

# Utility Information Integration - Vision, Benefits, Strategies, and Status

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**Abstract:** Successfully incorporating utility engineering functions into business decisions requires integrating the numeric-intensive world of the engineer with business systems that are designed for maximizing economic return. Today the engineer must make more high level analyses based on operational data to accommodate the needs of short-term business decisions. These decisions benefit greatly from improved quality and timeliness of information. Utilities are planing and installing more fully integrated information flow across their business and technical systems to improve the quality of the information available for these short-term analyses.

This paper addresses the need for sharing information both within and outside the utility, the benefits that are being derived from shared information, and some current implementation strategies being considered. A summary of associated industry activities is provided in an effort to provide the audience avenues for staying abreast in this rapid-paced still-developing information exchange arena.

**Keywords:** Application integration, CIM, Common Information Model, Data buses, Data management, Information systems, Information services, Message bus, Message systems, Messaging, Networks, Data communication, Automation integration

## I. INTRODUCTION

Traditionally, the business and the analytical design functions in an electric utility were run more or less separate and apart from each other. In this modularized environment, data isolation between billing and finance and the engineering design functions was not considered a critical issue. However, now that business directions of utilities have settled into a more firm casting, energy companies are focusing on the technical design and capabilities' assessment of their infrastructure to improve their asset utilization.

The amount of information required to develop a business case for each asset utilization is overwhelming. Add to this a constantly changing load and generation distribution across the "open" system, and tracking the combinations of asset utilization becomes ominous at best. Even determining impending asset failures may become a daunting task. There exist applications that perform the analyses for asset utilization, but the problem becomes one of obtaining and supplying accurate and singular data for these analyses.

More accurate information is needed served up more quickly. Access to accurate and timely information greatly impacts the capability of a company to maintain its service excellence while increasing its competitive edge. There are facilities and standards being worked upon, both in the USA and in international standards bodies, to effect improved

information quality, normalization of the data, and the speed at which the information is made available.

This paper will first frame the information problem from the engineer/designer/operations viewpoint. Then, a review of the types of information being aggregated within the utility environment will be presented, followed by a discussion of recent concepts and innovations for information exchange within the enterprise. A review of the current technical activities that are addressing the problem of information exchange in electric and other utilities is then presented for those that wish to take an active part in the solution and those who wish to keep abreast of the developments.

## II. THE DATA CONUNDRUM

Information has traditionally been isolated into departmental functionality within the utility business for many historically sound reasons. The most commanding argument for database isolationism has been philosophical and is a theorem that holds true today and well into the future – that is, the best quality data will be available in that functional database where that data is critical to that function. There are two corollaries to this phenomenon. The first is that there is data within each and every functional database that is not critical data to that function – this data is suspect for accuracy. A second corollary is that this non-critical data is also rarely, if ever, updated in that database.

There has been a "need" to have individual databases in purchasing, planning, operations, maintenance, engineering, client services, human resources, etc. The fact that there are multiple entries for a single data element across these databases means that across the enterprise the potential for incorrect data entries far exceeds the number of correct data entries.

To illustrate data accuracy and multiplicity problems, consider the data required for a power transformer as viewed from various functional perspectives within the electric utility. The Organization/Data Required functionality shown on the left of Fig. 1 defines additional databases whose data is an aggregation of parts of the already numerous databases shown in the right of the figure. The following discussion describes each functional perspective in the figure.

### A. Planning Engineer Data Needs

Planning generally estimates the impedance and tap characteristics for a new transformer in the planning model. This model is maintained in the planning department. To obtain the data for the planning model, planning must have access to the inventory database (will the planned addition come from stores?), the purchasing and test and measurement databases (what are the tested values for impedance?), the operations database (real loadings, generation dispatches, etc.), the construction database (when and what is installed), and others. Consider that to save time, once collected, planning will keep this data in their database. Very quickly some data that has now been duplicated and stored by planning becomes stale.

### B. Design Engineer Data Needs

Generating the initial design and budget for a substation or ordering equipment for an approved construction project requires that the design department collect some of the same transformer data as the planning department as well as additional data. The design engineer will require access to the purchasing database (prior costs), the manufacturer's CAD files (for equipment layout), control and protection department data, contracts and management data files for prior performance, as well as other data sources spread across the company. Again, to save time, once this data is obtained the design department stores it in their database to obviate the need to collect it in the future.

