White paper

Using Smart Grid data to power end-to-end asset health management

The asset health management imperative

Aging equipment is not a short-term challenge for the electric power industry — it is a core business driver. Transformers, circuit breakers and other critical assets in transmission and distribution systems have been in service well beyond their original intended working life, and will be required to continue performing for years to come.

Complicating matters, according to a 2011 Gridwise Alliance report[1], utilities will lose an estimated 46% of current skilled technicians and a like number of engineers by 2015 due to retirement or attrition — and with them, valuable performance and maintenance knowledge about all this aging equipment.

This brain drain couldn't come at a worse time for utilities, courtesy of the convergence of new smart grid capabilities in network communications with more data-rich equipment sensors and monitoring technology. Many utilities are ill-equipped to utilize this onslaught of data without a great deal of human intervention. New tools are needed to manage, analyze, prioritize and transform this data into actionable information.

Unfortunately, the threat of financial penalties for regulatory non-compliance at both state and federal levels raises the bar yet higher still — adding more work processes for utilities and putting more pressure on O&M budgets. The fact is, as utilities look ahead just three to five years, they are likely to face the reality of having significantly fewer experienced people to do increasing amounts of work with higher financial consequences.

How can utilities achieve their reliability, efficiency and regulatory goals given these challenges without increasing operational and maintenance spending and protect their bottom line? One solution to this looming crisis is the development of an enterprise-wide Asset Health Management (AHM) strategy that allows utilities to exchange dilutive O&M cost increases for additive capital investment.

Asset health management promises to do this by:

- Automating the process to evaluate large amounts of data for near real-time insight about the performance of assets across the grid.
- Better quantifying system and safety risks related to their aging infrastructure through the unique convergence of deep T&D equipment expertise, data management, performance models, analytics, visualization and system integration.
- Optimizing equipment and human assets across the network to achieve reliability, efficiency, environmental-impact and security goals.
- Facilitating condition-based maintenance practices that minimize risk of unplanned outages due to catastrophic asset failure.

1.The U.S. Smart Grid Revolution: Smart Grid Workforce Trends 2011, Gridwise Alliance

– Providing a repeatable, transparent, engineering-based process that incorporates advanced analytics and performance models to prioritize T&D equipment for maintenance and lifecycle management.
– Doing more with less through improved work force productivity, efficiency and effectiveness.

The role of end-to-end asset health management

AHM is not a new concept; as a label, it merely describes the discipline of overseeing the lifecycle of the electrical equipment required for utilities to do their job. But as a business strategy, end-to-end AHM describes a specific combination of technologies, analytics and work processes that has only recently become commercially viable to bring an unparalleled level of order, automation and comprehensiveness to this function.

The first job of an end-to-end AHM system is to gather information from the widest range of sources and integrate these disparate data so it can be analyzed and converted into actionable knowledge. These include test and inspection reports, maintenance status reports and data from OT (Operations Technology) systems.

