Capturing assets: Connected network modelling enhances quality and reduces cost for eThekwini Electricity

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A different approach to conventional field data recording methods which provided benefits to eThekwini Electricity's asset capture project.

As part of developing and implementing an integrated infrastructure asset management business plan for eThekwini Municipality in eastern South Africa, eThekwini Electricity embarked on an initiative to capture and model all of its electrical network assets.

This article explores the various components of this exercise with emphasis on the solutions deployed to address project challenges from the municipality and service provider's perspectives. It also discusses the resultant benefits unlocked during and following the project execution with improved detailed data availability and how this project contributes to the Smart Grid (SG) initiatives of the municipality.

Objectives

The primary objective was to comply with the South African Accounting Standards Board – Generally Recognised Accounting Practice – Section 17 (Property Plant and Equipment) (known as GRAP17) [1] and to enable the municipality to effectively manage its assets by providing a solid foundation of reliable and detailed asset information. Secondary objectives included establishing a connected network model and enabling data integration between systems. EThekwini Electricity engaged the services of the company that the authors represent to assist with the data collection and modelling exercise. The project team had to find innovative solutions to a number of issues inherent to an exercise of this nature, including:

- Planning and executing a very comprehensive field exercise spanning an area of over approximately 2 300 km^2 ensuring high quality of data
- Developing a connected network model with more than 900 000 network equipment items recorded from the field
- Defining the asset structures for the purpose of an equipment - and asset register
- Propagating information through all relevant systems with a view to future system integration

Different approach to conventional field capture

Conventional field capture projects focus on capturing attribute data while in the field. With the low cost of high definition cameras and the low cost of storage, this changes the data capture landscape. The project team took a different approach that proved to reduce costs and enhance quality by moving most of the attributed capture work to office teams supervised by technical specialists.

High resolution aerial photography also proved to be highly effective as many asset points could be identified on the aerial photographs assisting in verifying positional accuracy of field data recorded, as well as identifying missed assets.

A network-enabled Geographical Information System (GIS) environment was used to ensure data quality and to enable future benefit to eThekwini Electricity.

Minimising time spent in the field

Field data capture exercises of a technical nature often contend with the following major challenges:

- Detailed recording of asset data in the field is time consuming and places strain on resources due to harsh environmental conditions and at times hostile environments
- Electrical network asset data is of a technical nature and often requires qualified field personnel to correctly identify the asset and record the required asset data, which greatly increases the cost of field exercises
- Field data capture errors frequently occur as a result of capturer fatigue and incorrect field interpretation
- Where there are data queries there is no simple means of validating data apart from revisiting the specific site
- No additional information is available post capture, that equipment exists or in the state as recorded

On this project, field work was limited to recording a GPS position, capturing detailed photographs of the assets and recording minimum attribute data. This resulted in significant time and cost savings as well as improved data quality.

Maximising utilisation of resources

The project team took a different approach whereby office modelling relied on domain specialists, a well-structured data capture process

GIS – Geographical Information System
GNIS – Geographical Network Information System
GPS – Global Positioning System
GRAP – Generally Recognised Accounting Practice
HV – High Voltage
IFRS – International Financial Reporting Standard(s)
LV – Low Voltage
MV – Medium Voltage
PNL – Property/ Customer Network Link
SG – Smart Grid

Abbreviations

and state-of-the-art information systems in support of a largely unqualified, data capture and modelling team. The engineers and supervisors initially trained new data capturers and thereafter assisted with ad hoc queries and interpretation of data where the data capturers did not have the know-how.

Modelling software

Data modelling was carried out in a Geographical Network Information System (GNIS) supporting real connected network modelling. This greatly enhanced the modelling quality and added value to the deliverable as a result of functionalities enabled from connectivity. Most municipalities in South Africa maintain a GIS model which simply represents the equipment location but does not include actual connectivity that supports advanced functionality including capturing and managing a Property/Customer Network Link (PNL), which is of utmost importance for network operations as well as for smart grid planning and implementation projects. The model implemented allows full connectivity from the customer to any upstream device though network topology.

The GNIS environment allowed for development of automatic placement routines for template equipment which generated the relevant equipment at the GPS location. As an example, a miniature substation shown in *Figures 1 and 2*, consists of MV breakers, LV fuses, a busbar, transformer and container. Using the office captured attributes and the GPS position a complete and specific equipment model is automatically generated in the GIS. This reduced the modelling component to mainly establishing connectivity by connecting networks between the equipment.

Figure 1: Mini-substation containing an 11 kV/400 V transformer, an 11 kV ring main unit and LV circuit fuses.

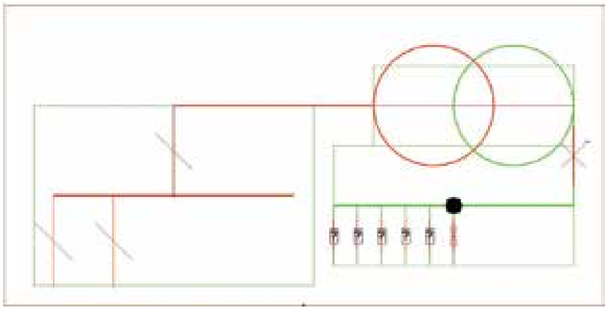

Figure 2: Mini-substation connected network model, allowing for 11 kV cable connections to an 11 kV ring main unit (left), the transformation from 11 kV to 400 V (upper right) and the connection to LV cable circuits at the LV fuses (right).