### C. Maintenance Engineer Data Needs

While the transformer is in service, the maintenance engineer requires data from various sources within the utility. Maintenance engineers will require access to GIS or mapping data to determine the location of the transformer. They also need access to the maintenance data (records on prior and outstanding service), the test and measurement data (past measurement history), operations and/or protection and control data for RTU or fault recorder data, and purchasing and inventory records to identify the transformer and changes occurring over its life. Generating a complete transformer history can take weeks in a manual process.

### D. Operations Engineer Data Needs

Operating the transmission EMS (Energy Management System), or the Distribution Management System (DMS) requires instantaneous status data for the system. These activities must know present alarm status for the transformer, its present and anticipated loading, and planned switching or maintenance activities surrounding the transformer. Additionally, today these systems are being asked to supply time-critical data to organizations outside their company.

An attempt to illustrate these data interactions for only the single transformer results in something like Fig. 1. Imagine

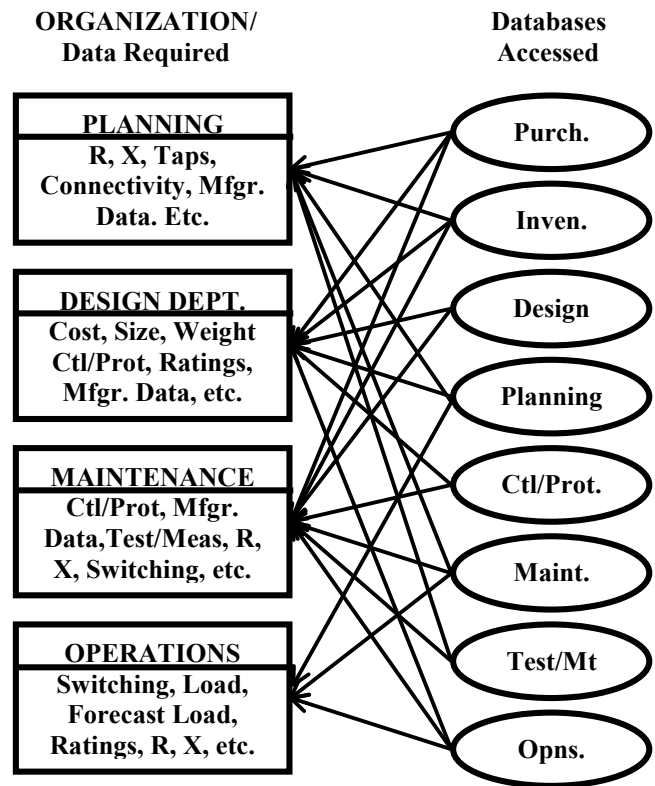


Fig. 1. Data islands result in complex application inter-relationships and encourage data multiplicity

the interactions and data multiplicity when the scenario is expanded into the entire utility data complex.

## III. INFORMATION AGGREGATION SCENARIOS

There are two methodologies available for improving the quality of data transmitted across the enterprise. Each will be discussed in the following section. The first is to accumulate all data into a single data resource. The second is to recognize and accommodate today's individuality between data stores and establishes rules and communications protocols for intercourse between the diversified data.

### A. Enterprise Resource Planning (ERP) Strategies

Much is said today about the benefits of ERP systems that aggregate business information systems and data while they aid in re-engineering functional objectives and responsibilities. Some see ERP as providing entire business systems integration and applications in one package. Others view ERP as providing a business data aggregation across the enterprise that enables selection of "best of breed" applications.

ERP systems have established themselves in the commodities manufacturing arena, but one may ask whether today's utility business sufficiently resembles a manufacturing organization such that ERP will make a utility

successful. The case may be made that ERP systems are more relevant to business decision applications than they are to the technical applications that keep electric utility systems operating reliably. There presently seems to be no consensus on utilities' use of ERP. Based on an industry survey, fewer than 40% of the major utilities have taken the ERP road, citing that it just may not be the time [1].