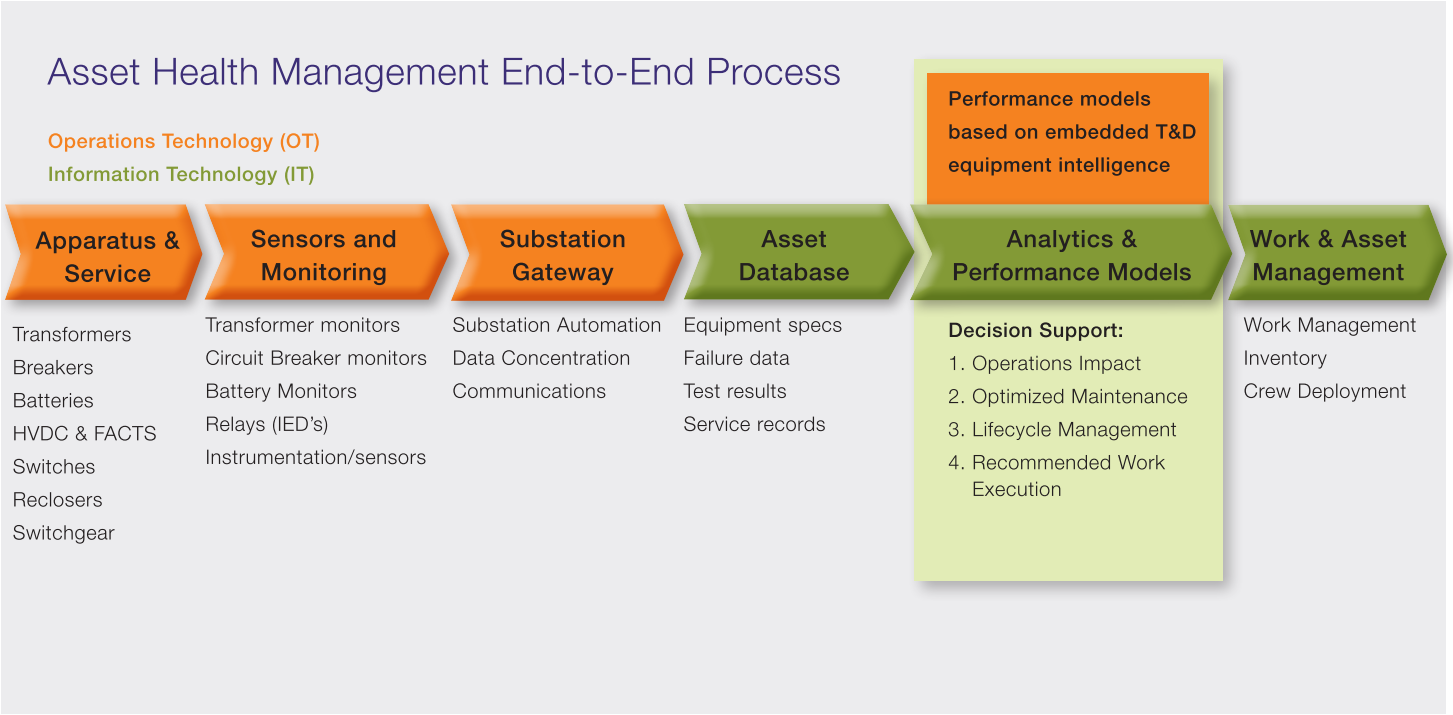
Secondly, AHM should add asset operational and performance intelligence — an embedded understanding of the equipment itself that:
– tracks real-/near-real-time information about the current condition and performance of each asset;
– provides analytics and dashboards so information can be contextually understood by individuals in accordance to their role and function within the utility; and
– supports repair and replacement decision-making.

The third function of AHM is to deliver this information in an appropriate format to whomever needs it — whether it's to the executive suite as a dashboard of Key Performance Indicators (KPIs) or to the operations center as an alarm to trigger immediate action in order to prevent an imminent asset failure. Finally, the most effective AHM takes full advantage of integration with OT and IT (Information Technology) systems to generate work orders and facilitate execution of these decisions.

"End-to-end asset health management must support all the business processes involved in maintaining assets to meet reliability, performance and compliance goals," according to Gary Rackliffe, Vice President of Smart Grid Development at ABB. "The entire industry is struggling with the big questions of how to decide what assets should be upgraded, refurbished or retired and replaced. This affects how they maintain their assets, determine and track the condition of assets, manage conditions that may impact operations, determine what O&M needs to be done and then prioritize and execute it. It affects how they choose to make capital investment, and how regulatory bodies respond."

The complex interconnectivity of these work processes demands an enterprise-wide approach to managing asset health, which is why leading utilities are developing an end-to-end AHM strategy that wed all of the following attributes:
– Asset knowledge and expertise;
– Sensors and monitors;
– Communication gateways;
– Data integration, archiving and storage;
– Equipment performance models and algorithms;
– Analytics and dashboards;
– Integration to systems for asset management, supply chain management, and work management and execution.

