EVOLUTIONS IN THE GRID OPERATION IN CARINTHIA

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ABSTRACT

The KELAG Netz GmbH (KNG) is the local grid operator in Carinthia, Austria. Following its strategy to optimize and centralize the operation of the power and the gas grid, a state-of-the-art control centre was built.

The key-element of the control centre is the SCADA/DMS software, which combines the monitoring and control facilities for the entire network, from the high voltage grid down to the medium voltage distribution network. To obtain a "real-view" of the network, the grid data, which are fed on a daily basis into the geographical information system, are imported in regular intervals into SCADA. Furthermore, the data of each consumer from SAP are linked to its electrical connection point in the SCADA world.

This paper presents the organizational and technical requirements for the centralized operation of a power and gas grid. Additionally, the key features of the successful project implementation and the enhancements in the last years are described.

INTRODUCTION

With a peak load of 751 MW and a distribution volume of 4 TWh, the KNG operates a high-, medium- and low-voltage network of approximately 18.400 kilometres in length. 46 substations at a 110-kV voltage level and 7.100 MV/LV transformer stations provide energy for more than 290.000 consumer installations. Furthermore, 770 km distribution system of natural gas with 34 pressure reduction stations delivers energy to 10.200 consumers.

The new operation centre monitors and controls the 850 km 110-kV grid and the 5.500 km 20-kV grid. Further, the operation of the gas-grid is integrated. The successful implementation of this project can be split-up in three sections:

1. Organizational adaptations
2. System integration and software implementation
3. Information and integration of affected employees

The following chapters mainly describe the implementations for the power grid. The software integration of the gas grid is not further explained.

ORGANIZATIONAL REQUIREMENTS

Before 2007, the KNG was divided into six geographical areas with its own responsibilities of the medium and low-voltage network. According to the new operational and regulatory requirements, a new organisation was set-up to obtain an integrative responsibility for the operation of the high-, medium and low voltage network.

Further, as the equipment-data and grid topology were essential for a centralization, the organizationally responsibility for the on-site data acquisition in the geographical information system (GIS) was linked to the department responsible for the grid operation.

The control centre itself consists of the Back Office and the Front Office. The Back Office is responsible for the planning of maintenance activities, for consumer calls regarding power failures and for all statistic issues. The operators in the Front Office are in charge of the operational part, e.g. grid monitoring, the assignment of switching procedures, fault location and restoration, etc.

Figure 1: Control centre at the KELAG Netz GmbH

One of the first tasks was the redesign of the Front Office, as seen in Figure 1. This room had to fulfill various specifications regarding security aspects, emergency-power supply systems, all requirements for a 24/7 working-shift, hardware redundancies, etc. Further, a crisis room was established, where the assignment of crews can be coordinated and the communication with the media takes places.

SYSTEM INTEGRATION

To control a power network from a central operation centre, a real-time overview of this grid is essential. Further, a relationship between the grid and the supplied consumer has to be available. This is necessary to identify failures in the grid and/or inform the consumer about ongoing outages. These data are stored in different databases. Therefore, system interfaces were established to concentrate and visualize this information in SCADA/DMS, as shown in Figure 2.

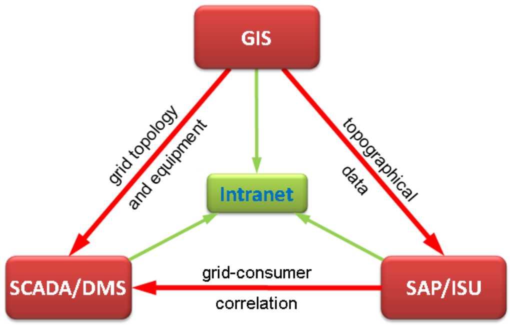

Figure 2: System interfaces

GIS

Within the KNG, all technical components are topologically and topographically stored in GIS. This system provides a detailed mapping of the high-, medium-and low-voltage system as well as of the gas grid. These data have to be up-to-date and are transferred on a weekly basis via a customized interface into the SCADA-system. The GIS data acquisition takes place in the regional operation units, where all construction and maintenance activities take place. To guarantee a compatible data set for the interfaces towards SCADA and SAP, a standardization of the GIS data acquisition was an essential precondition.

SAP/ISU

In SAP/ISU all consumer related data for the power and gas grid are stored. Further, these data contain a unique identification, which is the basis for the correlation with GIS. The interface between SAP/ISU and SCADA/DMS affiliates the data of each consumer to its electrical connection point. With this information, an overview of all unsupplied consumer during power failures is provided and the localization of grid disturbances can be supported.

