DMS, Scada and GIS interactions redesigned while renewing the GIS legacy system

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ABSTRACT

Sibelga (DNO of the Brussels region) has decided to replace his old GIS suite consisting of two legacy applications based respectively on IBM GPG and Autocad.

The scope of the first system (GeoGPG from IBM) is the production of both the geoschematic maps (scale +- 1/2500 for the gas and electricity networks) and the schematic maps (orthogonal maps for the Medium Voltage electricity network). The strength of this system is the fact that the objects are the same in both representations (consistency). The scope of the second system (Autocad) is the supplying of the detail maps of all the electricity and gas networks assets. Beside these graphical applications, there are several other alpha-numerical applications for technical database maintenance (electricity cabins, gas cabins, customer's supplies,…).

The goal of the renewing of the GIS application is to develop a single, complete technical asset management tool, based on a geographical view of the assets. A major concern in this operation is with the redundancy and inconsistency of the data between the systems currently in use.

When starting the project and reviewing the needs, a key issue arose about the orthogonal schematics. Those schematics have indeed to be deeply integrated in the SCADA system, including additional operational functions linked to a Distribution Management System. On the other hand, they should be coherent with the geoschematic drawings built from the detailed physical maps. The challenge is the combination between an existing real time application (SCADA) and a new off line application (GIS).

The fundamental choice is between:
requiring our new GIS system to be able to maintain the schematic (orthogonal maps) as the legacy systems currently does and concurrently develop a tool to link this GIS environment with the existing Scada / DMS.
building these orthogonal maps in a DMS system (which will constitute an extension of the current Scada) and linking it with the new GIS database?

Our paper will explain why the second choice was done.

We will also present the initial Phase of Prove of Concept that we planned in order to verify a lot of expectations and to validate the solutions for a lot of issues: use of similar representations on screen (in the Control Room) and on paper (on the field or on the desk), challenging the current symbols (which implies people change management), operational link with the GIS, compatibility of the data models, and plotting capacities.

INITIAL SITUATION

Sibelga had the following IT applications to support the management of its electricity networks:

- Supervisory control and data acquisition (SCADA) system Siemens TG8000[1]
- Geographical information system: in-house development based on IBM GeoGPG for the 1/2500 mapping (geoschematics) and the orthogonal schematic (operating schemas)
- Detailed diagrams: in-house development based on Autocad (scales 1/200 and 1/500)
- Various alphanumeric technical databases developed in Powerbuilder with limited interfaces with the GPG system.

REQUIREMENTS

During the project to implement the TG8000 Supervisory control and data acquisition system (in 1995), an extension of the system to a DMS for more real-time oriented management of the operating schemas for the MV network was contemplated.
This requirement was justified by the fact that for many years Sibelga has been setting up a policy of developing the remote control over the network, which, to be effective, must be supported by real time knowledge of the connection state of various sections located downstream of the supply points.
The biggest obstacle to the implementation of a DMS lies in the need to keep the schemas up to date in the GPG system. It also appeared difficult to implement an interface, and double encoding did not seem to be a very efficient solution, still more since a project to replace the GIS system was on the cards. The idea of carrying out a global review of the issues in order to reach an efficient and solid solution has thus gained favour.

[1] Formerly Telegyr Systems

THE ATLAS PROJECT AND SURVEY OF NEEDS

The objective of this project is to meet the following challenges by implementing a modern, open solution using the current standards:

1. Replace the current GIS product: it is no longer supported by the supplier and the interfaces are no longer appropriate to requirements.
2. Replace the current CAD product (detailed plans), which does not work well and is costly to maintain.
3. Provide efficient interfaces for the WORKS, ASSET MANAGEMENT and OPERATION processes. The current systems are not properly interfaced and no major functionality as regards optimising or automating these processes.
4. Bring together the asset data in a single coherent database: the technical and graphical data are currently dispersed across several applications which are not interfaced with one another, which leads to:

- Redundant data and encoding;
- Inconsistent data.

5. Adapt to the new environment (liberalised market) and anticipate requests for information, and the new requirements of network managers:

- A need for very precise indicators of network quality on the basis of multiple criteria (age, lengths, number of faults, etc.) in order to optimise investments and meet the requirements set by the regulatory bodies.
- Fast delivery of complete and consistent data
- Facilities for interfacing with and exporting to other software (network calculations, SAP, DMS, Trouble ticketing, Neplan, Synergee, etc.)
- Minimising the costs of encoding and updating data
- The creation of architecture allowing new requirements to be met on the basis of a true data management system:
- Better incident handling.
- Improved management of power cuts: customer – network connectivity.
- Improved management of network history (sections installed, abandoned, etc.) and project history (queries for coordination with other utility companies, etc.)
- Examining how best dynamically to maintain the frame of reference of network connectivity (schema) on the basis of the voltage level (MV, LV).
- Examining how best to process (store, update, present, etc.) collateral data, such as:
    - Event data (measurements, incidents).
    - Dynamic data (connectivity status, power supply status, asset data for access points).