Achieving end-to-end AHM is not a short-term project. At most utilities, it represents a series of technology implementations, as



well as a cultural and strategic transformation. A utility's strategy for maintaining assets is driven by the technologies it already has in place, so the approach to building out end-to-end AHM is different for every enterprise, according to Chris Lemay, Product Manager for Enterprise Asset Management Solutions at Ventyx, an ABB company. Further, its impact is cumulative. As an organization becomes more sophisticated using data to optimize processes, it becomes more effective at implementing increasingly high-level approaches.

The way an organization makes repair vs replace decisions provides an example. Deciding when to replace an aging asset such as a substation transformer is difficult because the likelihood that it will fail in the near future can only be inferred from measurement and in-depth understanding of its individual history. Yet the way this question is answered repeatedly will have a significant impact for decades to come on an electric utility's:

- management of O&M expenditures within accepted spend levels;
- ability to meet established reliability standards;
- overall performance as it relates to regulators, rate payers and investors.

The simplest approach — though costly and disruptive — is to wait for the transformer to fail. Companies closer to this end of the spectrum will have a steeper learning curve in building an end-to-end AHM culture than those that have developed more sophisticated models for making repair vs replace decisions.

In either case, the work of an end-to-end AHM system includes providing comprehensive failure risk assessments on an automated basis — including supporting documentation for business-case justification to regulators and other constituents; and downstream connectivity to automated systems that will manage workflow of executing the decision.

The idea of enterprise-wide AHM is simple enough: It requires systems integration, data, performance analytics and implementation of specific business intelligence capabilities that are rare today among utility technology portfolios.

Integrating data

End-to-end AHM utilizes information that is likely already being collected. Often, these data streams represent distinct information silos — each supporting a specific process or function not originally designed to be integrated with other systems.

Relevant information may reside in best-of-breed point systems such as workforce management or asset management; enterprise systems such as ERP or EMS; and operations technology systems such as SCADA. It almost certainly exists as well in internally developed subsystems and routines, and even basic spreadsheets. Because of its distributed nature, such data are notoriously difficult to locate, understand and share. But all of these streams provide vital information that, when integrated and effectively analyzed, offers the promise of a quantum leap in value through improved management and execution of asset health initiatives. For that reason, implementing an end-to-end AHM strategy requires an approach to extract data from functional silos and — more important — convert it into actionable intelligence instantly accessible to every corner of the enterprise in functional formats and views tuned to individual roles and responsibilities.

Realistically, most utilities will have gaps in the available data. Significantly, this includes field data from transformers, relays, breakers and other components across the transmission and distribution grid.

Randy Schrieber, North America Region Marketing & Sales Manager for ABB Power Products, advises that any decision to invest in monitoring of such equipment must be made prudently. It is neither feasible nor necessary for every component to be monitored. But a cost-benefit analysis may point to specific needs for improved data collection in localized segments of the system — such as those that serve particularly sensitive customers or that represent ongoing reliability issues. To this end, utilities will seek to invest in monitoring capabilities on assets whose failure would present a significant impact on reliability. Other information gaps may be allowed to remain.

Typically, this economic analysis places early emphasis on transformers, breakers and other high-value transmission assets. However, an end-to-end AHM strategy encompasses critical distribution assets as well.

To that end, as previously noted, investments in smart grid technologies and communications include the addition of monitors, sensors and smart devices to nodes across the electric grid. Wherever these new data exist, they can be leveraged to support AHM capabilities.

Business intelligence provides the missing link

The rise of affordable remote monitoring explains why an end-to-end strategy for asset health management was previously unattainable — and why it is now both economically feasible and, based on increasing data volumes, necessary. In fact, there is a degree of urgency to process all this data into actionable intelligence utilizing fewer people as utilities face the loss of so much institutional knowledge via retirements.

To solve this problem, utilities need more than software. In order to extract knowledge from data, and deliver it to multiple constituencies across the enterprise, the AHM platform needs to be embedded with an intimate understanding of the assets, systems and processes of a modern-day transmission & distribution operation.

