

BIOGRAPHICAL INFORMATION

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Specific Responsibilities

Join company in April of 1997. Manages product development projects for power utility customers, including all aspects of design, implementation, and delivery of product. Also manages data delivery projects including such as aspects as data extraction from source systems, process development for data manipulation and enhancement, and data integration and export to target formats. Responsible for interface analysis and configuration of FastGate gateways to meet specific data requirements. Leads project teams and manages resources dedicated to each project.

Past Experience

From 1997 to present have been a Product Development Manager and Research Engineer for Osmose Utilities Services, Inc, (formerly Coherent Networks, Inc.) of East Syracuse, NY. From 1994 to 1997 was a Research Engineer at the Institut de Physique Nucléaire, Orsay, France. Was previously a Research Associate at Physikalisches Institut Bonn, Bonn, Germany.

Education Information

BS – Physics, University of Delaware, 1986.

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Data: The Key to Successful System Integration

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Introduction

Any implementation of an operation support system such as Outage Management, Energy Management, or Engineering Analysis used by an electric utility requires a number of pieces to come together to be successful. These pieces include the following:

- Technical expertise on the operation support system
- Knowledgeable and supportive end-users
- High-quality data feeding the operation support system
- Good communication between parties involved

This paper will discuss the lessons learned from one particular implementation of an Outage Management System at one particular electric distribution company, Los Angeles Department of Water and Power (LADWP). The discussion will consider the need for operation support systems in a power system, their complex nature, and their critical dependence on accurate and precisely formatted data.

System Requirements at LADWP

LADWP has operated an Outage Management System (OMS) from M3i / CGI for 12 years. It has included a pure graphic-based (MicroStation) as a component of source data to populate and maintain GIS data in the OMS database and diagram files. The OMS system, in conjunction with an integrated Mobile Dispatch System, is used to handle all electric trouble work at LADWP, both emergency and scheduled work, and has become an integral part of daily operations for the utility. The graphic-based source system data had been customized to handle verification and deployment of circuit connectivity before being available to a process that imports the necessary data into the OMS system along with facility data from various other systems. This data is used within the OMS system to accurately display both the electrical network layout and electrical status. This same

information is also made available to the field units as a visual tool to display the same information, though in different formats.

Operation support systems such as an OMS system help maintenance/trouble crews both in their day-to-day activities and during trouble calls such as vehicle accidents and major storm situations. To respond quickly to trouble incidents, crews need to know where to go. The OMS system is generally very good at this. Based on the incoming trouble calls, the OMS system will use its inferencing engine to pin-point the equipment that has a fault. However, if the OMS system does not have a fully connected network model, the inferencing engine will make mistakes. It may have numerous “orphan” or “misconnected” calls, creating confusion and extra work for the crews in the field. Such factors also have an enormous, adverse effect on the accuracy of any reliability metrics that a utility typically reports to the local public utilities commission.

All customization of the graphic-based source data system was done in-house with changes to the system required anytime upgrades to the OMS system were made. Costs and resources were growing with each OMS upgrade due to issues with knowledge transfer and implementation on old technology. No enhancements to the interface system were possible due to data confines with both the graphic-based source data and other systems providing source data. Twelve years of data enhancements and business process improvements could not be implemented within the scope of the existing interface.

When LADWP began implementation of its new version of the OMS (CGI’s PragmaLine V5) and its new functionality, a switch from pure graphic-based source data system to a newly implemented GIS (Intergraph FRAMME) based data was possible. In previous versions of the OMS system, all data had to be associated within the connectivity of the circuit data being imported from the graphic-based source data. In this new version of the OMS, additional information could be imported into the OMS system even though it may not be part of the connectivity of the circuit itself. This allowed for more information to be made available to the system and be available graphically for the end user to make business decisions in a more informed manner.

The cost and timeframe of building this new import process in-house would only lead to the kinds of functional limitations imposed by the old graphic-based system with no room for enhancements or new functionality. A decision was made to look for outside assistance in providing a solution that not only provided the OMS system with all the information required at this time but would provide a path for future growth and enhancements without a large commitment of internal resources.

Technical Expertise

Requirements for the new OMS model system were based on 12 years of experience running a circuit- and customer-based distribution model. With enhancements to the new OMS system and the availability of the GIS system, this was precisely the time to make changes to the process in which this distribution model was imported into the system. It

was important not only to understand the basic requirements for the OMS system, but to execute on LADWP's accumulated experience in creating business process improvements that have been difficult to implement due to the legacy system interface and patchwork changes made to it.