## B. Integrated Data Strategies

An alternative to wholesale adoption of the ERP methodology is to align existing data information sources within a utility into a cogent virtual information system. There are several strategies that are being cultivated toward this end. These generally give the appearance of a single all-encompassing data structure to support technical efforts within the utilities, while maintaining the individuality of data sources.

ERP or not, there still remains a strategic need for utilities to aggregate their technical information from across the various databases that exist within the utility. The question is what strategy is safe, will make progress toward future needs, and will not paint the utility into a corner if and when the ERP decision is made?

The remainder of this paper will provide a roadmap toward information aggregation in the electric utility consisting of applying today's technologies, stretching slightly into new frontiers, and suggesting ongoing activities that will provide a pulse on the integration progress in the industry.

## IV. PRESENT OPPORTUNITIES

In the early 1990's, EPRI (formerly the Electric Power Research Institute) initiated several data communication and aggregation projects, primarily in the utility operations and distribution automation arenas. The Control Center API (CCAPI) task force, sponsored by EPRI, has developed the Common Information Model (CIM) which is a data representation for the types of data generally found in electric utility EMS systems [2]. The CCAPI task force goal is to develop an API such that applications in the utility operations (e.g. EMS) environment will be "plug and play."

The EPRI Utility Communications Architecture (UCA) work in automated substation and distribution systems has spawned the GOMSFE (Generic Object Model for Substations and Feeder Equipment) data model. Adopting this data model enables area network communications to occur between dissimilar equipment from suppliers who subscribe to the UCA environment.

These two activities, CCAPI and UCA, could converge to enable communications from the electrical service meter (or below) all the way to the EMS control room. This EPRI work is unique in that it has the support of the manufacturers who are now implementing the data representations. This

vendor activity, plus the cross-pollination of the IEC with representatives from these EPRI forums make timely standardization of data representation a reality.

GOMSFE modeling is strong in substation and distribution automation with greater than 20 vendors demonstrating their UCA products at a recent UCA seminar. In operations, at the present time there are on the order of three or four vendors who subscribe to the use of the CIM as a data model and are offering products based on the CIM, while building on and expanding the CCAPI efforts.

Beyond these EPRI-inspired activities, there are many other activities that have been initiated on a number of fronts. While these activities will be discussed in more detail in later sections of this paper, some treatment here is justified.

The International Electrotechnical Commission (IEC) Technical Committee 57 (TC57) Working Groups 10-14 (WG-10 to WG-14) are actively engaged in standardizing data structures used throughout the "wires" side of the utility industry. The CCAPI organization has submitted the CIM model to the IEC as a proposed standard, and every indication is that the CIM will be adopted on the whole as an IEC standard. Similar liaisons between the UCA/GOMSFE working bodies and the IEC are bringing similar cooperation in the substation area.

Coordination of efforts on other fronts is accelerating the standardization of integration methodologies. The CCAPI Working Group has formed alliances with the Object Management Group (OMG), a body in which representatives from major industrial groups are cooperating to define common application interfaces. Groups representing medical, industrial, utility (water, gas, electric), automotive, etc. participate in the OMG activities. As a part of these activities, a proposal has been put forth to OMG to develop a Data Access Facility (in accordance with the general needs of the CCAPI). The OMG has brought other parties to this proposal from which the utility group can learn.

The goal of these efforts is to enable any enterprise software application to address a standard variable (e.g. transformer.resistance(I)) and know that the enterprise environment will recognize this variable as a singular entity on the enterprise. Fig. 2 is an illustration of the logical interactions in Fig. 1 with data aggregation.