THE ISSUES

Examining the matter of the possible integration of a DMS and a GIS, we first considered the question of whether, if the technology evolves, it would not be more efficient to integrate the two functions into a single product.

This issue led us to consider internal issues but also to make contact with various specialists in different horizons.

The First Conclusions

It emerged from this process of reflection that it seemed preferable to separate the DMS from the GIS, with keeping diagrams updated falling more within the scope of the DMS.
A DMS is essentially oriented towards network operations, i.e. towards recording events which affect the network in terms of its electrical connectivity. The DMS is the source (data master) of the "living" network and an operational tool making it possible to display, record and manage the events affecting its "dynamic" topology (i.e. elements powered from a given source on the basis of the position (open-closed) of sectioning equipment).
A GIS, conversely, is oriented more towards the presentation of the network inventory, i.e. the recording of its constituent parts in the form in which it was constructed: the GIS is the source (data master) of static data on the network and the physical topology of its components.

In other words, although it seems likely that the basic functions of maintaining an up to date diagram of the MV network could easily be integrated into a GIS, account must be taken of other functions which are just as important but which would be harder to integrate:

- The requirement for system redundancy (a DMS is inherently designed to provide maximum reliability 24/7 - real time system)
- The requirement for specific functions, typical of a DMS, which is designed to manage operations such as: simulation, check on operations, dynamic link with the SCADA, security instruction, management of multiple open "operation sheets", etc. - functions which do not typically form part of a GIS application.

Development

We were at a turning point as regards setting up the new GIS, the DMS issue, and updating orthogonal schematics. To tackle these different aspects of our task and their specific demands, we needed to develop a long term view.

The functionalities offered by a DMS appear increasingly vital in the context of developments in network monitoring and requirements for cost reductions, or in other words the improved use of assets. The dynamic colouring functions that provide warnings of connectivity faults alone are vital in the case of scheduled operations.

The need to implement a DMS is also increased as a result of liberalised markets, organisational changes and the new requirements of regulators who have changed and will continue to change organisation and networks management tasks.
In this context, a management centre will have a leading role to play in the following areas:

- Reducing "Customer's minutes lost" by proactive management of control tools and better decision making by the operators
- Support for operational services working in the field: real-time follow-up of operations with constantly updated dynamic reference image of the network; simulations of operations (load-flow calculations), increased safety
- Dissemination of accurate, targeted real-time information on the network status
- Keeping recording systems for measured values, incidents, works, etc. constantly updated
- Implementation of resources in order to provide and increase the safety of various players.

The Issues Surrounding the Implementation of a DMS.

Implementing a DMS does not pose any major problems as regards hardware or defining functionalities. The major challenge lies in an ergonomic design for the diagrams. When we work on paper our brain automatically shifts from a global view to a detail view. To use a DMS, we thus need to provide an equivalent tool on screen.

A PROOF OF CONCEPT

Implementation

In order better to understand the difficulties of implementation, which is vital for the success of such a project, it has been proposed that we should start with a Proof of Concept (POC) phase.

The aim of the POC was to demonstrate the possibility of moving from the operational use of paper schemas to a mixed use (paper in the field, screen or workstation for the operator). The three following criteria had to be respected:

- A minimum of alteration to presentation from the current paper schemas.
- A similar schema in the field and on an operator workstation
- Reliable and proper ergonomics for on-screen work

Another aim of the POC was to bring all the interested parties and users on board.

Starting with a version of a DMS which was basic but had all the tools required to create and exploit schemas, prototype work has been started on some schemas.

The work has followed three tracks:

- Pilot meetings with the operator to specify the schema design
- Workshop with the supplier[2] in order to adapt the system to our needs
- Creation of the prototype in house and proposals to the operators.

In parallel a number of additional specifications have been drawn up so that the system can be implemented in our environment and adapted to our specific needs, including:

- Connection with the GIS
- Cross-references between schemas
- Numbering, plotting of paper schemas

At the same time, on the basis of certain constraints or the operator's wishes, design principles have been defined, while retaining the existing "look and feel". It is also worth noting that the opportunity was taken to restore order in the symbols used and with certain information which had been added to the diagram but did not belong there.

