Roadmap to the Future: Integrating Substation Information and Enterprise Level Applications

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The past decade has seen a rapid advancement of technology supporting transmission and distribution utility engineering and operations. As such, the utility industry has increasingly turned to information and automation technology as a means to increase the efficiency of operations and to improve customer service.

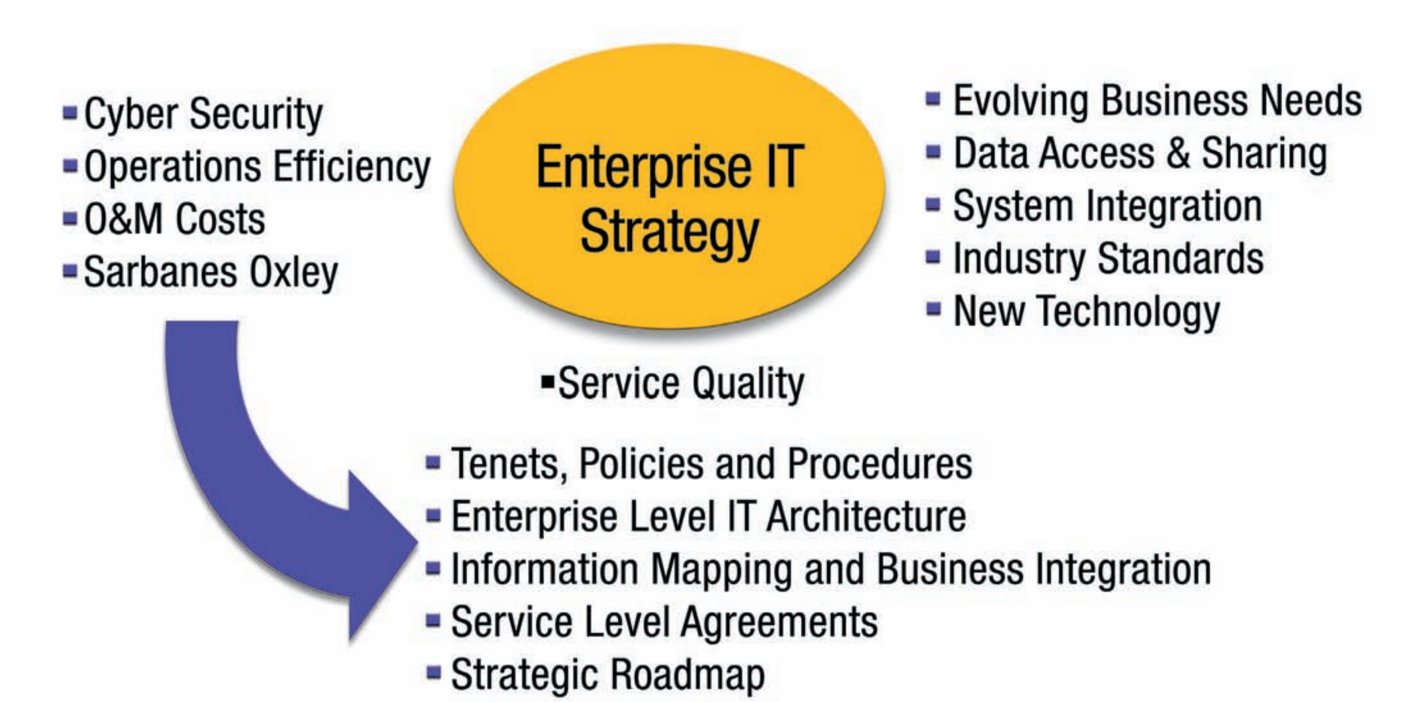
Traditionally, technology and automation projects are scoped, designed and deployed to support a given organizational unit. Often business function owners, faced with a specific business need, lead the procurement of a new application without enterprise level considerations for information integration and management, systems maintenance, and long-term support. The utility industry also faces the complexity of the real-time grid operations, system reliability, specialized mission critical applications and ever-changing regulatory environment and requirements. This is combined with more traditional IT paradigms of customer information, customer services, billing and back-office functions, asset management as well as administrative functions.

However, the industry has recognized that improved grid reliability, enhanced customer services, and improved operational efficiency will require information integration across the enterprise and enhanced levels of automation. User communities expect timely and often ubiquitous access to certain information, while management maintains pressure on costs, and higher levels of service quality and reliability. The emerging Utility of Future concepts for Smart Grid demand timely availability of additional information and integration of data and functions across traditional utility organizational boundaries. The improved access to information must be balanced with the appropriate levels of cyber security across the enterprise. And information management and control policies need to be in place to support access, reporting and audit requirements.