SCADA/DMS

In the Distribution Management System (DMS) and in SCADA, the grids are monitored and controlled. Here, an on-line view of the whole system is available. The information from SAP and GIS are concentrated to obtain a unified database customized for the grid operation. This system, working with a very high operational availability, does not depend on a 24/7 availability of GIS or SAP. To support an exchange of grid information with the local operation units, workstations are set-up with the same view of the SCADA/DMS system as in the control centre but with a restricted control authority.

Intranet

From each system selected data are transferred to the intranet, where a management information system is set-up and reports are generated. These data are available, in contrast to the SCADA system, from every PC with an intranet access.

SOFTWARE IMPELMENTATIONS

Import of GIS data into SCADA/DMS [1]

To provide SCADA/DMS with all data of the medium- and high-voltage grid, a customized interface was developed to obtain an almost automatic data transfer from GIS. In a first step, due to security reasons, these data were forwarded into a test-system. Here, the employees from the Back Office verify the data and release them to be transferred to the operational SCADA/DMS system. This data import can be broken down into the following activities:

GIS export: Using the Feature Manipulation Engine (FME), all required data are exported from GIS. The geographic information is put into a dxf-file. All technical data, e.g. grid topology, electrical equipment, information about transformer stations, cable and overhead-lines as well as organisational information are stored as comma-separated ASCII-file.

Tiling und incremental update: For a comfortable data handling, the whole grid is segmented in more than 300 tiles. For each tile own dxf- and ASCII-files are generated, which contain the data of the corresponding grid segment. In a next step, a comparison between the data of the existing files and the generated files from the last import takes place. If any relevant chances in the grid and therefore new information in the files were detected, the files are flagged for the incremental update of the SCADA system.

SCADA import: For each tile, special import files are generated from the ASCII-files. These files are transferred into the database of the SCADA/DMS system.

Graphic import: The dxf-files of each tile are converted into import files, which are used for the generation of the geographic view of the grid in SCADA. As the design of transformer stations in the GIS-world is not appropriate for the SCADA visualisation, a customized application generates the design of each station using its equipment data and topology.

Schematization: The exported dxf-files contain the topographically correct grid-design. From these data, an algorithm automatically generates a scheme of the power grid. This algorithm is based on an optimization function and finally provides further dxf-files for an orthogonal and schematic grid visualisation. Once more a tiling and an incremental graphical import is executed. The schematic as well as the geographic views are linked to each other and are fully integrated into SCADA/DMS. Figure 3 shows the SCADA import and the automatic schematization of a part of the medium voltage grid.

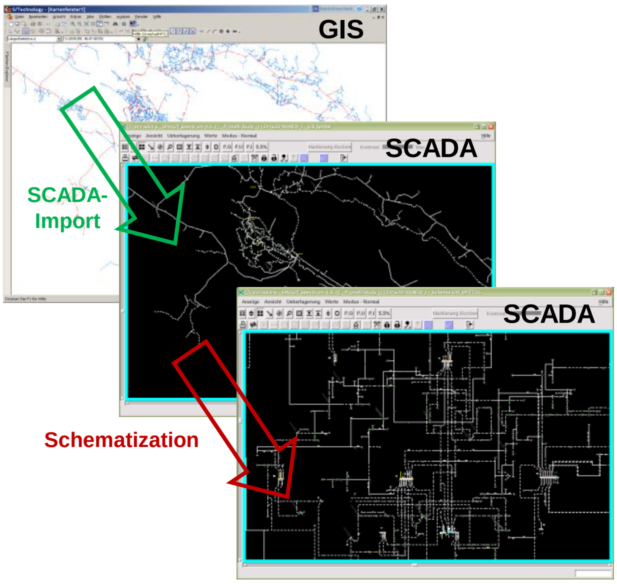

Figure 3: Geographic and schematic grid view

Outage Management System

The Outage Management System (OMS) contains the process from the planning of building and maintenance activities to the switching operations and restorations of the power supply.

Before any planned interruption takes place, an information of the affected consumers is carried out. This information can be executed in different ways, depending on the on-site situation, personally, via placards or via letters. Further, an automatic consumer service via email, SMS or fax is available.

The process for planned interruptions starts in SAP, the planning platform, and leads to the Work Force Management (WFM), where all orders and switching procedures are dispatched [2]. Finally, the data are transferred into the SCADA/DMS system, where an OMS-record is generated. In this record, all data regarding the outage, e.g. time and date, location, switching procedures, affected consumers, etc. are stored.

If a power failure in the grid occurs, an OMS record in SCADA is started automatically. The form is prefilled with the known grid and consumer data. These data are forwarded to WFM where a work order is generated. The field engineer responsible for this area receives the data on his laptop and executes the fault location and/or grid repair. To support the field engineer with the grid geography, GIS is available on the mobile devices. The advantage of this method is that both – the operator in the operation centre and the field engineer – use the same database with information about the grid, its assets and the work orders.