A different approach moved most of the attributed capture work to office teams supervised by technical specialists – reducing costs and enhancing quality.

Connected network model

Network modelling includes rule sets for connectivity enabling the utility to trace and follow networks from the supply source to the client connection adhering to actual network connectivity behaviour. This approach to modelling holds many benefits for the utility – it underlies all network planning activities and is essential for network operations.

As such, GNIS is the application of choice for networked utilities, including electricity, water, gas and telecommunications worldwide. GNIS software presents a realistic view of the network in terms of geographical location, how equipment connects to each other and supporting technical data for engineering analysis.

As a result of GNIS modelling, the project not only recorded asset data, but also delivered logical information regarding the assets, including:

- Network connectivity modelled from MV devices to LV networks
- Supply areas for devices is dynamic based on network open points
- Asset plant slot identification could be automated based on location within network
- Network portions completed by data modellers could be subjected to various test routines to ensure data and modelling accuracy.

Connected network modelling is still a relatively new concept for many local municipal GIS departments in South Africa which do not model connectivity.

Information is key to unlocking benefits

Proper asset management can only be implemented with good data about those assets, including its location, technical attributes, dynamic attributes and logical attributes. In electrical utilities this is a big dataset to extend and keep updated with asset counts that could easily run into the millions. It is impossible to stay in control of your asset data without proper business processes supported by relevant information systems influencing asset data.

GNIS information is helpful in providing decision makers strategic information about the network equipment for example:

- Visual representation of location of all assets
- Visual representation of connections and dependencies of equipment on one another which enables many previously impossible tasks such as:
  - Coordination of maintenance efforts by knowing which other equipment will be outaged through a scheduled HV circuit breaker maintenance procedure
  - Grouping of outstanding maintenance work-orders by spatial proximity
  - Analysing resources or tools required to perform specific maintenance tasks
- Accurate tracking of costs such as:
  - Installed kilometres of cable
  - Correct area calculation for vegetation management along feeder corridors
- Accurately informing consumers of intended outages based on connectivity
- Optimising existing transformer capacity through load tracing on connected networks
- Accurate reallocating of customers and equipment to new infrastructure is now much simpler. The GNIS allows for the 're-creation' of the hierarchies through connectivity
- Providing a holistic and visual representation to determine allocation of resources to specific functions or geographical locations
- Locating and identifying important and sensitive customers and notifying them of intended outages

Enabling smart grid technology

When analysing the functionality and requirements that utilities place on smart grid implementation, it is clear that the technology is more about managing assets and information about assets rather than protecting revenue or identifying illegal connections.

The various perspectives and requirements of smart grid implementations for the generation, transmission, distribution and customer sector point of view, rely heavily on accurate and readily available information about the customers, plant, network connections, energy sources and sinks, markets, real-time tariffs, network status, consumption, incidents, smart device location, 'area of influence', and more.

To enable this inter-operability, sufficient emphasis needs to be placed on the requirement of network information availability and how the network is connected or related to the various devices in the field.

As a result of this project, eThekwini Electricity has the ability to perform connected information analysis and unlock full smart grid requirements. Further enhancements can be implemented to ensure communication connectivity is also achieved.

Getting your assets under control

Due to various reasons very few entities have all of their asset data under control, especially at the lower voltage levels. This can be corrected by:

- Developing and implementing asset and equipment structures that make sense for your business and systems
- Establishing business processes and workflow that will ensure any future asset changes are correctly recorded in the relevant information systems
- Utilising available electronic and hard copy data to capture historical asset data (the decision to follow this step should be made based on the quality and control of historical data available)
- Field exercise to capture and update assets with lacking data

EThekwini is located on the east coast of South Africa in the Province of KwaZulu-Natal (KZN). The municipality spans an area of approximately 2 297 km^2 and is home to some 3,5 million people. It consists of a diverse society which faces various social, economic, environmental and governance challenges created by the ever increasing population.

Conclusion

Asset management is far greater than simply being compliant with guidelines such as GRAP17 or IFRS. It gives utilities the opportunity to really understand, optimally plan, effectively manage, operate and maintain their assets. Major investment is often made to ensure reporting on assets is in compliance with regulatory requirements, and utilities often miss opportunities to really address proper asset management, through projects and funding available. EThekwini Electricity realised the effort involved in enabling proper asset management, and will in future reap the benefits of investing in data capturing, implementing processes, systems and continuous training ensuring that through the unequivocal support of management the journey towards excellence in asset management is successful.

An enterprise asset management system is not just a single piece of software, but rather a system consisting of multiple parts; being processes, resources and various technical and non-technical software applications working in unity to realise asset management. There is a significant dependence on supporting systems to keep asset data up to date. Any entity serious about asset management should work through an exercise to define what asset data they need for proper asset management. This should be based on a holistic view of the assets from where a data attribute ownership mapping can be done which defines data ownership and responsibility for the various information systems.

Reference

[1] GRAP17: 2012. South African Accounting Standards Board (ACB). Generally Recognised Accounting Practice (GRAP) – Section 17 (Property Plant and Equipment).

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