Some of the benefits of a standard data model for data exchange are:

- Applications written to a standard environment require less environmental customization;
- Each data supplier or consumer must only know how to translate to a single model instead of multiple point to point translations;
- Although data may be distributed, a virtual database built upon a common schema helps reduce data duplicity;

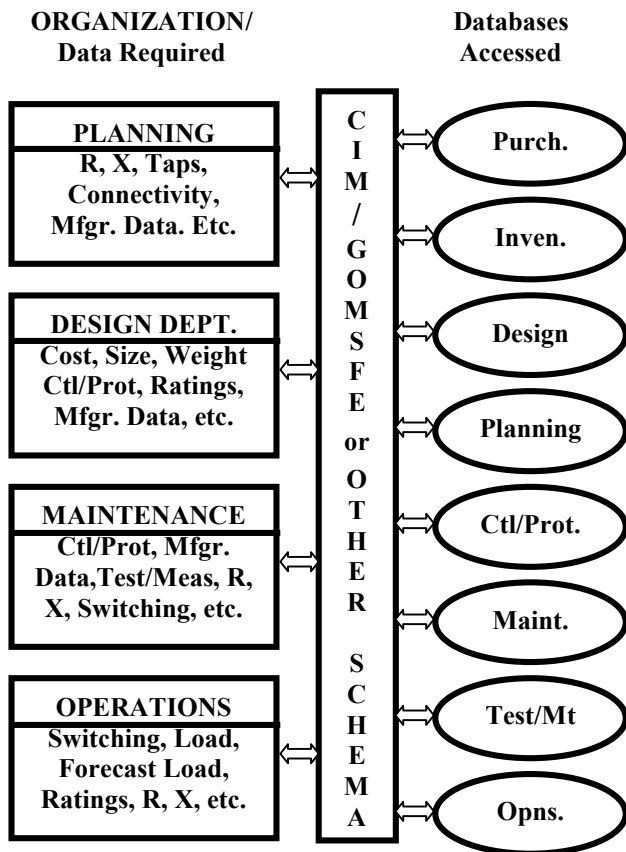


Fig. 2. With a uniform data schema, the logical relationships become much clearer and potentially, data multiplicity can be avoided

- Making data changes available enterprise-wide to numerous applications simultaneously;
- Given an “open” system, front office tools such as MS Excel, Word, etc. can access the enterprise data; and,
- Moving in this direction maintains pace with enterprise developments making it less rigorous to take subsequent steps in advancing capabilities.

Derivatives of this logical layout are already demonstrating these benefits. As mentioned previously, the interoperability of substation devices has already been shown to be a reality using the UCA/GOMSFE technologies. Also, in the EMS arena, use of the CIM is encouraging the aggregation of vital EMS model data from different vendors into a single data model in yet another vendor’s data schema. This is critical to the ISO/RTO/Security Coordinator activities in the USA.

## V. THE VISION

The strategy needed to stay in the race over the near term is to recognize the value of the standard data definitions and integration methods and to begin to move toward them. Efforts are being put forth both in the USA and in the international arena to create a unified integration reference model for use by the utility industry.

The view presented up to this point has been database-centric, relying on a “database” at the center of the scheme. If the “database” in Fig. 2 is now viewed as only a data schema, and a communications bus is placed over the top of this shell as shown in Fig. 3, the logical view of the world becomes very powerful. In this enterprise arrangement, the individual databases among all the departments have become more or less extinct and have been replaced with applications in each of the departments that serve up the data, or calculate and serve up the data, as the environment changes or as data is requested. In other words, the applications virtually talk directly to each other rather than through intermediary databases. The communication bus performs the required data translations.

Currently, the CCAPI task force is defining this communication bus. At this point, the working group has concluded that a message bus is well suited to utility application integration where one wants to tie together existing loosely coupled applications.

The “message bus” evolution promises plug and play applications and real or near real-time communications. Such visions have been developed and installed in other industries, and derivatives of these have shown themselves to be quite effective in the utility industry [3]. There are projects underway to install more elaborate versions of a messaging bus within a utility.

## VI. THE BENEFITS

Translating the payback from such an enterprise installation into a single benefit is difficult. Once the concept is put into place, the possibilities mushroom.

Consider the transformer example above, now with enterprise messaging in place. The transformer is now viewed as a single object on the enterprise that holds all the transformer’s data. Departments can pick and extract data from, and place data in, the transformer, as needed without generating multiple data entries. The transformer was created by planning and will probably live on within the enterprise long after it is physically scrapped.

Planning no longer needs to keep duplicate data, since when a planning study is started, it generates the transformer object and goes to the message bus and requests specific information on the last similar transformer. Each application on the message bus that has appropriate data serves up its data to the transformer object. The planning database contains only in-service and status data for the transformer – all the other data is in other applications across the enterprise.

