INVOLVEMENT OF SCADA EVENT AND FAULT DATA INTO THE CONDITION-BASED MAINTENANCE SYSTEM FOR EHV- AND HV-NETWORK AT WIEN ENERGIE WIENSTROM

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ABSTRACT

The early full opening of the electricity market in Austria in October 2001, unbundling and the regulation authority strongly cutting revenues demanded a paradigm shift from the network operators.
An important action taken by Wien Energie Wienstrom was the implementation of condition-based maintenance for significant parts of its high and medium voltage network [1].
Thus the expert system MABIplus was developed together with the strategic partner SAG Energietechnik GmbH. It supports condition and risk based maintenance processes for relevant asset components.

INTRODUCTION

MABIplus consists of single modules correspondent to different maintenance tasks.
Among other function blocks as equipment data management, work order planning and maintenance process management, also a module for fault management is included.

After due consideration, during the introduction of these functions it became that fault management is a weighty part of the full maintenance process. Automated data transfer from the SCADA system into the expert system was realized.

The integration of event and fault information is a determining factor to get continuous processes of fault management. Also the generation of work orders for fault clearing was integrated into the full process of work order planning as a part of the full maintenance cycle.

To optimize the maintenance strategies mentioned above, additionally fault affected equipment is being recorded. This allows identification of potentially weak components for the network operator at an early stage. Expert protocols therefore were developed and integrated to permit statistically firm technical analysis.

In addition documentation and statistics for the regulatory authority and for the network operator himself is being created. Automated outputs of the expert system are reliability figures, documentation for legal safety and of course technical know-how concerning the condition of the network components.

TERMS AND DEFINITIONS

The European Norm EN 13306:2001 [3] defines the following terms, important for the issue described in this paper.

Maintenance

Combination of all technical, administrative and managerial actions during the life-cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function.

Condition-based maintenance

Preventive maintenance based on performance and/or parameter monitoring and the subsequent actions.

Fault

State of an item characterised by the inability to perform a required function excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.

Failure

The termination of the ability of an item to perform a requested function.

Additionally for maintenance purposes, we define an event, when, not due to a fault, at once or in the course of time, measures by the facility guarantor are necessary. Also any external causes (e.g. false reports, vandalism to parts of a structure), but no planned services, are included.

MABI

MABI [2] stands for "Modulares Anlagen- Bewertungs- und Instandhaltungspaket" (Modular Plant Evaluation and Maintenance Package). It consists of multiple software modules concerning the areas master data, technology, maintenance, evaluation, faults, and history.

The equipment data is stored in the master data and in the technology module.

In the master data module the equipment (e.g. switchgear,

bay) is inventoried as an individual. The various maintenance objects are embedded in the respective object levels where their individual data is being stored.
In the technology module, the relevant technical data of the various devices is type-coded and defined. Statements regarding the degree of standardization are possible.
These modules also feature integrated intelligent search functions and user-friendly navigation.

The maintenance module represents a planning module for cyclic inspection measures, a condition-based and network-oriented adaptation of inspection intervals is possible. This is also where the technical condition of e.g. the switchgear and the technical input parameters for condition evaluation are acquired.
These parameters were used for the maintenance reports recorded in the system. The compilation of these reports permits a detailed visualization of the processes of the various measures. The process-oriented perspective makes cost-boosting factors and flaws in the maintenance organization transparent.
This module comprises not only planning but also budgeting, cost-targeting and -tracking, and the cost-effective use of human and material resources.

The evaluation module (Figure 1) contains a knowledge editor, which stores reference values ("fingerprints" of the individual component concerned) and estimates technical limit values to be used in detecting the condition and defined based on the experience of the technical expert. A function generator computes the required values from the raw measured values.
Similar to a traffic light, these messages are available in three steps ("green", "yellow", and "red").

The traffic-light states are to be interpreted as follows:

- Red: immediate action required!
- Yellow: device fulfills its tasks, however, needs to be serviced!
- Green: no action is required, everything OK!

Furthermore, it is possible to indicate negative developments.

The fault acquisition module in MABI deals with special technical component types troubles. The extension of its functionality is the main improvement in MABIplus.

In the history module, all technically and commercially relevant events in the life-cycle of a device are recorded. Typical milestones of a component are: procurement, startup, change of location, damage, modifications of the device, maintenance, scrapping. These data is also used as a basis for determining the life-cycle costs.