The support team for the OMS system has 40 years of experience with both outage management systems and the graphical information that is required for the interface, most of that with the OMS. While the OMS has evolved over the years, the basic functions of using connectivity data extracted from the graphic-based data environment for the basis of grouping customer calls and incidents within the electric model have remained the same. This provided a strong basis on which to build the final functionality the interface was to provide. It also cut down on the amount of time the project team expended searching for answers on issues that were to arise. What the OMS support team was lacking was an understanding of the functionality in the new GIS system and the intricate details of how information was available from the system.

The GIS implementation group was still available for use in the project. This avoided the pitfalls of reverse engineering or relearning the GIS system in order to accomplish requirements that were to be defined for the interface. While members of the GIS group realized that one of the benefits of having a GIS system was to provide this data to the OMS system, they also saw that in the structured environment of this interface, they would be able to catch problems with their data and correct it as it became necessary.

In an attempt to avoid many of the problems having occurred with integration of data between two systems, it was decided early that any solution would not rely on changes to the business process or system structure of the source system, in this case the GIS system. If functionality was missing or data was not formatted in a convenient way, it would be up to any solution to fix this problem. Too many times had changes been made to the source system that was providing data to the outage management system. This would either lead to problems in other areas of the source system, or would always seem to lead in limiting upgrade possibilities for the existing integration system.

Supportive End-users

The end users had extensive experience operating the outage management system. With this experience, users have requested modifications that were limited to the graphic-based interface that was in place. Now, with the chance to implement all of the improvements that have been requested over the past 12 years, the end-users were extremely supportive of this project. Requirements were gathered and used as a portion of the business case to move forward. These detailed additions, plus all previous requirements, set a goal for the final product that was well defined and would satisfy all current end-user requirements.

From a user perspective, the quality of data is the most important requirement necessary for a successful implementation. Ninety-five percent data integration would not be considered a success and with the implementation of the Mobile Dispatch System, this data was now viewed by both dispatchers and field personnel in both tabular and

graphical form, usually under emergency conditions. The user was looking for both verified quality data from the new system, and a tool in which, if the data was incorrect, corrections could be made or information added quickly for use in the system within moments of a change. This tool would have to be simple to use, not based on the requirements that the GIS system puts on data input and verification, which was too complex for users use.

In addition to meeting these requirements and the capabilities for future enhancements, turnaround time with the new GIS system could be handled immediately, meaning that the information in the OMS system was current, unlike the old graphic-based interface whose interface process would keep circuits within the distribution system out of date for unreasonable lengths of time.

Good project communication

Because expertise in each system tended to lie within the subject area and with the technical experts for each system, it was important that communication took place not only between those responsible for the development of the interface, but among those ultimately seeking the solution. It was important that all sides understood the major functional requirements for each system and how that information could be used to best develop the solution. To facilitate a timely product, project management identified proper technical experts, and while project management was involved in overview conversations, it was properly implemented to make sure there was always communication among all. There was to be no delay in technical issues. If any technical questions were to come up, communications lines were to be opened immediately, including documentation and synapse for project management review.

Meetings were scheduled weekly between all parties involved, facilitating both understanding of each portion of the solution and allowing lines of communication to remain open. As solutions for each phase of the project were completed, it was important that everyone involved knew that both a milestone had been reached and that any solution may have had requirements placed on it that was important for all those involved to understand. It also became apparent that in spite of all communication, documentation became extremely important to avoid repeating problems that had already been technically solved.

Importance of High-Quality Data

The system of record at LADWP is the GIS system. It is a complex system supporting many aspects of various business processes within the organization. These include field inspections, pole-spotting inspections, planning for load calculations, system mapping and others. Another important related business process is to update the OMS whenever the circuit information to the 'as-built' system in the GIS system is updated. As more business processes are supported, the data and data models are forever changing, thus in this regard the GIS is a moving, changing source of data. While the OMS is also a

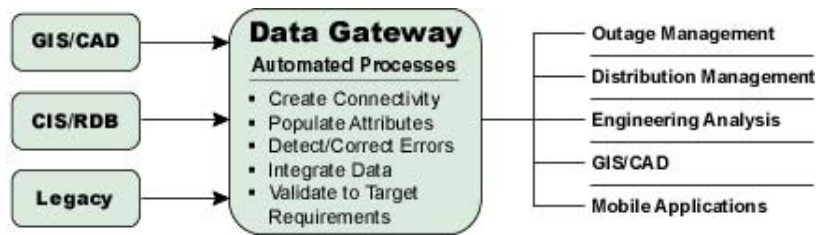
complex system, it has a well defined data structure. This data structure is critical to enabling the OMS to function in effective way.