The design engineer needs only to specify a particular transformer. The design drawings, the cost and construction estimates, and protection requirements can be made available via integrated applications.

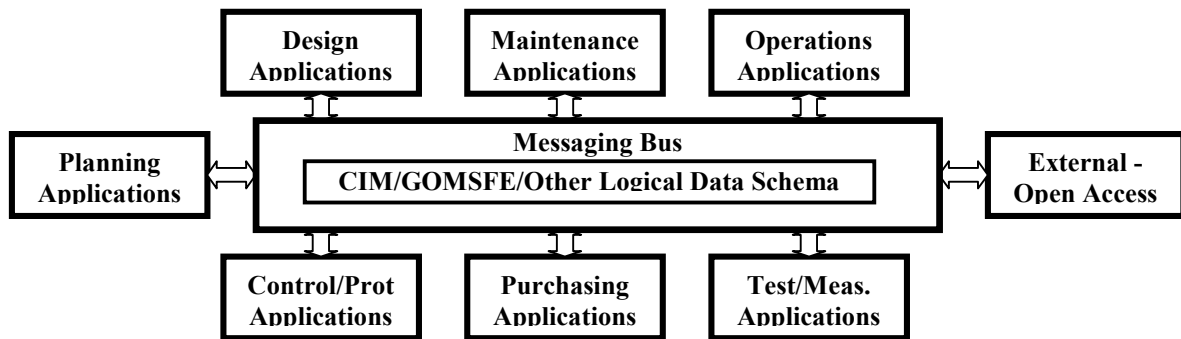


Fig. 3. The messaging bus vision, operating on the central core of a standard logical data schema, brings the promise of plug-and-play applications and real-time communications between applications

Operations information for the transformer is immediately available to other systems, including when a transformer is scheduled to be taken out, when it is switched out, and when it is placed back into service.

One of the more dramatic improvements in capabilities is in the maintenance department. Continuous monitoring of devices such as a transformer becomes more and more important as Reliability Centered Maintenance is adopted. For example, a message bus can be configured so operational data can be sent to a preventative maintenance (PM) system automatically. The PM applications can also retrieve historical data and send alarms to maintenance crews, or initiate requests for substantive data reports for delivery to the maintenance crews.

The opportunities would seem endless once there is one language in use across the enterprise; but these opportunities are increased even more when, in addition to the language, the communications are standardized.

## VI. MAINTAINING CURRENCY

Data aggregation and enterprise messaging are not only seen as critical steps toward improving capabilities, accuracy, and efficiencies, they are seen as plausible readiness steps for an ERP implementation in the future.

The following discussion describes various activities that are guiding the developments in utility data/information enterprises and the organizations sponsoring the activities.

### A. Control Center API (CCAPI)

This is a volunteer organization, sponsored by EPRI, and has no membership fees. It has developed the CIM data schema and provides a forum for discussing and informally refereeing extensions to the CIM. Its main area of investigation at this point has moved from the CIM to the API's and inter-application messaging. For information on CCAPI activities, see the ftp site hosted at: <ftp://ftp.kemaconsulting.com/epriapi>

### B. IEC Technical Committee 57 Activities

Technical Committee 57 of the IEC - Power System Control and Associated Communications has five Working Groups working on data definitions for the utility industry. These activities are identified as the following. Also see the IEC web site: <http://www.iec.ch/home-e.htm>

WG-10: Communication standards for substations: Functional architecture and general requirements

WG-11: Communication standards for substations - Communications within and between unit and station levels.

WG-12: Communications standards for substations: Communication within and between process and unit level.

WG-13: Energy management system application program interface (EMS - API). To produce standard interface specifications for "plug-in" applications for an electric utility power control center Energy Management System (EMS) or other system performing the same or similar functions.

WG-14: System Interfaces for Distribution Management. Identify and establish requirements for standard interfaces of a Distribution Management System (DMS) based on interface architecture.