The mobile data acquisition system permits the automated recording and transfer of data when detecting faults and when performing maintenance jobs. It is used in the place of the previous paper-based process and seeks to accomplish the greatest possible minimization of administrative processes.

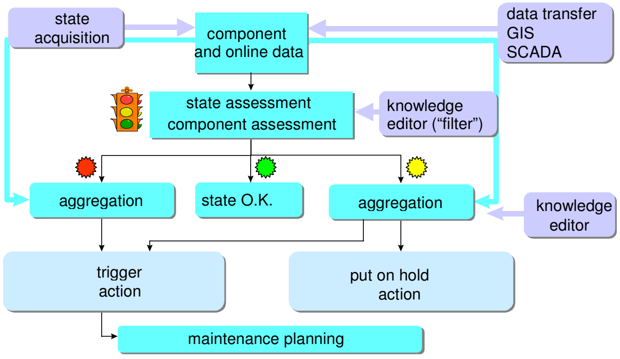

Figure 1: Evaluation module

MABIPLUS

MABIplus provides an improved standard platform for condition-based maintenance based on MABI.

The main upgrades are an all new fault acquisition module, a new reporting tool and a protocol editor.

Fault acquisition module

A known problem for condition-based maintenance systems is the gathering of data according the fault cause and history [4]. A core request for MABIplus was the implementation (and interpretation per component) of maintenance relevant SCADA messages (especially the course and consequences of network faults) into the system.
Thus a new interface for the fault data transfer and new .NET dialogs were created for data gathering.

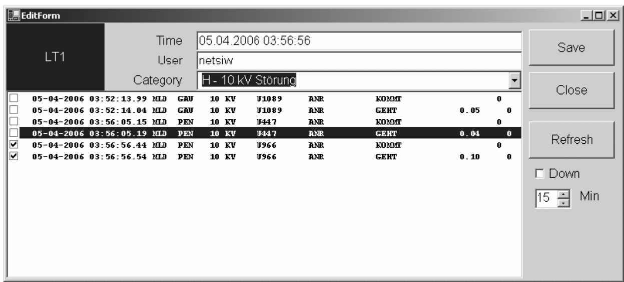

Figure 2: .NET dialog for SCADA message grouping

SCADA constantly delivers a huge amount of messages concerning the network state. In the course of an fault or an event even more messages must be handled. An automatic filtering of the messages concerning a special occurence is seldom possible (we do also research regarding this topic), so, with a "small" number of faults, a manual selection is more practicable. This selection is done by the knowing personnel in the network center,. The front end for the user is a client application, based on the .NET-framework (Figure 2). It accesses the SCADA database.

The data gathering dialog (Figure 3) additionally requires the user-ID (responsibility), the data acquisition time and a category (e.g. event/Fault, voltage level). In the database of MABIplus a dataset for occurrence (fault or event) is being created and receives an unique ID. MABI, using a standardised interface, automatically processes and associates the SCADA data to facilities.

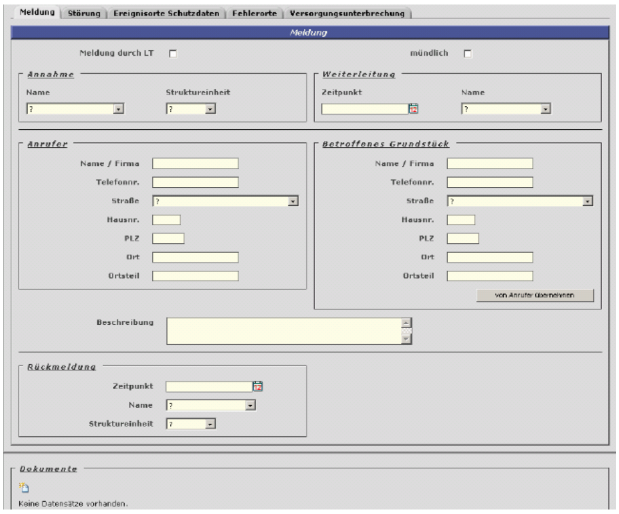

Figure 3: Example for a fault acquisition dialog

An expert later analyses the occurrence in MABIplus, interprets it and associates it to network components (Figure 4).

