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PREPARING FOR THE FUTURE: HOW ASSET MANAGEMENT WILL EVOLVE IN THE AGE OF SMART GRID

ABSTRACT

For many years, utilities have struggled to organize information on a wide variety of assets to support operations, accounting, and other business processes. With asset management functionality spread across several software applications, utilities have been forced to maintain multiple databases and cope with approaches to synchronize them. Further, with Asset Management Systems in place that were initially intended for Power Stations, utilities are now trying to adapt older asset management approaches to the Smart Grid, where the topology of the network can change frequently and where a vast amount of asset information is being added each day in terms of meters, home automation devices, sensors, and other hardware.

- Changing the approach to constructing the asset database in a smart grid world
- Managing database integrity and reducing the versions of asset data that add complexity
- Utilizing the database to support a wider variety of operational and engineering situations

INTRODUCTION

Utilities have had a consistent focus on managing their assets over the past several decades, and while there have been many approaches and technology solutions focused on asset management, most utilities utilize a variety of software applications and business processes for this purpose. With the era of Smart Grid approaching, added attention is now being given to asset management practice, as new types of enabling assets are being added to the network, and the definition of critical assets is expanding and changing. Meanwhile, the high cost of asset replacement and the new capabilities for using information to optimize asset use are also driving changes in asset operations and maintenance.

This paper is intended to provide a discussion regarding the management of assets in the Smart Grid era. It will focus on the changes to existing asset management approaches that are necessary to achieve success as smart grid becomes a more important part of our everyday operations.

THE STATE OF ASSET MANAGEMENT IN UTILITIES TODAY

Electricity utilities have a variety of software tools to use to manage their assets, ranging from Asset / Work Management Systems (often called Enterprise Asset Management (EAM) systems), Geographic Information Systems (GIS), Planning Systems, System Control and Data Acquisition (SCADA) systems, and Fixed Asset Accounting Systems (often called Plant Accounting or Continuing Property Records (CPR) systems). Each of these tools has a different business application:

- Asset / Work Management Systems – These systems, which have been available for over two decades, enable engineering recordkeeping, the creation and tracking of maintenance schedules, supplier information (in some instances), and related project / work order information that chronicles the history of the asset (from initial construction / assembly through retirement).
- GIS – These systems are used primarily to track the location of assets once they are installed and operational, and also can be used to track connectivity of electrical devices (determine network topography). GIS is often seen as a software application on its own, when it is truly a technology enabler for asset information and various computations regarding assets.
- Planning Systems – Utilities utilize a variety of planning software solutions (load flow, etc.) that contain a mathematical construct of the network based on the asset configuration and the demand at each network “node”. These planning systems use a model of the assets, and these models are generally built separately from the asset management / GIS systems at the utility.
- SCADA – These systems maintain sufficient asset information to enable dispatchers to operate the network, including operational characteristics, connectivity to other devices, and telemetry information regarding the load on those devices. SCADA systems use telemetered information from the electricity network that is “real-time” (within a second of actual occurrence in the field).
- Fixed Asset Accounting – Fixed asset systems manage the property records of the business. These records are used in computing

depreciation values, rates (via a regulatory process), and property values in case of loss or replacement. Assets are added to the fixed asset ledgers when initially assembled or constructed, and then are removed at retirement.

Utilities have struggled with managing these disparate systems for the past decades, which are often implemented independently from each other, and by different parts of the organization to meet different business needs. For example, engineers generally implement asset management and GIS systems, accountants implement fixed asset systems, and system operations organizations implement SCADA. The systems are generally from a variety of suppliers (perhaps each from a different supplier), and may be based on different technologies, including programming languages, databases, and human interface approaches.

Because all of these application software systems have been used for several decades, the individual systems are all mature and often have a large user base. Some of these applications software systems have been interfaced by utilities to create a stronger asset management framework, but virtually all of these interfaces are "project-ware", and not integration products that are supported and upgraded by their specific software developers.

There has been a strong level of recognition that the assets in these systems are replicated, and the industry has taken some limited steps to reduce the level complexity caused by management of multiple asset databases. The biggest step taken is an approach called the Common Information Model (CIM). This standard model is an attempt to ensure that assets have a singular definition across the various applications that might deal with asset information.

CIM, however, has met with limited success in the industry, and while vendors say that their software is "CIM-compliant", the truth is that this works well for some assets (mostly those on transmission / production systems) but not as well for distribution assets. There are many reasons for the lack of focus on distribution assets. Business / accounting issues contribute to the problem, as distribution assets tend to cost a small amount (per unit), and record-keeping at the same level of detail as transmission has been an difficult and expensive concept to consider. For example, while each transmission tower may be kept in a Fixed Asset ledger, distribution poles are kept in categories based on vintage, length, and other factors. And there are many more transactions (capital changes, operations and maintenance expenses) that result in changes to the distribution system, while the transmission system changes less frequently.

