P28

Revitalization of SCADA system in DCV Elektro Primorska

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SUMMARY

The fast development of the hardware and software technology today has a direct influence on the life span of the SCADA system for managing electricity networks.

The paper gives a brief description of the most important phases of the revitalization project of the control system for the distribution system operator Elektro Primorska in Nova Gorica (Slovenia), with particular emphasis on the application of Končar's own solutions.

KEYWORDS

SCADA, Elektro Primorska, upgrade, revitalization

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1. INTRODUCTION

Elektro Primorska is one out of 5 electric power distribution operators in Slovenia. From the geographical point of view, it is placed in the western part of the country supplying a little more than 123.000 buyers placed on the surface of 4335 square km with the electric energy. It operates as an independent legal entity owned by the state and individual investment funds. From the organisational point of view, it is divided into four business units: Gorica, Koper, Sežana and Tolmin. Elektro Primorska control system concept is of a centralised type having one dispatching centre placed in Gorica and interconnected with workstations in other business units.

The existing Supervisory Control and Data Acquisition (SCADA) system used for control and supervision of the power distribution network was put into operation in June, 2007. The integration of the Outage Management System (OMS) for processing of outages and planned works with the SCADA system was completed during 2008. The implementation of Distribution Management System (DMS) functionality for the analysis of the power distribution network represents a next step planned for the near future.

The upgrade of the existing SCADA system was initiated due to several reasons:

1. The server hardware manufacturer ceased to support the stated equipment in 2013 and the hardware had to be replaced following by the replacement of the software as well;
2. The SCADA application manufacturer ceased to support UNIX software platform in 2012; and
3. The SCADA software new functionalities were implemented and the existing ones were improved.

The replacement of the established SCADA system with a new one, applicative engineering and testing of the new system represented a very challenging procedure. End users of the system – dispatchers had to have as large availability of the system as possible to perform their everyday tasks and duties regarding the control of the electric power network all the time.