The acquired data can be used for various purposes, internal (network operation) and external.
Internal scope of application ranges from asset management to network planning and operation. External applications are e.g. regulatory questionnaires or common statistics [5].

MABIplus is a maintenance planning system, including the network components´ entire life-cycle specific tasks. Its main targets are the changeover from time-based and event-driven to condition-based maintenance strategy and subsequent cost reduction.

The technical premise to do so is a hierarchical approach, emulating the network according the classification of component types. For the single individuals (component X in station Y), and therewith for statistical purposes, any individual and technical type data is accessible.

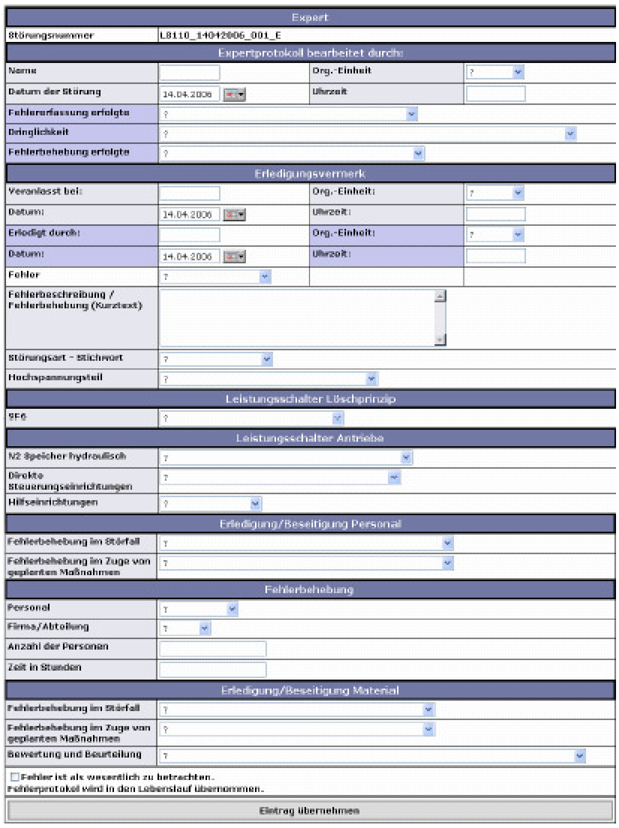

Figure 4: Expert protocol for technical component type analysis

A maintenance expert traditionally possesses knowledge and experience according special component types and sets fixed maintenance cycles dependent upon component construction and service requirements (time-based). With the additional information available in MABIplus (e.g. component event history, failure rates dependent on this, repair duration dependent of availability of personnel and failure rates in the network,...) the expert is able to optimize maintenance measures dependent on the component, its relevant surrounding system (condition-based) and the entire network.

Regulatory questionnaires and common statistics (e.g. CAIDI, SAIDI, CAIFI, SAIFI) demand system and consumer indices. For the network operator, e.g. for asset management, other values are relevant.
Failure rates combined with component condition allow to identify weak-component types of the system and to undertake countermeasures against (before) unexpected costs.

Fault interpretation furthermore delivers more detailed information about failure types and rates of the components. Failures can be assigned to individual components or component types (including year of construction, year of

beginning of operation, etc.).
This allows also for power quality based network planning as e.g. special component choice for special requirements. Also network operation gets more secure through more precise information about the system.

Reporting tool and protocol editor

Based on MABI experiences so far, the reporting tool, concerning standard export interfaces, was improved. In workshops important report structures were elaborated and implemented. For the network operator e.g. maintenance planning costs and measures are being presented clearly.
It was also realised that the protocols in MABIplus must stay flexible for future changes in requirements. Fast changes can only be achieved by the possibility of in-house accommodations, using own personnel and a new protocol editor.
These changes concern all modules of MABIplus.

SUMMARY AND OUTLOOK

WIENSTROM decided to develop maintenance system together with the strategic partner SAG Energietechnik GmbH. It supports condition and risk based maintenance processes for relevant asset components.
Most important new development issues are the implementation and interpretation of SCADA data.
At the moment this starts in the EHV and HV network, but as the database of MV switchgear components is available enhancements will concern all maintenance relevant messages.

Only with all life time information about components the condition can be estimated.

A bonus is the automatic acquisition of fault data for statistical purposes.

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