A great deal of work was also carried out behind the scenes, namely the redesign of the orthogonal operating diagrams. In general, these have been designed so that one supply station (PF, Transport/Distribution interface) corresponds to one paper diagram. In this form, links between stations (allowing different supply stations to be used in parallel) are represented by a reference to the relevant cabin on the other plan.
Moving from a purely paper representation to a mixed paper/screen representation thus necessitated a fundamental review of the diagrams so that

- it was possible to display a continuous image of the network on screen, while reducing as far as possible the number of crossings of cables used for these inter-station links
- while allowing for one diagram per station to be generated on paper as before

The chosen solution is thus a "stack" of paper diagrams

[2] The supplier is Siemens, and the product selected is the DMS module of the TG8000 (formerly a Telegyr product).

arranged like bricks in a wall, so that for each station the most direct links with up to six others can be represented easily.
All this preparation work was carried out with the aim of achieving one of the primary requirements of our network operators, namely that the diagrams be identical on screen and on paper.

Result

The POC has shown that it is possible to keep the diagrams up to date and to meet the set requirements using a DMS.

During the POC all the representation principles were defined and the templates created. This will save a considerable amount of time when the operational phase starts.

INTERFACE WITH THE GIS

Apart from the ergonomics of the DMS, it was vital to determine the interface with the GIS. Basically, when redesigning both the DMS and GIS together, we wanted to be certain to avoid double encoding with all the errors and inconsistencies that it can lead to.

It should be noted that the DMS handles future "heavy" updates (i.e. those which affect the assets themselves and not just connection changes) by creating an altered version of part of the local network while waiting for it to be brought into service, in a construction mode. At the appropriate moment this version is activated in real time. The interface would thus have to be at the level of construction mode.

Objectives of the Interface

Several types of data exchange are anticipated.

- Management of the medium voltage schematic plan is handled by the DMS. That involves the production and updating of this plan using the drawing tools from the DMS in addition to the technical information available in ATLAS[3] . This data thus needs to be sent from ATLAS to the DMS.
- The plan produced in the DMS must also serve as the basis for the creation and updating of the diagram managed in NEPLAN[4]. To achieve this objective, the position concerning the elements of the orthogonal diagram must be transmitted to ATLAS.
- The DMS must provide real time data on the references of stations which are powered down. This information is used in the ATLAS incident management module in order to display the unsupplied parts of the LV network after power has been cut off (accidentally or scheduled).

Interface DMS Update

Daily batch procedure which writes an XML file from ATLAS data containing the assets "to keep", "to drop" and "to create" for the part of the network to be altered. These data are referenced using a project number. The following information must be sent:
- Name / ref of the station
- Installed transformer power
- R and A station loads
- Location of the station in the geoschematic reference
- Cutting elements (circuit 1; circuit 2; …)
- normal cutting point for the circuit
- Equivalent line (as opposed to succession of cable sections)

Interface ATLAS Update

Batch procedure (frequency not defined) which writes an XML file containing the relevant position of assets in the DMS and various attributes, and updates tables of the ATLAS database.
The following information must be sent:
- Diagram number
- Return of the colour of the MV feeder
- Geometric schematic coordinates (x,y) for a station
- Geometric schematic coordinates (x1,y1; x2,y2) for a busbar (PR, PF, etc.)
- Summary of the access path

Bi-directional Interface for Consistency Check

DMS batch procedure to export, check and retrieve data to, in and from Atlas. It means that any discrepancies between the two databases can be picked out and corrected by the respective database managers.

Interface Unpowered Stations

Real time procedure which waits for an XML file to be read which contains the identifier of a station transformer and its status (powered down or powered up) and updates the

[3] ATLAS is the name of the planned replacement for the GIS. The solution chosen following a call to tender is that offered by Intergraph.
[4] NEPLAN is the network calculation product used by the planning services. Since this product is very specific and specialised, it has been decided not to include it in the GIS but rather it is intended that the basic data, including the topology, should be retrieved from it.

corresponding Oracle tables in ATLAS.

Exchange Format

The interfaces comprise data exchanges using XML exchange files described in an RDF schema which is itself based on a UML CIM operational model.

CONCLUSION

The completion of the Proof Of Concept stage for the implementation of a DMS has not merely allowed the choices made and principles adopted to be tested and validated, but has also helped bring the affected users on board.

Today we move into the first phase of implementation, i.e. the delivery of the definitive product which will allow the diagrams to be generated on paper in conjunction with the new GIS. Two other phases will follow shortly:

- Implementation of real time tracking in connection with the SCADA for the diagram (the raison d'être of a DMS).
- The addition of secondary but still important functionalities: real time load flow, simulation of operations, links with incident management tools.