Experiences on Development and Implementation of a Management System for Protection Relay Assets and On-duty Personnel

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***Abstract*— This paper presents an automatic data transfer from digital relays, disturbance recorders, counters, breakers and other devices to standard web application running in "Protective Relay Monitoring Centre" of Holding slovenskih elektrarn (HSE). Data can be monitored, updated and valuated by users using standard web browser. Therefore, a higher availability of the entire system is achieved, since data from devices is available wherever the Internet or Intranet network is present..**

***Index Terms*— protective relay, control centre, remote monitoring, Internet access**

I. Introduction

Electrical power systems are constantly exposed to faults and disturbances. This may lead to element damage or it may pose a threat to reliable power system operation if a faulty power system element, e.g., line, transformer or generator is not quickly isolated from the system. Therefore, protective relays and devices are installed in the power system, with the basic objective being to reduce the consequences of faults by disconnecting the faulty elements. Disturbance recording facilities have been used to capture abnormal system conditions for many years. They also monitor the operation of protection systems. The information obtained from recorders is used for a post-fault analysis of the power system operation as well as for the protection system performance [1].

In need to get quick and reliable evaluation of data that is vital for control centre the need for development of management system for protection relay assets and on-duty personnel (EVA PCC) was raised. There was a call for single application running as standard web application, so it could be accessed from many different locations wherever Internet is available. The system should be as transparent as possible, so it can be applied to many different existing equipment from different manufactures. The application should be as user friendly as possible and adoptable to different screen sizes raging from mobile phones, Palms, Notebooks and PC-s.

II. Hardware Overview

HSE consist of many sub companies with different types of power plants [2]. Altogether 18 power plants were included in this project with possibility of extension. Coal, Gas and Hydro power plants with many different protective equipment manufactures raging from Siemens, ABB and Iskra were included.

All power stations were connected, or were able to connect into Wide Area Network (WAN) of HSE, so communication and data transfer between power stations and control centre was possible with no limitations. Inside power stations there was wiring between local communication units and all equipment that have been shown in local SCADA system. Not all protective relays and disturbance recorders were wired. For accessing data on those relays, one had to physically connect to relay with his portable computer.

III. Dataflow

Because there are so many different existing equipment manufactures every power station had to be individually treated.

Custom software application had to be made to gather data from some older versions of protective relays. Data from relays was gathered directly from devices. Cyclic connection to relays and event checking is implemented to look for new events on relays although it is possible to look for new events through events witch can be captured from existing control and supervision systems.

When new event is found oscillography and chronology files are downloaded from protective relay or disturbance recorder and copied to main data server in control centre.

In project scope was also requirement for collecting a data from local SCADA systems. For this purpose some additional drivers for were configured. Drivers are storing fetched data into database server (MSSQL), which is the source for vortal application and web SCADA.

Equipment was wired to local communication unit for witch many different protocols and wiring raging from RS-485, Ethernet, Modbus, Profibus etc. were implemented.

TCP/IP protocol was used for communication between local communication units and the control centre.

In order to achieve described dataflow some minor hardware modifications were needed like applying new routers and wiring of some protective relays. Web and database server had also been implemented in the control centre.