It is also critical that the data feeding the OMS is accurate, complete, and timely. Small errors in the data feeding the OMS often translate into large calculation errors by the OMS application (Petrik, 2004). While the GIS system, in principle, models the network information necessary to support the OMS, the data is not always there to support it. Data problems include badly formatted data, wrong data, or just plain missing data. Thus writing a standard interface that maps attributes of the GIS to attributes in the OMS data models was not enough in this case. This just takes the data problems that exist in the GIS and sends them along to OMS system. The solution chosen for LADWP is one that the telecommunications industry has used over the last few decades: a data gateway.

The Data Gateway Solution

System integration projects come in a variety of forms and types. The integration could occur in real-time, in near real-time, or in a batch mode. Batch mode integration could be a process that is automatically run or manually initiated at the appropriate time as determined by an end user. The system integration project could make use of messaging bus architecture, a bulk-file-based transfer, or a software strategy commonly referred to as a data gateway. Each of these integration methods has its pros and cons. Ultimately it is the business function requirements that dictate which method is the most appropriate. LADWP opted for the data gateway approach to integration. The utility selected the FastGate Gateway technology from Osrose Utilities Services as the data management gateway strategy. Because of issues related to source data, both from an underlying design view point and various known data-related problems, this data gateway solution permits data structure changes, data enhancements, and data corrections before putting the data into the target OMS.

A gateway solution makes use of an intermediate system between the source data systems and the target systems. In some regards it can be considered a portal between the source and target systems (Czyzewski, 2002). The data gateway is the software bridge between the two systems. However, it is more than just a “pass through,” since the gateway system has detailed knowledge of both the source data and target data systems. The gateway provides the automated data transfer path of all required data. In addition to data transfer, however, the gateway is responsible for verifying existing electrical connectivity and for performing numerous data verifications to ensure that data delivered to the OMS is accurate and appropriately formatted. Well known problems can be automatically accounted for and corrected. For data problems that could not be automatically corrected, the gateway provides an opportunity to make modifications and corrections to the data before continuing the process. The gateway solution not only established a clean interface into the OMS system but as a side benefit provided a tool to correct problems within the GIS system that have been overlooked up until this time.



The data gateway “understands” the source systems in a number of ways. It knows the data format, knows how the data is structured into tables and/or objects, knows what attributes exist on each, and knows how these tables or objects are interrelated. The gateway software also understands any data-related problems within the source system, in particular how it pertains to the target system. This is because the gateway also knows how the data needs to be explicitly formatted for the target. It knows which parts of the data structure are critical for the proper operation of the target system. In effect, the gateway software has folded together the pertinent pieces of the source system data models with the target system data models.

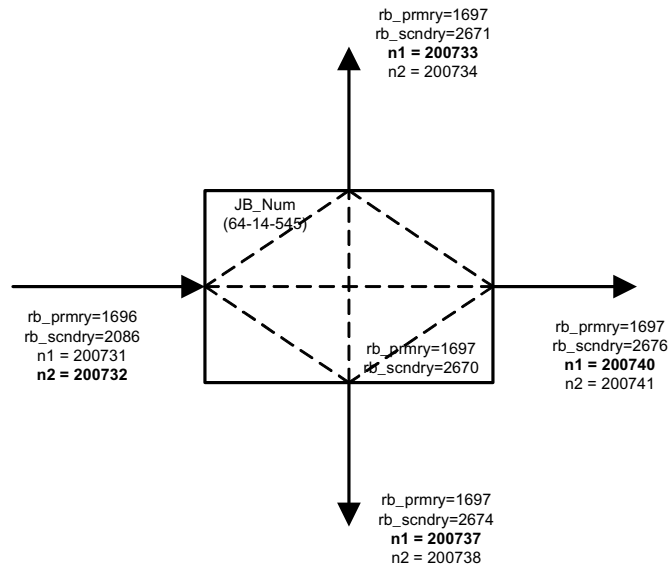
Connectivity Modeling and Correction

A good example on how the gateway solution folded together the data model of the source GIS and the target OMS is the differences in the connectivity models. The GIS uses a logical two-node connectivity model that is independent of current flow. Every protective device or primary span has two unique node values, but these node values do not have a “direction.” That is to say, one can not determine which node is the “from node” and which is the “to node.” Furthermore, the GIS system modeled some devices with multiple nodes with implicit “protective devices.” A good example of this is how junction boxes were represented in the GIS system.

The OMS application, on the other hand, uses a graphical and logical two-node connectivity that respects the direction of current flow. Each device and span has two nodes values, where one value is considered the “from node” and the other is considered the “to node.” In this way, the OMS inferencing engine can determine either the upstream or downstream devices from any position on the network circuit.