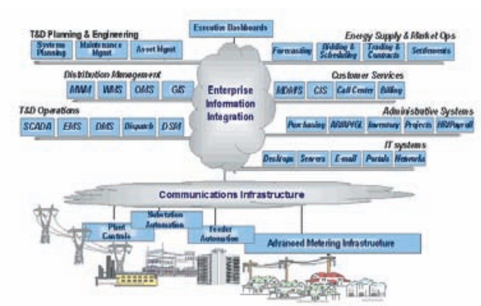
These challenges require utilities to establish tenets, policies and procedures for governing information assets and systems. To be effective, however, these tenets need to be driven by both requirements of IT systems management, as well as the realities of utility and grid operations and their specific business and technical requirements.

The technology

Traditionally, substation data were acquired through Remote Terminal Units (RTUs) and processed by Supervisory Control and Data Acquisition (SCADA) applications in support of power system operations. The introduction of multi-function digital relays and other Intelligent Electronic Devices (IEDs) at substations has made additional data available that can help minimize system restoration time, reduce equipment maintenance costs, and improve equipment availability and system reliability.



Modern substation protection and control systems use local-area networking technology to interconnect computer-based intelligent electronic devices that are able to communicate high-rate streams of electrical or other measurements (operational data) as well as records of how the devices and the power apparatus reacted to faults, system disturbances, and normal cycles of operation (non-operational data). This data is required to analyze the transient and long-term performance of the power system and its control systems. As compared to older non-intelligent systems that did not alert the utility of business opportunities or impending problems and disasters, the new systems provide vast quantities of valuable data.



Telemetry data, equipment conditions, digital fault recorder (DFR) and sequence of events (SOE) data can now be made available to users and applications in a consistent, and reliable fashion, using data marts and enterprise level integration schemes. This can facilitate the adaptation of performance enhancing strategies such as condition-based inspection and condition based maintenance (CBI/CBM) to improve equipment and system availability while reducing O&M costs. Continuous monitoring of dissolved gas levels, oil temperature, vibration levels, and HV transformer loading, for example, allows for the dynamic adjustment of equipment ratings to improve asset utilization and scheduling of inspection or maintenance. Timely access to, and analysis of, Digital Fault Recorder (DFR) and Sequence of Events (SOE) data allows quicker determination of fault location, and quicker service restoration.

Some utilities that integrated or automated substations hoping to get information for better management have found themselves wrestling with masses of data that overwhelm and handicap the organization. Realizing the strategic benefits of substation data is hindered by utility IT systems that frequently are not designed to allow access to this data by engineering and O&M applications. Comprehensive enterprise level substation systems integration (ELSSI) initiatives can help electric utilities get their arms around the huge bodies of data now stranded in substations. Converting masses of operational and non-operational data into business intelligence, organizing this intelligence, and interfacing it with enterprise-level applications can yield operating and financial benefits.

The key is to enable timely access to substation and equipment data by enterprise-wide users in planning, engineering, operations and maintenance that need this information. Utilities need to develop communications and processing systems that yield hard, timely, and succinct information for system operating security, economic operation, asset management, maintenance management, system planning, capital planning, and resource allocation. ELSSI adopters should understand key business metrics that support closed-loop business improvement processes. This makes it far easier to justify existing or new investments in substation automation and communications systems, and to reach the true payback promised by these substation systems.

Users also need to develop an approach that captures, organizes, and applies the data to assess improvements to system security and reliability, predict or schedule repair, replacement, or upgrading and the spending required, and to determine the most economical way to operate the system and the business. The challenge is to bridge the gap between the available substation data and the business goals. Utilities can bridge the gap by taking a number of interconnected steps including:

- Road-mapping solutions based on long-term utility business objectives;
- Planning communications system, data hosting, gathering, protection, and cyber security design;
- Organizing and interfacing data to applications that extract information;
- Selecting and developing applications that clearly and succinctly present all the enterprise users with the levels and types of information they need to perform their jobs; and
- Designing enterprise processes that close the loop between the management information delivered by ELSSI and the business improvements that result, constantly detecting and correcting problems, and constantly improving the whole cycle of information processing and use.