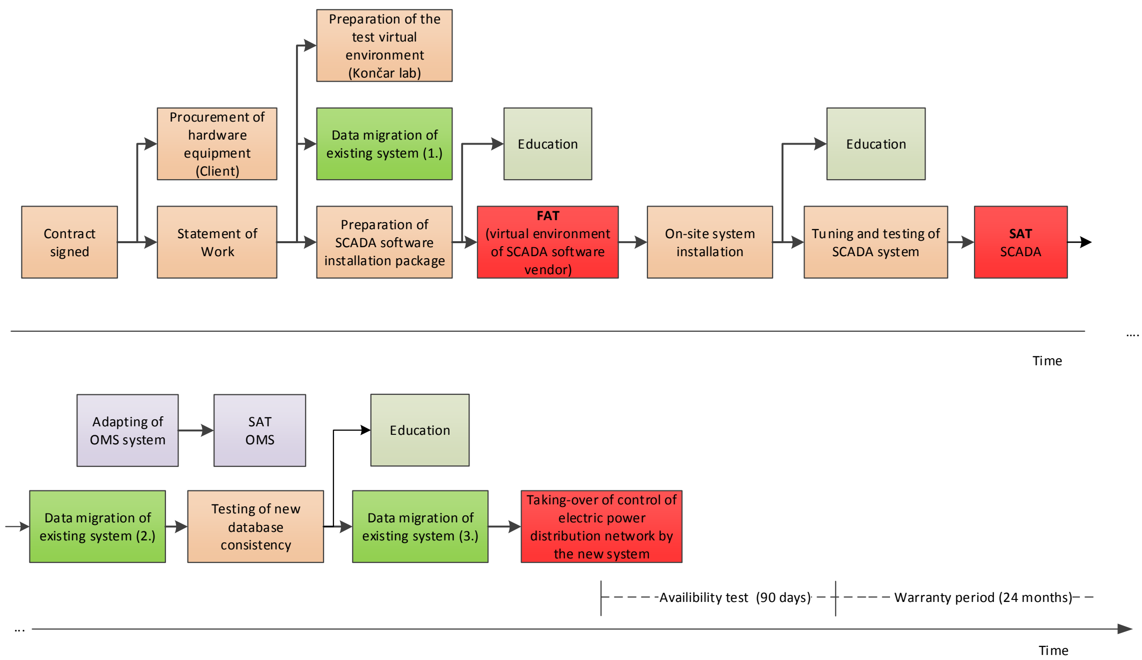

Figure 1 Project Performance Block Diagram comprising implementation key points

2. HARDWARE

Elektro Primorska was in charge of the purchase of new hardware. Coordinating activities with its IT Department, "Blade" version of Hewlett Packard manufacturing programme - HP BladeSystem c7000 was selected as the server solution including servers of the type HP BL460c G7. Figure 2 shows a new SCADA system block diagram.

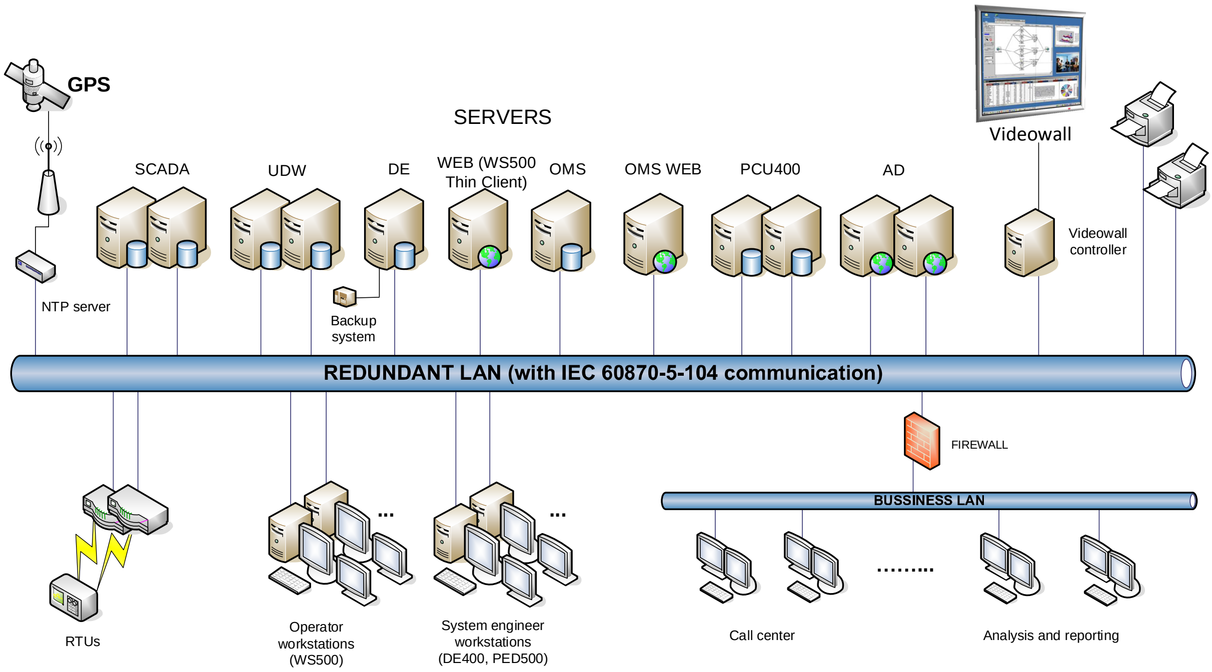

Figure 2 New SCADA system block diagram

New hardware components on which a part of the functionality of the new SCADA version software is distributed are the following ones:

- Active Directory (AD) servers – servers for the control of user accounts; and
- Process Communication Unit (PCU) 400 servers – communication so-called front-end servers.

A device for storing of the failsafe copy of the complete SCADA system was integrated in the system as well. It takes care independently about storing of data on magnetic cards as well as about due time replacement of data storing tapes that takes from its internal tape storage.

3. SOFTWARE

Since the hardware was upgraded, new corresponding software had to be implemented as well. Computer Operating Systems of the new SCADA system were changed in accordance with the Table 1. Moreover, Data Engineering (DE) and Utility Data Warehouse (UDW) databases were based on the most recent Oracle Database 11g technology.