### C. Object Management Group (OMG)

The Utilities Domain Task Force of the OMG is currently working on two application interface specifications: The Utility Management System Data Access Facility; and the Data Access from Industrial Systems interface. The former deals with data access from simulation and analysis applications and the later deals with SCADA data access. More information can be found on the OMG web site at: <http://www.omg.org>

## VII. SUMMARY

A common data schema applicable across the entire electric utility enterprise was once thought of as a ridiculous undertaking. In the times that this assessment was made, the tools were not at hand to accomplish this task. However, in this age, other industries are having measured success in defining enterprise-wide data aggregations.

While the utility industry processes are perhaps not a mirror of the activities in these other industries, much has already been gained by those in the utility market who have started down this road of common models for information organization.

Whether ERP is in the works or not, it would seem that the aggregation and presentation of data in a common scheme has benefited those who have begun this undertaking. There is also something to be said for organizing technical data in a common industry form prior to undertaking an ERP process where somewhat arbitrary definitions are applied to technical data. In the long run, organizing along industry standard schemas will be done either before or after ERP is tackled. There would appear to be some benefit to tackling the technical data standardization prior to undertaking the ERP processes.

## VIII. REFERENCES

- [1] Cissna, Tami, "ERP Software Packages May Not Fit the Business Strategy," *Utility Automation: Innovative Energy Solutions*, vol. 4.4, May, 1999, pp.24-30.
- [2] EPRI, "Guidelines for Control Center Application Interfaces," EPRI Technical Report TR-106324, Project 3654-01, Final Report, June 1996.
- [3] Brown, Pat, "KCPL CIM Project," EPRI CCAPI Workshop, September, 1997 (see: <http://www.ces.com/uib/workshop/index.htm>)

## IX. BIOGRAPHIES

**John Gillerman** graduated with a BSEE from Rutgers University, New Brunswick, NJ. Mr. Gillerman has over 16 years experience working in the field of power engineering. Since 1988, Mr. Gillerman has concentrated on the design of software systems for power system monitoring and control. At SISCO, Mr. Gillerman has co-lead the design and prototyping of the Utility Integration Bus (UIB). The UIB is a utility application integration tool based on open standards. Mr. Gillerman has served as the Integrated Security Network Facilitator for NERC's Data Exchange Working Group as well as been active in EPRI's MMS Forum, OMG's Utility Domain Task Force, and EPRI's Control Center API working group.

**Stephen Mauser** (M' 1968, SM' 1979) was born in Seattle, Washington and received his BSEE from Oregon State University and MSEE from the University of Pittsburgh. In 1969 he joined Westinghouse Electric as a Power Systems Engineer in the Advanced Systems Technology division. He held various positions at Westinghouse and performed research and development projects in both software and hardware engineering. In 1988 he joined Power Technologies, Inc and was Manager of the PTI Transmission and Distribution Department. With Westinghouse and PTI, he directed five major engineering workstation and test facilities' software development efforts. In 1997 he joined EPRI as Manager of Software Delivery, and in 1999 he joined PsyCor International where he continues the design of engineering and information software. He is an active participant on the EPRI CCAPI Task Force. Mr. Mauser is a registered Professional Engineer in the Commonwealth of Pennsylvania, and in 1979 received the honorable mention EKN Outstanding Young Electrical Engineer award. He is an amateur radio operator and holds a multi-engine instrument commercial pilot certificate.

**Daniel Nordell** (M' 1970, SM' 1983) was born in New Ulm, Minnesota and received his BSEE from the University of Minnesota. In 1969 he joined the Northern States Power Company Research Department. During his time at NSP he has worked on a number of advanced automation and data communications projects. He has been part of the EPRI UCA work from its inception. He is currently a Senior Consultant at NSP, where he is working to deploy advanced distribution automation systems. He is a member of several industry standards groups, including IEEE Standards Coordinating Committees 31 (Metering) and 36 (UCA), and several working groups of the IEC Technical Committee 57. Mr. Nordell is co-chair of the OMG Utilities Domain Task Force, chairman of the IEEE PES Communications Committee Protocols Subcommittee, and a member of the EPRI CCAPI Task Force. He received the IEEE Young Engineer of the Year award. Mr. Nordell is a registered Professional Engineer in the State of Minnesota, has Amateur Radio Operator and commercial radio licenses, and holds a private pilot certificate.