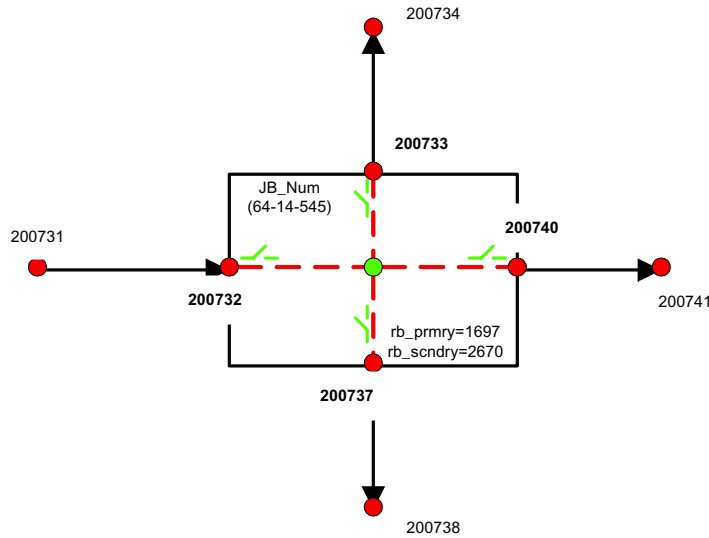
A typical junction box has up to 4 feeders and/or primaries arriving to/departing from it. An actual case is depicted in the diagram below for the junction box number 545 on circuit 64-14. In this case one feeder approaches the junction box from the left and 3 primaries depart from it. For this particular junction box, the GIS models the connectivity with 6 different entries in its connectivity table. These 6 entries correspond to the 6 different possible connections between the 4 feeders/primaries. This is depicted in the figure by the four dashed (black) lines. The GIS connectivity table determines if any of these dashed interconnected lines are “energized” or not. The junction box itself is not a noded object, i.e. an individual unique node does not exist for the junction box.

This method of modeling connectivity within the junction box will create multiple loops (and hence errors) within the OMS connectivity model.



Junction Box Connectivity within FRAMME

Once the data has been imported into the data gateway software (primaries, feeders, junction box, and corresponding connectivity information), the connectivity model is automatically altered by the gateway software as depicted in the figure below. First, a node will be created at the location of the junction box with a unique node ID as well as at the ends of feeders/primaries with the correct node ID based on the information within the GIS connectivity table (red dots). Then four new primaries will be created between the node of the junction box and the nodes of the 4 feeders/primaries (red dashed lines). Finally, four actual switches will be generated at the location of the nodes of the feeders/primaries and will be related to the nodes as well as the four new primaries. The switch positions of these switches will be determined from the status1 and status2 values of the GIS connectivity table. This method of modeling the connectivity better matches the connectivity model within OMS.



Junction Box Connectivity within Data Gateway and OMS

Conclusions and Future Plans

One of the main conclusions that can be drawn from this project is the importance of high-quality data. This can not be overemphasized. At the lowest level, if the data is not formatted correctly, the OMS will not accept it. But past this formatting issue, if the data is not accurate and complete, the OMS will generate errors that translate into sending crews to the wrong locations and service reliability metrics that are calculated and reported incorrectly.

Another important lesson learned is that you can't always rely on the data getting corrected in the source systems in a timely manner. For one, the source systems are typically the systems of record for a number of business functions. It is possible that correcting the data for one business function actually "breaks" the data for another business function. One could argue that this is poor design within the source system, but it is often difficult to know all the various business functions that will be needed at the time of system design. The data gateway solution overcomes this by enabling data correction and formatting specific to the target system without having to go back and re-design the source system.

Secondly, data within the source systems changes over time. Connectivity data will slowly but continuously change. Therefore there needs to be a long-term, ongoing commitment to data maintenance and data quality. Poor data quality often quickly leads to a catastrophe. "Data must be not only collected but maintained, an additional task that forms part of the data maintenance process" (Thurbly, 2002). The data gateway solution provides a method for ongoing data-checking, in particular as it pertains to the target systems.

The gateway approach selected by LADWP provides the high-quality standard required by an operation system such as OMS without requiring changes to a GIS system—changes that may impact other functionality within the GIS. As long as the GIS system can provide the core requirements expected of it, any other changes should not impact other systems it may interface with through the gateway.

LADWP has future plans to enhance and expand the use of this gateway technology in the following areas:

- Modeling of sub-transmission and transmission system for the OMS systems.
- Provide model of circuits for other systems such as SCADA, Energy Management System, and distribution and sub-transmission planning.

This system integration approach for these and other systems will enable LADWP to leverage the investment in these systems and in the data that drives them.

References

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