"Such a system should optimally combine equipment knowledge with asset and system intelligence to give utilities the ability to track and monitor asset health and to prioritize recommendations for performance, capital investment, and O&M expenditure," explains Marlene Benoit, Senior Business Development Manager, Asset Health Management.

The business intelligence module resides at the intersection of operations technology and information technology, assembling existing information to support decisions based on an asset's present condition rather than length of time in service. It pulls data from all available sources and then provides embedded subject-matter expertise to provide information that:

- Triggers alarms;
- Initiates condition-based work orders;
- Feeds asset health dashboards;
- Drives decision-support processes; and
- Enables a transparent process for lifecycle management of assets — determining when to retire and when to refurbish or upgrade equipment.

Many utilities, as they set out to build higher level strategies for asset health management, are facing some thorny challenges. This is especially true with legacy systems, since these were never designed to manage so much data from so many sources. It is a struggle to know what information exists, where it resides, how many ways it might be used, and how it can be shared. As a result, much of the value in this data is being passed over.

The business intelligence capability of end-to-end AHM drives the ability to get ahead of the flow of data — centralizing the strategy for extracting value from information while automating and distributing the work to execute that strategy. Its role can be encapsulated as:

- Making sense of the vast data streams that result from smart grid and other utility technologies;
- Applying a deep understanding of the assets themselves to develop meaningful knowledge;
- Synthesizing that knowledge and packaging it appropriately for the specific needs of different users across the enterprise;
- Facilitating the sharing of information;
- Encouraging development of new processes, key performance indicators (KPIs) and other information-based tools to run the business more efficiently and effectively;
- Improving the way information is shared.

Ultimately, this is the system functionality that allows a utility to make the leap from reactive asset management to a proactive strategy of end-to-end AHM.

"It has become an imperative for utilities to have a planned basis for the replacement of capital equipment," Schrieber says. "They need to make sure that they are picking the right equipment to be replaced with a methodical process to reduce maintenance hogs and high risk assets."

Improving work processes

End-to-end AHM can be viewed as a technology platform, but its breadth also necessitates understanding it as a business strategy. As a system, AHM delivers unprecedented intelligence for critical asset-investment decisions. As a strategy it provides a methodology for optimization of interconnected work processes across the enterprise.

Achieving condition-based maintenance: O&M activities are typically performed using a time-based maintenance model — servicing equipment on scheduled intervals. While it is a well-accepted practice, it is inherently inefficient — assuring service on some assets that don't yet need attention, while overlooking others that may be likely to fail before the next scheduled maintenance. By adding a layer of intelligence to incoming asset performance data, end-to-end AHM enables the transition to condition-based maintenance. Unlike preventive maintenance, condition-based (or predictive) maintenance allows finite O&M resources to be deployed based on how assets are actually performing — focusing field service work on equipment that is about to impact reliability.

Of further benefit to O&M work processes, end-to-end AHM can optimize field force utilization by identifying multiple tasks that may need to be performed at a location where a field crew is scheduled. Servicing a transformer, for example, can be combined with compliance inspection and other tasks that typically arrive from separate work-order systems.

Also in support of end-to-end AHM, outlying systems are being extended. As an example, workforce management systems (WFMS) have historically focused on functionality to support outward-facing activities such as meter reading and customer service. But now, as the execution arm of AHM, they are increasingly able to support high-value work. Features include the ability to schedule multiple visits for extended substation projects; provide tool and supply inventories; and deliver safety and workflow information such as schematics and validation rules directly to the work site.

The objective is to extend the reach of AHM to deliver unprecedented levels of O&M productivity by reducing the total number of service calls while increasing work conducted per call.

Reducing unplanned outages: End-to-end AHM improves reliability by offering visibility into the condition and performance of a wider range of grid assets. By increasing intelligent use of real-time and other data, the AHM strategy extends beyond improved fault detection to provide fault prediction through identification of risks as they arise, based on the performance of assets.