In fact, the industry has generally not paid the same amount of attention to distribution assets as it has to transmission / production assets. However, with the advent of Smart Grid, that must change.

THE ADVENT OF SMART GRID

Changes in the electrical system caused by environmental and economic factors have resulted in the move to what is commonly known as the "Smart Grid". The Smart Grid recognizes that utilities need to manage their distribution grids more effectively than in the past, because:

- Demand patterns are changing – Electricity consumers are now adding electric vehicles and other devices to the grid at growing rates, changing the previously reliable patterns of consumption on the grid. In addition to devices that simply attach to the grid and consume energy, electric vehicles may also connect through "charging stations", creating a different business relationship for the customer with the utility. While electric vehicles are a key driver in the change that is occurring with the distribution system, there is no doubt that consumers (all types) are relying on electricity for more and more of their daily routine.
- There is added demand to understand the topology of the distribution network – Utilities that have paid limited attention to the real-time understanding of their distribution networks are finding that in the era of Smart Grid, it is important to manage that network topology more precisely. This management of the network is needed to extend the life of the assets, and to provide reliable service downstream.
- Generation is becoming more distributed – Distributed, "green" generation is growing throughout the world as a result of environmental concerns of large fossil fuel plants that have a role in global warming. While some of these new distributed generators are linked to the transmission grid (e.g. large wind farms), they will often be connected on the distribution network to provide power to local consumers. This adds more complex assets to the distribution network, and creates challenges around operating those assets in a reliable and sustainable manner.

- Additional telemetry devices are being deployed on the distribution network – These devices are generally used for sensing and data telemetry (meters, smart home devices, others). In each utility, a large number of new assets associated with the distribution network are being added, including the end-devices and the telecommunications systems that transmit telemetered data to the utility.
- Additional smart switches are being added to the distribution network – There is a strong movement to add intelligent switching to the distribution network to support "self-healing" operations, to balance load, and to resolve outages more quickly. This results in additional assets in the distribution network with additional attributes not generally seen before.

These factors result in a significant growth in assets associated with the distribution network. Asset management systems of all kinds used by electric utilities must adapt to this growth, which is largely driven by the need to create the "smart grid".

THE IMPACT

Utility companies with distribution assets must reconsider their approach to asset management in the era of Smart Grid. The older approach to asset management in multiple, diverse, interfaced systems and synchronized databases are not able to manage the requirements placed on utilities to operate their distribution networks in a smarter way. For example, It is no longer feasible to rely on disparate technology systems with large numbers of interfaces, or to have "multiple versions of the truth" that require constant synchronization. Instead, utilities must consider getting to "a single version of the truth" for their asset-intensive software applications.

"One version of the truth" does not mean that utilities must have a single physical database. With all of the software applications involved, this is not a possibility in the near-term. Instead, utilities must at least reduce the number of physical databases and must manage its business processes to update this data as new information is received, and to ensure that updates are made to ensure data integrity across the enterprise.

For example, utilities should have processes to accept changes to the network (e.g. new assets, change in switch positions, etc.) to be entered once and accepted by other systems. In fact, data updates can be manually entered or be a product of telemetry from SCADA or other systems. Further, some systems can take advantage of using a single, shared database for multiple purposes.

Without these changes, Utilities are likely to experience:

- Higher Cost – Multiple physical databases suggests multiple maintenance activities that would not otherwise be needed. As with many utilities today, data will be maintained by specialists in their specialized systems, as opposed to considering the data a corporate asset and simplifying to lower cost and reduce error.
- Operational Issues - It is likely that utilities with even more physical, separate databases will experience more data errors, and as experience suggests, these may lead to operational errors that can negatively impact reliability.

WHAT UTILITIES NEED TO CONSIDER

Utilities should consider the following in order to support their asset management efforts in the age of Smart Grid:

1. Establishment of a "single version of the truth" – Utilities should consider the future, and take steps to get to a greater level of data integrity related to distribution assets. Movement towards shared databases will be one approach, and will hopefully be provided by vendors to the industry who recognize this as a critical need for the future. Where multiple physical databases are required, strong business processes that enable update of the asset information when updated information is received will suffice.
2. Elimination of the use of "special purpose" databases for smart grid assets – Utilities should consider using the same asset management software used for power equipment to manage the additional assets that come along with the Smart Grid era, including smart devices, communications equipment, and the equipment needed to manage distributed generation. This will reduce the number of systems involving asset management of any kind, and will greatly simplify the IT environment.
3. Establishment of spatial databases as the key to the management of smart grid asset information –Today's database technology manages today's asset information reasonably well, but the needs of smart grid suggest that data will be more useful while managed in spatial context. Using spatial technology enables utilities to more readily manage the topology of the network based on manually entered or telemetered data. Further, it is easy to create reports, charts and graphs from spatial information, but it is not as straightforward to

create maps from traditional asset databases. Connectivity and network topology are far more easily represented and maintained in a spatial database context