Roadmap for the future

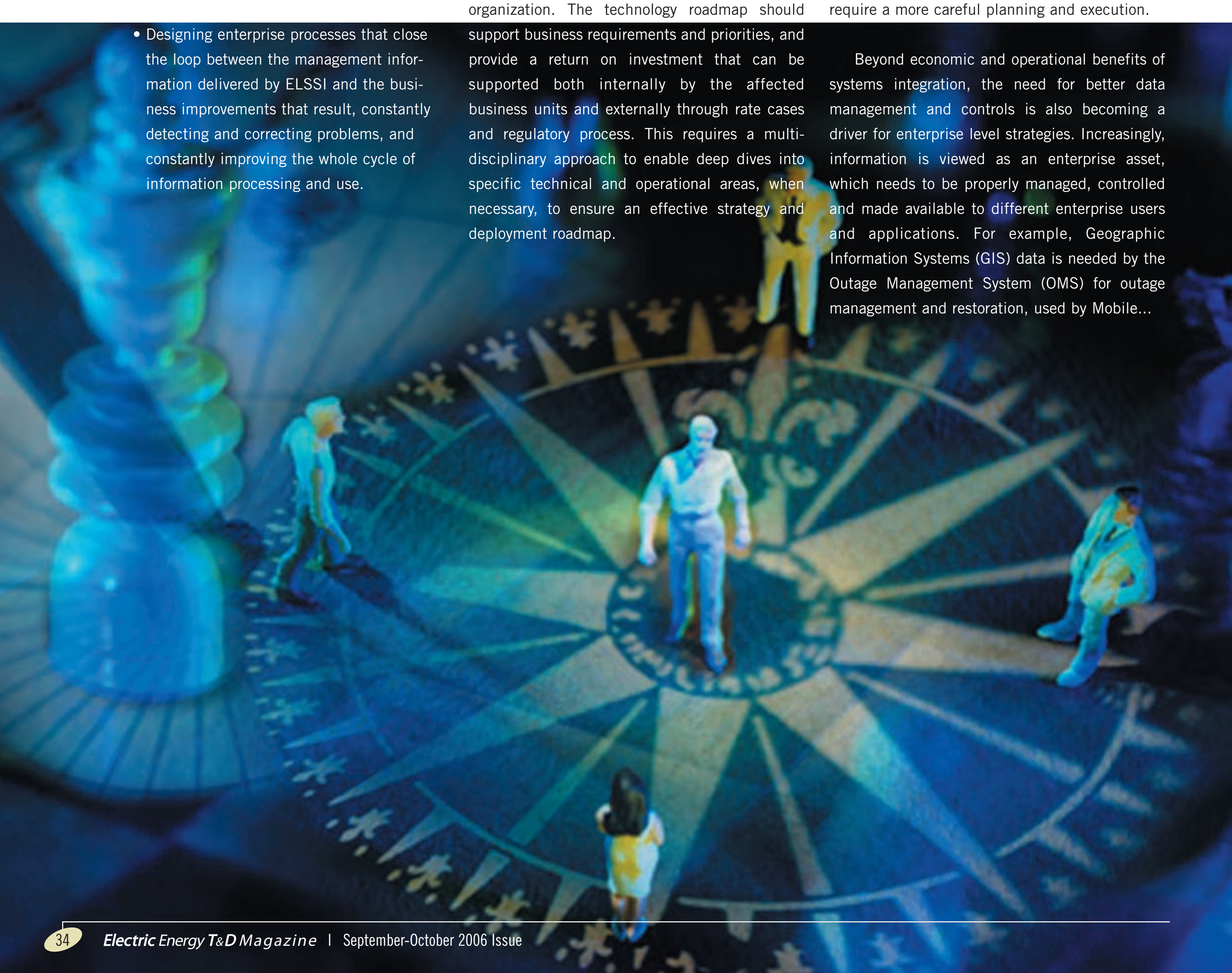
Enterprise level systems integration is a complex process involving technology, applications, data, business process and people. Focusing on the road-mapping solutions step provides a high-level overview of general issues and approach for establishing a strategic plan for IT technology and systems integration across a utility enterprise.

A holistic view

Utility enterprise-wide systems integration and technology road mapping requires a holistic approach bringing together operational needs, business applications, data and process across the utility business units. This requires a broad range of subject matter expertise covering operating practices, technology requirements, and business opportunities across the organization. The technology roadmap should support business requirements and priorities, and provide a return on investment that can be supported both internally by the affected business units and externally through rate cases and regulatory process. This requires a multi-disciplinary approach to enable deep dives into specific technical and operational areas, when necessary, to ensure an effective strategy and deployment roadmap.

Utility IT professionals are increasingly faced with information integration needs across traditional organizational boundaries. However, many of the individual business improvement opportunities are difficult for utilities to justify on their individual merits, or to accomplish in the absence of readily available hard data. A holistic approach to providing integrated data enables the utilities to realize economic benefits in a similar holistic fashion that they could not approach taken piecemeal. However, this requires planning projects that cross the traditional organizational boundaries. Different business units may have to agree on the scope, budget and control of the technology. Utility IT professionals have become accustomed with enterprise applications, but in large part for applications outside of the operational environment. Enterprise level integration for support of operational systems will require a more careful planning and execution.

Beyond economic and operational benefits of systems integration, the need for better data management and controls is also becoming a driver for enterprise level strategies. Increasingly, information is viewed as an enterprise asset, which needs to be properly managed, controlled and made available to different enterprise users and applications. For example, Geographic Information Systems (GIS) data is needed by the Outage Management System (OMS) for outage management and restoration, used by Mobile...



