Conducting a GIS Data Refresh—The Foundation of Your Smart Grid Program

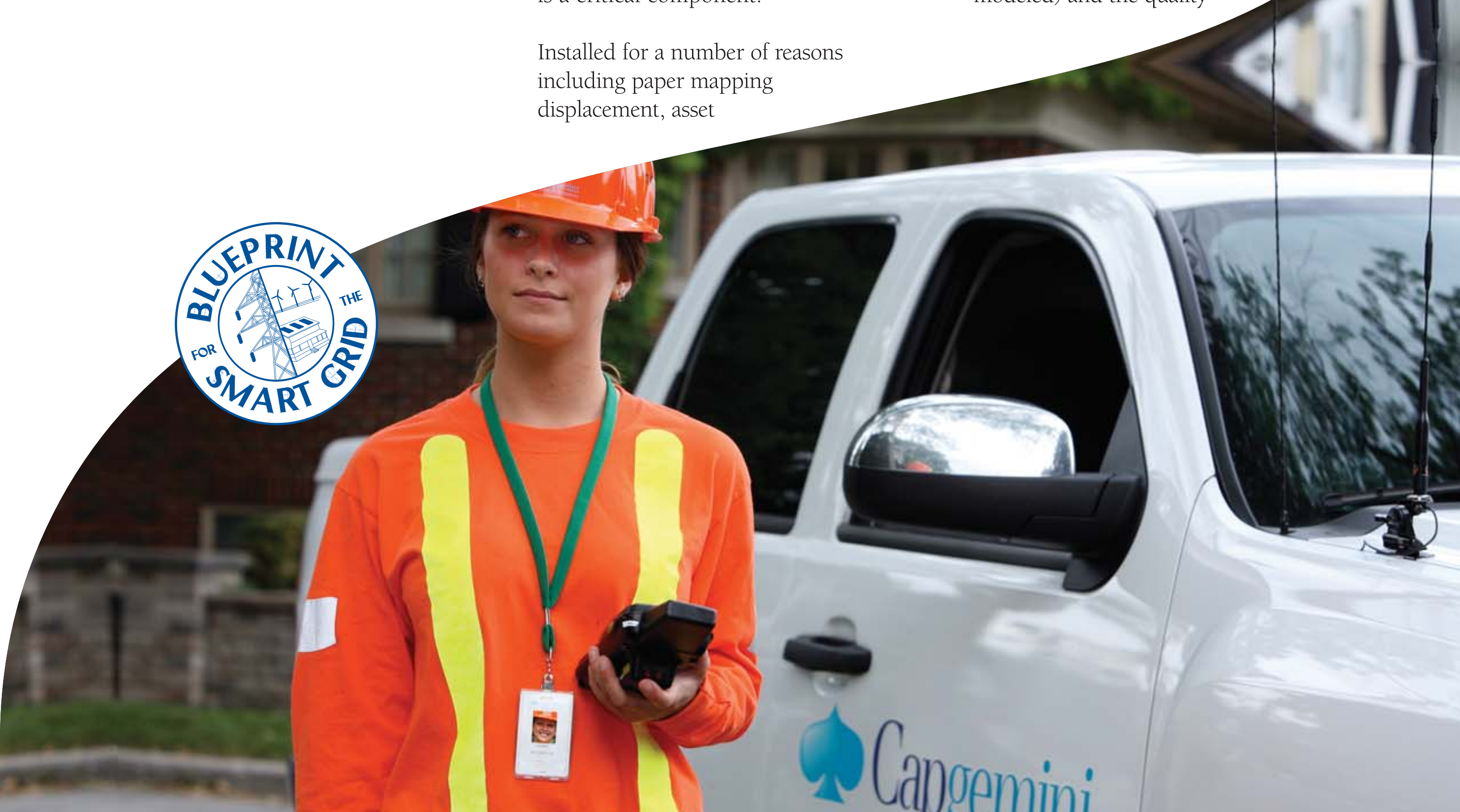
GIS refresh strategies, processes and considerations

Introduction

After worldwide spending on Smart Grid initiatives in 2008 exceeded $12 billion—a total expected to surpass $33 billion within the next five years—utilities are intensely focused on maximizing their Smart Grid investments. To that end, companies are reviewing the state of their existing infrastructure systems. To successfully meet the future business expectations of Smart Grid, the availability of complete and accurate grid data is essential. Therefore, the Geographic Information System (GIS) is a critical component.