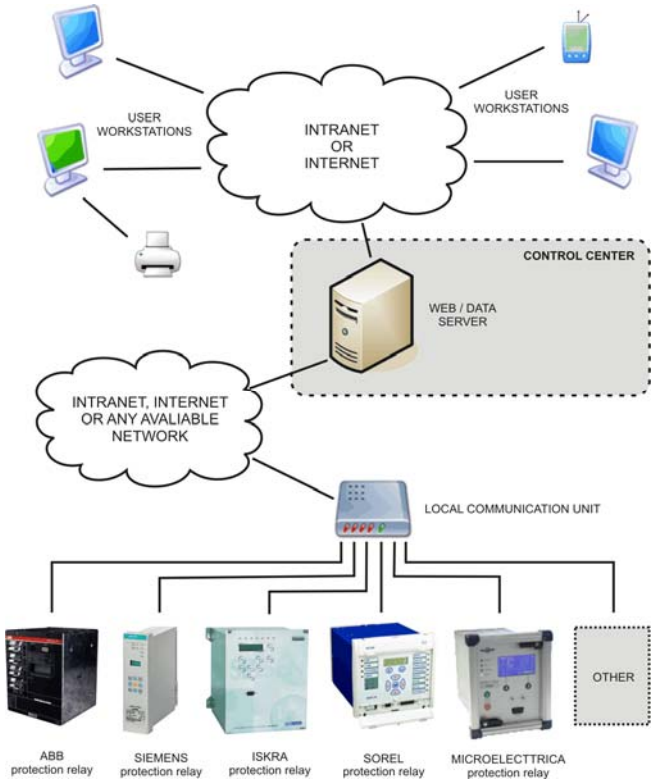

Figure 1. Hardware Overview and Dataflow

IV. Application Modularity

In order to represent gathered data in a user friendly mater a modular build vortal application was the choice to be. The essential part is the system backbone to which all other modules are attached. Here administrator can add users, assign their username, password, language, company own style (theme), time format and many other settings to modify appearance of user interface. Only administrator can access this module. All other modules are attached to system backbone [3].

Figure 2. System backbone

Many modules have been made in this project and because of the modular structure, all of them can simply be modified or rebuild. On request new modules can be build so all customer wishes and needs are fulfilled. Main features of the most used modules are briefly described below [4].

V. Module Technical Database

Technical Database (TDB) allows user complete overview of entire inventory, installed equipment and machinery. Inventory items are presented in the tree structure, so even huge number of them does not represent a big task for locating them. Every item has properties depending on type to witch belongs, plus its own custom properties. Inventory presented in TDB serves as foundation for other modules.

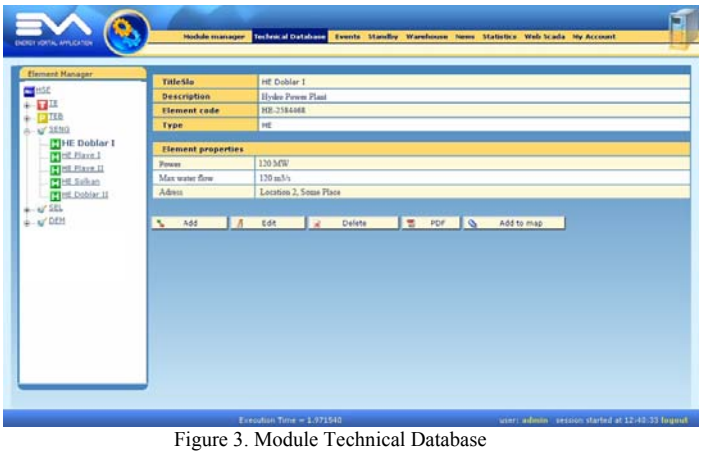

Figure 3. Module Technical Database

To every item administrator can add users and assign their level of privileges for viewing or modifying data.

VI. Module Events

This module represents a direct connection to the real time database. In case of event the alarm is issued. The message about the event is shown in event list where it can be clicked to reveal more detailed information like oscillography data and chronology about event. Depending on user privileges assigned in module Technical Database user can edit, add or delete event data. All data can be printed and exported to different file formats like PDF, Word or Excel document for preview. Oscillography and chronology files can be downloaded for further analysis in special applications. Figure 4 shows example of detailed information about event.

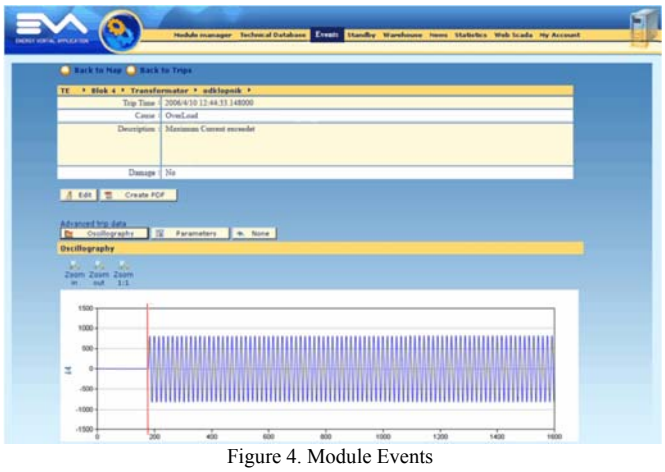

Figure 4. Module Events

VII. Module On-Duty

For every item in the module Technical Database, schedule for users who are on-duty can be applied. In conjunction with the module Events, on-duty users can in case of event receive an SMS message on their mobile phone or email.