...Workforce Management (MWM), needed by Customer Information System (CIS) for customer mapping, is used by systems planning and engineering in support of asset management and network analysis, is used by SCADA for world-maps, etc. Real-time equipment condition monitoring data is now being passed through SCADA to engineering and field crews for condition based inspection and maintenance activities, and used for asset management. Planning of information systems and enterprise applications require a holistic approach to address these diverse needs.

Typical components of utility enterprise information system assets include:

- T&D Planning and engineering - systems planning, maintenance management, asset management
- Distribution management – MWM, Work Management System (WMS), OMS, GIS
- T&D operations – SCADA, Energy Management System (EMS), Distribution Management System (DMS), dispatch, Demand Side Management (DSM)
- Energy supply and market operations - forecasting, bidding and scheduling, trading and contracts, settlements
- Customer service – Mobile Data Management System (MDMS), Customer Information System (CIS), call center, billing
- Administrative systems – purchasing, Accounts Receivable (AR)/Accounts Payable (AP)/General Ledger (GL), inventory, projects, Human Resources (HR)/payroll
- IT systems – desktops, servers, e-mail, portals, networks
- Communications infrastructure – plant controls, substation automation, feeder automation, advanced metering infrastructure

Enterprise wide integration brings these assets together, facilitating information access and sharing, utilization of common infrastructure and enabling applications and processes to achieve higher degrees of operational efficiency and reliability. This vision requires a strategic view to address an environment that may include many legacy applications, with no or limited integration capabilities, diverse data bases, data duplications and data quality issues, various standards and regulatory requirements, and diverse and evolving business needs.

Analysis approach

Planning, specification, design, deployment and maintenance of enterprise IT systems require significant levels of analysis and documentation that must follow a methodical approach. There are several technical approaches available, including Rational Unified Process (RUP) for technical analysis and requirements documentation, and well as KEMA's iAdvantageTM framework for project task activities, that can be tailored to specific utility requirements and operating culture. As appropriate, the supported industry standards, recommended technology stack, reference models and business practices, and tenets that will govern the information management, technology deployment and systems integration activities need to be identified.

In general, there are three broad areas of analysis and assessment to be considered:

Current state and requirements analysis - Current and the future state assessment activities should be based on the analysis of the various technology, data and process layers that encompass the solutions for an individual business application or the enterprise business needs. These layers include the infrastructure; the various vendor supplied or in-house developed business applications; the data, data access and its required security and controls; and the business processes and user functions.

Often, enterprise applications integration strategies and projects are based on the selection and deployment of information integration technologies, without much attention to the specific requirements and constraints of individual business applications and processes supporting those business functions. Technologies suitable for integration of transaction based applications, e.g., those typical in Customer Services, purchasing or administrative functions, may not be suitable for real-time and data intensive applications typical in T&D operations. The utility enterprise integration strategy needs to consider application area requirements and constraints.

Cost benefits assessment - Technology projects typically require cost and benefit justifications. Enterprise level projects impose an additional degree of complexity due to their broad reach and impact on multiple business activities. The analysis requires an understanding of business and operational benefits of the technology to often highly technical T&D and other operational facets of the business. The analysis may require assessment of strategies, options and alternatives. Deep subject matter expertise is often needed not only to perform the analysis but also to have the support and buy-in from the functional and business owners.

Qualitative and quantitative analysis should be performed based on business objectives, nature of the project and data availability. Where utility specific data is not readily available, utility industry best practices is used as a reference in assessing the benefit and cost magnitudes. The technology benefits, at a macro level, may be grouped into the following key categories: Increase Workforce Productivity; Improved Customer Services; Improve Electric Service Reliability, e.g., reduced outage frequency and duration; Increase System Operations Efficiency; Reduce/Defer/Eliminate Capital Investment. Automation and technology projects can thus be linked directly to business benefits and metrics, as an integral part of the enterprise strategy.

Cost benefit models become an effective tool for evaluation of alternative strategies and their sensitivity to schedule, capital and O&M cost variations. Advanced analysis techniques, e.g., Real Options analysis, may be deployed for support of multi-year phased projects.

Technical approach - The enterprise technology and integration strategy also requires establishing reference models for recommended technology stack and integration framework. Most utilities already have adopted a recommended position for enterprise technology stack. However, these are not fully applied as guidelines to systems and applications supporting engineering and operations. Integration reference model complements the technology stack and established recommendations for services, standards, design components, and patterns that are used in design, implementation and enhancements of integration infrastructure. Applicable industry standards and practices, e.g., Common Information Model (CIM), various Service Oriented Architecture (SOA) requirements, NERC cyber security for critical infrastructure (CIP), and other applicable standards may be considered. Systems integration requires numerous interactions internally and externally, and these interactions are typically implemented via SOA or, in other words, by consuming or providing services. ■

About the Authors

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