, delayed and momentary data and data, delivered out of chronological order.

Corollary event data

The OMS should receive not only power failure and power restoration events, but also partial power and power quality events, communication status, meter disconnects and upstream device events. Power quality events, such as low voltage, can signal an isolated or area-wide voltage issue that may or may not be a precursor to an outage event. A “no communication” status event would serve as notification to the OMS that a given meter is not reachable, and that analysis functions should be adjusted accordingly. Upstream device events can be prioritized by the OMS since related downstream events would not require analysis.

Reasons to send all AMI operational data to OMS

- AMI events related to a specific incident can be aggregated, and unrelated events filtered, prior to prediction analysis.
- Momentary events may not require creation of work, but could be beneficial for OMS historical analysis.
- Remote disconnect events are important to the OMS for prioritizing outage events and classifying affected customers appropriately.

How will you report outage times?

Keep in mind: the AMI will record an event time with a time stamp, but the OMS might experience a delay in receiving that event. The utility will need to consider which time it reports to a regulatory body for purposes of documenting outages and response efficiency.
Consider your analysis goals and solutions

With AMI delivering much more information to OMS than previously available, the OMS will require enhanced analysis in order to best leverage the data.

Outage prediction – with more data, the OMS will need to address how prediction algorithms will apply appropriate thresholds and timing to predict the source of the event and the upstream devices involved in the outage. In some cases, unique, configurable prediction might be required, giving the utility the option of analyzing AMI events differently than customer calls.

Prediction validation – similarly, the utility will have the ability to initiate on-demand pings, automatic or manual, to confirm power status and better predict the incident location.

Nested outage prediction – with integrated AMI/OMS, the utility will have the ability to directly communicate with meters to determine where independent downstream outages, or nested outages exist. With this information, the OMS creates new events and restoration activity as necessary. The accurate outage timestamps provided by the AMI identify not only what was restored, but when — information that can yield more accurate restoration times than those reported by crews — improving reliability reporting.

Various event types – the OMS will need to consider how it will analyze information relating to partial power and power quality events, and how to differentiate them from standard outage events.

Upstream devices – data collectors, and other primary voltage devices that are part of the AMI network, can be prioritized to provide information that streamlines outage response.

Architecture considerations

Keep in mind these architectural components that might be involved in proper collection, processing, analysis and storage/recall of AMI data — part of the framework for facilitating and optimizing AMI/OMS integration...

- Message adapter – receiving data
- Log service – storing events for tracking
- Message queue – handling the influx of mass amounts of data
- Event processor – processing of message events
- Message export – sharing validated data with other systems
- Data storage – separate storage of all AMI event data
- OMS event creation – prediction analysis of AMI events

Visualization – OMS can geospatially render validated events prior to and independent of predicted activity — providing dispatchers with visual awareness in near real time.
Factors affecting performance

Factors that can impact the success and performance of AMI/OMS integration include...

**Quantity and size of outages** – substation-level or high-circuit-level events might not require the need to analyze all AMI events. Conversely, isolated and dispersed events, as well as single-premise events require more processing and analysis, since they must be treated individually.

**Upstream devices** – indicators higher in the network will support more efficient processing of larger scale events.

**AMI communications** – the reliability and speed of various communications systems can vary widely, making testing in advance highly beneficial.

**Message batching** – bundled AMI messages, where available, from AMI are an option that can improve performance compared to discrete messaging.

**Hardware infrastructure** – it is important that infrastructure be sized appropriately to handle the increased processing and data storage requirements.

**OMS model quality** – a poor or inaccurate OMS network model will cause inaccurate analysis that will reduce the level of benefit offered by AMI integration.

**High data throughput** – the OMS must have the ability to sustain high bursts and sustained load for extended periods of time, under varying weather patterns and AMI network configurations.

**Proven interoperability** – look for product-supported integration that adheres to the latest standards.

**Vendor experience** – AMI solutions vary in messaging patterns and ability to support data options; an OMS provider with experience in integrating the system with various AMI and MDM solutions can be a critical element in project success.
Lessons learned

Experience in working with utilities deploying AMI/OMS solutions yields these suggestions...

• Push for standards-based integration and identify the integration mechanism, such as Web services

• When planning AMI/OMS integration, ensure that the AMI vendor will support the integration deployment effort as necessary

• Consider a staged implementation that utilizes an increasing amount of available AMI data types and functionality over time

• Run performance tests in advance of the roll out

• Do not overload the AMI with unnecessary ping requests, which can slow or prevent access to vital information

• Remember: AMI is not a SCADA system
Develop a strategy

A robust integration strategy will lead to robust functionality

AMI/OMS interoperability is just one tactic of a comprehensive and successful integration. To fully realize potential returns and accommodate both near-term and future Smart Grid goals, utilities should carefully consider an integration solution built according to the following principals...

**Upgrade path** – as AMI solutions evolve, utilities will need an upgrade path for their AMI/OMS integration solution.

**Enhancements** – implement a productized integration solution that ensures future product updates and enhancements.

**Technical support** – strive for a solution that will be covered under standard product support and not require custom support.

**Input from other utilities** – take advantage of solutions that will evolve with feedback and requirements from a wide base of utilities.

**Standards-based implementation** – look for products designed for ease of deployment and maintenance.

**Layers of component extraction** – investigate systems with components — such as database engine, queuing mechanism and event logging — that are flexible in technology and easy to replace and maintain.
Conclusion

In summary, AMI and OMS systems are clearly synergistic. Leveraging AMI integration for operational purposes offers benefits that extend well beyond meter to cash. An OMS that provides the ability to consume AMI events for validation, visualization, analysis, and reporting will facilitate enhanced outage management. This functionality can be instrumental in helping a utility improve customer service while decreasing operational costs — and getting more value from its AMI investment.

With the Smart Grid, the road ahead can seem overwhelming. The utility that implements a proven OMS integration solution designed to leverage the benefits of AMI will simplify its strategy, and be better prepared for what the future has in store.