Installed for a number of reasons including paper mapping displacement, asset management, engineering design and construction and to support advanced applications such as outage management, GIS has been around most electric utilities for many years.

As they begin to implement Smart Grid initiatives, utilities are increasingly realizing that the accuracy of the data stored in their GIS is essential to their projects' success. As a result, companies are concentrating on two GIS issues that significantly impact Smart Grid implementations: how the initial GIS was implemented (how data was modeled) and the quality



of the electric network data contained in the GIS. Utilities that implemented GIS as an asset model frequently discover that the electric network data may not be electrically connected creating complete electric feeders as required by Smart Grid. The other issue of data quality is obvious -- with incorrect network feeder data, the Smart Grid is unable to correctly analyze and operate the electric network.

Solving both of these issues requires refreshing and correcting both the model and the data contained in the GIS. However, as companies quickly learn, conducting a GIS data refresh is more complex than performing an initial GIS data loading. For most utilities, the initial data loading was easier to estimate because all data had to be validated and input into the system. With a GIS data refresh, all the data must be reviewed and validated (typically called a "walk-down") but only new data and errors must be updated ("data posting"). Because many factors can affect the costs of a refresh effort, the purpose of this paper is to review and discuss GIS refresh strategies, processes and considerations.

Feeder Walk-Down

The feeder walk-down is the process of an operator physically walking each feeder starting at the substation and tracing it to the end of each branch. During the walk-down, the operator validates all current GIS data and collects any missing data. In addition to correcting the current GIS data elements, if Smart Grid initiatives require data that is not currently maintained in the GIS, the operator must update the GIS data model and collect the additional data during the walk-down. This is usually done by printing paper feeder maps from the GIS and marking up the maps with discrepancies as the operator walks the feeder.

The data to be captured or updated depends upon the utility's data requirements. However, it typically includes electrical connectivity, circuit phasing, electrical asset information, sizes, ratings, and conductor configurations.

Two major factors impact walk-down costs: the labor rates of the walk-down field operators and their productivity. While the labor rates can usually be easily determined, field crew productivity can be impacted by a number of factors which vary between overhead and underground construction. We will look at each type of walk-down separately because they vary significantly.

Overhead

The easiest and least costly walk-down is of overhead construction. These feeders are visible, reasonably easy to access and fairly easy to understand. Operators need only to start at the substation then follow the wires, noting any electrical device or change. They do not need special skills or experience that cannot be provided through simple training. They can be outside contractors or unassigned internal staff. Crew size can be one-man or two-person depending on local utility requirements and desires. If the feeder can be driven, sometimes the increased cost of two-man crews can be offset by the increased productivity. An allocation should be provided to cover overhead and transportation costs.

Factors that affect productivity include the type of electrical construction, the number of feeders per right-of-way, feeder accessibility (backyard, alley, etc.), number of devices per feeder, number of customers per feeder, the amount of new data to be collected and most importantly, the number of GIS data errors detected that must be documented. An overhead walk-down usually has minimum safety concerns since the walk-down staff is not required to make contact with electrical equipment.

Underground

A walk-down of underground construction is much more complex and expensive. Unlike overhead, underground construction requires inspection teams to open enclosures, man-holes and vaults. This increases the complexity, safety concerns and crew skill requirements. These issues usually result in the need for supplementary crews and equipment support to meet safely requirements. The result is increased costs and reduced productivity. An allocation should be provided to cover overhead and transportation costs.

Factors that affect productivity are basically the same as for overhead with the added complexity of exposing the underground network for inspection. Again, these factors include the type of electrical construction, the number of feeders per right-of-way, feeder accessibility (vault, man-hole, etc.), number of devices per feeder, number of customers per feeder, the amount of new data to be collected and most importantly, the number of GIS data errors detected that must be documented.

Data Posting

Following the walk-down and the documentation of the GIS data to be updated, the next major step in a GIS refresh is the posting of the documented update data to the GIS. This process is time-consuming but relatively straightforward. Many companies outsource the data-posting process, usually to an off-shore firm to benefit from the reduced labor costs.

The first step is to transfer the data updates to the off-shore vendor. If the data updates were captured on paper maps, there are two options to transferring the data: the maps can be copied and mailed or they can be scanned and electronically transferred.

The data-posting vendor's job and cost is determined by three factors: the number of updates to be posted, the productivity of the GIS software tools and the business processes imposed by the utility. It is assumed that the vendor's staff is skilled and trained on the appropriate GIS system.