4. Establishment of a workflow management tool to support database updates – Utilities should set the rules for database update, and then use workflow tools to ensure that the single change in an asset is replicated across other databases that contain the same asset. For example, when a pole is replaced, the act of updating the spatial database should also update the asset management and fixed asset accounting systems, and (if desired) planning and SCADA systems as well. Further, if a normally-open switch is closed, the change in the network configuration should be made immediately, and software to evaluate the state of the distribution network based on the new configuration should be initiated.

THE ADVANTAGE OF SPATIAL DATABASES IN ASSET MANAGEMENT

Utilities have struggled for over 20 years to understand where Geographic Information Systems (GIS) fits within their IT environments. Often seen as a "splinter technology", GIS has generally been used solely to create maps for various uses within the organization. On occasion, GIS has also been used to perform geographic analytics, including the siting of transmission / substation assets or the placement of assets in planned development areas.

Spatial databases, however, have the ability to do much more than create maps and to perform simple geographic analyses. With software applications added to basic GIS, utilities can manage the topology of their electric grid based on information provided by people or telemetry. Further, once the topology is known, the spatial information can be used to compute a topology model of the grid, enabling study of potential outages, contingencies, and the identification of other problems such as voltage issues.

Spatial databases are a necessity for advanced outage management, as the use of these databases simplifies the process of determining the likely cause of an outage, and can also support the deployment of crews and associated switching operations. While some software uses the spatial database to show the location of outages to operations staff, the actual use of spatial databases to process outage information and to speed outage recovery is a strong function of spatial database technology and its associated applications software.

Finally, putting GIS in the field (mobile GIS) enables data capture locally to where the changes are happening, and reduces the after-the-fact cost of updating maps as a second step (e.g. from marked-up paper maps). Further, the data reflected is timelier, and that is critical when dealing with outage situations.

THE ADVANTAGE OF WORK FLOW SOFTWARE IN ASSET MANAGEMENT

Utilities have yet to make extensive use of workflow software in their IT environments. Instead, business processes are programmed into applications software more directly, or continue to be more manually driven.

Utilities have, for many reasons, operated in a vertical or "silo" type of operation, where experts in an area manage the business functions in that area. Business processes within those vertical / silo areas tend to be very strong, but are not as strong when crossing boundaries from one vertical area to the other.

Work Flow Management software enables utilities to cross that boundary by tying multiple software applications together to enable a business process to be completed successfully. For example, outage management requires strong cooperation between operations and customer service, and work flow management can support this need by tying the groups together for the benefit of both the utility and the consumer.

While supporting customer and other operations, workflow software has the added advantage of taking data regarding changes to the electric grid and passing those changes to applications software that needs to know about those changes. For example, while a change in switch position from open to closed may not change its fixed asset accounting record, the Asset / Work Management software should know as there is likely a relationship between the number of switch operations and maintenance planning.

Work management software, as a result, can provide the "synchronization" of both data and applications in support of smart grid functions.

Workflow management software has other benefits to the utility:

- Lowers cost of interfacing legacy systems – In older software applications, much of the custom coding performed when implementing the software is to embed the business process into the software. With workflow software, applications no longer contain these customizations, which make it less expensive to own and operate the systems. It also enables older legacy applications software to be used for a longer period of time, as the software no longer has to manage applications functions and workflow functionality.

- Lowers the cost of application replacement – Many utilities that invested in various smart grid applications years ago are having difficulty replacing them, partly due to the high cost of replacement. Workflow management software actually reduces the cost of implementation, making it simpler for utilities to build the business case to move towards more modern software at a time when it may be most needed. It also enables utilities that understand the advantage of using spatial technologies and databases to link their software applications to the GIS and spatial databases, and take advantage of the "one version of the truth" concept that is so important to success in this field.

SUMMARY

The era of smart grid is not only creating significant additions to utility infrastructure in the form of smart meters and other devices, but is also challenging our notion of how asset management will occur in the industry. Utilities are challenged to move towards an approach in which asset data and the processes to update that data must evolve to "one version of the truth". Leveraging spatial and work flow technologies will help bring asset management to a new level of functionality for utilities, and will help lead the industry into the era of smart grid.