During the working hours, the Back Office in the control centre is responsible for consumer calls related to outages. After the regular working hours, this task is executed by the Front Office. Every consumer can be allocated with its location in the grid using the existing relationship between the consumers and the grid topology. The benefit of the integration of this call centre into the control centre is that the communication with the consumers takes place where the grid operation is executed. The consumer gets a first-hand information about the duration of the outage and the control centre receives detailed information about the location of grid-failures, e.g. a broken line.

If an OMS record is generated, an Interactive-Voice-Response-System (IVR) is started automatically and gives the caller information about unsupplied regions. When the failure is repaired and the line is reconnected, the IVR is deactivated once more automatically. With this on-tape information, up to 85% of the callers are satisfied. Only 15% need to speak with an operator to gain further information or to report a disturbance or exact fault location.

From switching requirements to switching orders

Every switching request is generated within WFM and is transferred to SCADA/DMS. There, the single switching steps are recorded in a digital “switching letter”, which contains all operational instructions for e.g. the disconnection of a grid part. These switching-letters can be created individually or system supported with an own application called Advanced Network Operation Program (ANOP).

ANOP proposes a solution considering the limits for the system voltage and the load flow boundaries using the imported grid data. The solution is documented in a switching letter containing every single switching procedure and its calculated voltage and load values. Furthermore, if a failure in the grid occurs, a switching-letter for the resupply is offered to the operator automatically.

In a next step, ANOP is supposed to consider measures for a congestion management, e.g. reduction of the infeed of a power plant, and to cover parallel requests in the case of several disconnections in the same time window and net district.

Finally, the operator executes this switching letter. Depending on the existence of a remote control of the substation or transformer station, the switching procedure is done directly from the control centre or as an assignment to an on-site field engineer.

REPORTING SYSTEMS

Documentation

A regulatory as well as an internal requirement is a documentation of all data regarding the reliability of the power supply. The software product "Interaktive Erfassung und Auswertung von Störungen, Schäden und Versorgungsunterbrechungen" (INTERASS) was designed to meet these requirements in Austria and Germany and is used within the KNG.

As explained in the previous chapter, every outage or switching operation is recorded in an OMS record. Therefore, the required documentation is already started in SCADA/DMS. From there, a customized interface selects these data and transfers them on a daily basis into INTERASS. With this approach, the manual operation could be reduced to a minimum and the data quality increased significantly. Further, an up-to-date documentation can be guaranteed.

Information handover

A special requirement in a 24/7 control centre is the handover of selected information during a change of shifts from one operator to another. In the control centre, two operators are on duty for 12 hours. During this time, information has to be documented and concentrated and passed over to the new operators.

During working hours, the regional operation units are responsible for the operation of the low-voltage grid. After the working hours as well as on weekends, this task is carried out by the control centre. When the responsibility is transferred from one of the local operation units to the central operation centre or vice versa, a documentation of the status of the grid is obligatory.

For this purpose, an web-based platform was developed where individual information and selected data from SCADA/DMS are summarized. This platform can be divided in an individual text, a section for ongoing and executed grid disturbances, a Gant-chart of all maintenance activities, a list of equipment deficiencies, etc.

Media communication

One important issue during grid-outages is the communication with the media. With the introduced system, an up-to-the-minute overview of the grid topology and geography, as well as information about the number of unsupplied consumer during power failures can be provided. Therefore, with a quick response time, continuous information can be given to print and broadcast media.

CRITICAL FACTORS OF SUCCESS

The centralization of the medium voltage network required, beside all technical challenges, severe organizational rearrangements within the KNG. This impact in a well-known and functional workflow was known to KNG before launching this project. Therefore, a strong commitment to all adaptations starting from the management level was a precondition during the course of the project. Furthermore, integration and regular information of affected staff members was carried out.

During the first month with this new system, the huge amount of data and the multiplicity of applications was a major challenge for the grid operators, especially during grid disturbances. Therefore, the key task in the first year was to improve the usability of the applications and the user-friendly interaction between them. As a result, the identification of the operators with this system was increased considerably.

CONCLUSION

In this paper, the organizational und technical requirements of a centralized control centre are described. The various software applications as well as the interfaces between them are presented, and the key factors for the successful implementation are highlighted.

The base of the described system is the unified data base in GIS and SAP and its system integration into SCADA/DMS. There, an up-to-date overview of the power and gas grid and of all consumers is provided. The result is a quick identification and response time during disturbances and a concentrated internal and external communication and documentation.

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