The vendor normally uses the following factors to estimate the total cost for data posting: the number of feeders, the number of conductor segments (not conductor miles), the number of pieces of electrical equipment, the number of customers per feeder, the number of breaks or jumpers, and the estimate of the percentage of errors that will require posting.

By totaling the number of facilities on a feeder and assuming that 30 percent of feeder data requires updating, you can calculate the number of updates. If you assume three to five minutes per change, which is dependent upon the GIS system tools available and the business process of the utility, you can determine the cost per update and per feeder. You must also provide for the QA/QC processes, which will add additional time and costs per feeder.

First Steps – Forecasting Model

The first steps in any GIS refresh are to estimate the cost of the data refresh, forecast the expected benefits and develop the business case. To estimate the effort and cost of a GIS refresh, it is necessary to build a cost forecast model. This is accomplished by first performing an analysis of the GIS data for the feeders to be refreshed. Any new data

requirements must be accounted for and included in the GIS model.

The initial analysis should capture as much data as possible about the feeders including:

- Facility counts (all major facility types)
- Distance measurements (miles of conductor)
- Conductor segment counts
- Construction characteristics
  - Overhead vs. underground
  - Three-phase or single phase
  - Multi-circuit right of way sharing
  - Vertical vs. horizontal on overhead
- Neighborhood characteristics
  - Urban or rural
  - Front lot or back lot construction (can you drive or must you walk?)
  - Ease of access to facilities (high, medium or low)
  - Tree coverage

After an initial analysis of the feeder data and characteristics has been performed, a sample set of representative feeders should be selected for a pilot walk-down. The goals of the pilot are to capture metrics data on crew performance and the time required to walk-down the feeder, as well as to capture a sample of update metrics.

Walk-down Forecast

Following the pilot walk-down, the team should conduct a statistical correlation analysis to determine which feeder characteristic variables are significant and contribute most to estimating the cost and effort required to walk-down all the feeders selected for refresh. A separate analysis will need to be conducted for overhead and underground feeders since the characteristics and crew requirements are so different. The correlation analysis can be conducted using one of many different tools available on the market including Microsoft Excel. The results of the statistical correlation analysis will enable you to construct a forecast model using the significant feeder characteristics to forecast the time and cost to walk-down all the feeders with similar characteristics. Since the pilot sample size is limited, the forecast model can be improved as more feeder metrics are captured.

Posting Forecast

The approach for developing a forecasting model for data posting is similar to the walk-down model but the variables are different. The two factors that most impact the posting are the number of data updates required and the productivity of the operator doing the posting. The number of updates required depends on the number of errors in the existing GIS feeder data and the amount of new data that must be posted. The pilot walk-down should give you some idea of the error rates as a percentage of facilities on a feeder. The amount of new data can be determined from the data requirements and from the pilot walk-down metrics. This data then can be statistically analyzed to develop a forecasting model. The operator productivity is based on several factors. The most significant are the GIS system being used and the software tools provided with the system. In addition, the business process imposed by the utility can have significant impact. The business process can range from simple editing (fastest) to a complex asset-management work order process (much slower). And finally, the individual skill and talent of the operator comes into play as well. However, with this factor the operator tends to increase in skill as the job progresses. As always, the quality-control process must be added into the overall posting process.

The pilot sample will allow you or the vendor to capture metrics on posting productivity and cost. This data can then be used to develop a forecasting model. If the utility used an off-shore data conversion vendor, the vendor will have a great deal of experience in forecasting the effort and cost.

Summary

For most utilities, the key source of both grid asset and feeder connectivity is their GIS. Analysis of systems across North America and throughout the world has shown that while most utilities have invested significant effort and cost in creating their GIS, their data quality has been in steady decline due to lack of business emphasis and ineffective supporting business processes. In addition to data deterioration, the Smart Grid may require additional data not currently modeled in the GIS. This new data capture could be significant if the current GIS data model is inadequate.

In fact, depending upon the state of data corruption and the number of new data elements, the GIS data refresh project can be a significant undertaking. That's why the utility should assemble an experienced project team, with experience in GIS and GIS data capture.

Remember, one reason for the GIS data refresh is poor data quality. Assuming you invested in good data when the GIS system was initially installed and the data quality has been deteriorating, you will need to protect your refresh investment with improved business processes. The bottom line? The walk-down is only as good as the business processes that keep the data maintained.

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