AHM addresses information overload by providing analysis of incoming data to deliver actionable information about potential equipment faults and failures. The information may be delivered to control room operators in the form of an alarm as appropriate, but it also may be delivered to engineering, O&M, executive and other functions through carefully designed use of dashboards, alerts and emerging KPIs. Says Schrieber: "It's a system that pores through all the reports and data to put information in front of the people who need it. It provides visibility and advanced warning to allow a managed response."

Compliance reporting: Regulatory reporting requirements are embedded in end-to-end AHM. Scheduling of time-based substation compliance inspections is an example of work assignments that, through automation, can be scheduled to coincide with other maintenance or repair work – reducing redundant field work and shortening lead times.

Supporting data or compliance documents can be drawn from the various information systems to populate templates for fast and timely filing and on-demand retrieval. As the work processes of compliance management are increasingly streamlined and automated, the financial exposure of non-compliance is reduced.

Conclusion

The technology now exists for an end-to-end asset health management system that manages the vast amounts of information utilities generate; analyzes it to provide actionable knowledge about how to care for assets distributed across the grid; and shares that knowledge in a meaningful way to maximize its value in every corner of the utility enterprise. Such a system enables these activities:

- Facilitate repair vs replace decision-making with engineering-oriented intelligence to identify, document and support performance-based capital investments — resulting in improved use of capital;
- Aid in the transition to condition-based maintenance, thus increasing O&M capacity;
- Better predict failures for improved reliability and fault recovery;
- Assist in field force workflow through improved scheduling, for further O&M efficiency;
- Ease the process of compliance reporting through proactive scheduling of inspections, automated gathering of data and population of templated reports.

End-to-end AHM provides these benefits by bringing order to the new data streams that smart-grid initiatives generate. That order is provided through a high level of integration for managing data, and by embedding deep knowledge of field assets in the business intelligence capability of the system — thus automating the delivery of actionable knowledge to any user based on his or her function in the enterprise. It facilitates sharing of insight to break down information silos and extract the fullest value of any available data, regardless of where or why those data are generated.

For many companies, the development of end-to-end AHM is a long-term strategy that involves implementation and updating of multiple subsystems, along with cultural and process change.

Implementation of this strategy is a more comfortable progression for utilities that already make high-level use of

advanced operating and technology systems. But for all companies, the potential benefits are real: a transparent system to support repair vs retire decision-making, significant reduction in O&M expenses, a corresponding increase in returns from capital invested, and a tool to enable work process optimization. End-to-end asset health management affects cost structures and efficiencies across the enterprise from field force to network operations, to reliability and compliance and ultimately to finance and the executive suite.

Final thought…

Utilities act on end-to-end AHM

In 2011, the McDonnell Group conducted interviews of 34 decision-makers at 23 of the 100 largest utilities in the United States and Canada. Those interviewed represented corporate management, IT, transmission and distribution, and reliability/ regulatory compliance functions at companies accounting for nearly a third of all substations in the United States alone. The study was commissioned by Ventyx, an ABB company.

Highlights of the results include:

- 53% of respondents rank ensuring reliability of aging assets as the No. 1 strategic priority for their company, while 94% considered it one of their company's top three priorities.
- Regarding substation O&M and asset management practices for substations 34kV and up, 35% rank compliance management as the top priority for the next 2-3 years, driven by concerns about fines imposed by regulators.
- 74% said rising costs to maintain aging substation assets is another top-three priority to address in the next 2-3 years.
- Only 29% reported the current level of IT/OT integration at their company as excellent (12%) or very good (17%).

Of the remaining participants, 100% agreed that achieving a higher level of IT/OT integration in the next 2-3 years is important — with 83% ranking it as either very important or critical.

Utilities that have started implementing the vision of a broad-based asset health management capability report a higher level of receptivity to making additional investments on asset health — an indication that others in the enterprise see the benefits once early systems are deployed.

To see the study results, Optimizing Deployment of Next Generation Maintenance Strategies, visit http://resources.ventyx.com/?elqPURLPage=36.

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