The module enables:

- Inputting and editing of on-duty personnel,
- Overview of the on-duty personnel,
- Writing reports at the time of duty,
- Report printing,
- Exporting the reports to a Word, Excel or PDF document

VIII. Module Statistics

All gathered data can be used for further analysis and report building. Most common reports include statistics about events. Statistics can be made on particular item from the technical database or all his sub elements. Figure 5 shows example of event statistics.

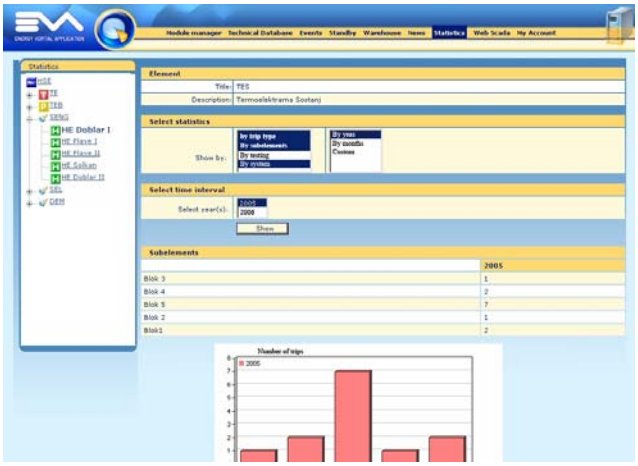

Figure 5. Module Statistics

IX. Module Warehouse

Warehouse module allows the user complete control of the entire inventory equipment and machinery. User can supervise the quantity, the shifting of the equipment to different sites as well as maintenance and service interventions

X. Module Web Scada

Real time data from counters, breakers, and other Items from technical database, can be easily put on the screen to make custom SCADA user interface. Users can monitor real time data afterwards.

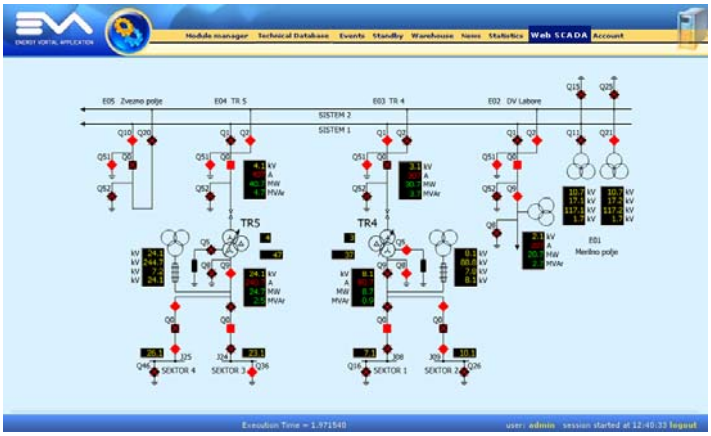

Figure 6. Module Web Scada

XI. Module News

The module is designated to inform the employees. Depending on the user's rights the news can be accessed in "read only" or "edit" mode. The editor can import content also from standard MS Office applications, like MS Word and Excel. Besides these, usual functions of text and image editing can be applied. The system administrator can limit the color scheme, font size and type, thus preventing administrators of individual pages from deviating from the overall company image.

XII. Benefits

Several aspects on benefits could be exposed. The most important is that the reconnection of the system is faster since detailed information from all active process equipment is distributed to responsible personnel. On the other hand the crew management is improved because SMS and e-mail massages are used. In comparison to the situation before, when all data were collected manually, the ergonomics of work is significantly improved. All those aspect results in cost efficiency of protective relay department.

XIII. Conclusion

Remote access to protective relays, disturbance recorders and SCADA system provides, when made available to protection engineers, an immediate fault diagnostic. The engineer can assess the response of the protection to a system incident and determine the reason of its operation. If this process is accelerated, the power system element can be returned to the operation mode faster. This has an enormous impact on power system technical and economic efficiency.

XIV. References

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