Table I Existing and new SCADA System Operating Systems

Computers	**OS (existing system)**	**OS (new system)**
SCADA, UDW	True64 UNIX	Red Hat Enterprise Linux 5.6 64b
PCU400, Web, DE	Windows Server 2003	Windows Server 2008 R2 64b
Workstations	Windows XP	Windows 7 64b Pro

Great attention was paid to the security aspect of the new SCADA system. For that purpose above stated AD servers for control of the user accounts within the system was implemented. The design had implemented security technologies such as Kerberos, a network authentication protocol enabling a high level of security of authentication of client/server oriented applications using a “secret” key cryptography, also Lightweight Directory Access Protocol (LDAPS) over a Secure Sockets Layer (SSL), the application protocol for access to directory services that also used a crypted form of communication, etc.

The SCADA software of the existing system was updated from 2.3 version to 5.5 version enabling the Employer to work with a whole range of new or enhanced functionalities out of which only a smaller quantity is stated below (see [1] and [2]):

- Colouring of events in the alarm list, as well as in the event list according to various criteria;
- Dynamic Contour Colouring (DCC) - dynamic colouring of contours in accordance with measuring levels (Figure 3);
- Advanced Real Time Calculation (ARTC) – a user oriented interface for defining of complex data based calculations in real time on the basis of MATLAB software package;
- Table presentations – a software module that enables users to define complex interfaces based on data in real time;
- Multilingualism,
- Significantly simplified operation with alarm and event lists (sorting, filtering, easier creation of user own lists, etc.);
- Numerous “smaller”, but more important novelties (permissible manual entry without data collection blocking, possibility of configuration of alternative data sources for individual indications, etc.);
- The number of characters for EXTERNAL_IDENTITY parameter is set to 40, while it can be extended for IDENTIFICATION_TEXT up to 60;
- The functionality of the redundant DE server, etc.

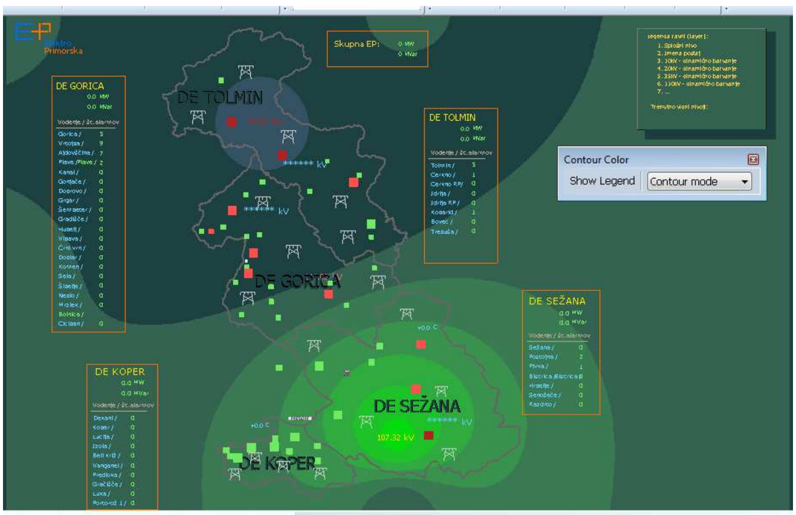

Figure 3 Dynamic Contour Colouring

4. MORE IMPORTANT PHASES WITHIN SCADA SYSTEM UPGRADE PROJECT

This chapter comprises a short description of more important phases in the SCADA system upgrade procedure (See Figure 1).

4.1. Preparation of SCADA software installation package

The software supplier prepared an initial version of the SCADA software package (a client and a server part) in accordance with the specification stated in documents [3] and [4].

4.2. Data migration of the existing SCADA system

As the existing SCADA system was active during the complete performance of the upgrading project, sensitive and challenging conversion of the following data of the existing SCADA system had to be performed during the performance of the complete upgrading project:

- DE databases;
- UDW databases;
- process displays;
- calculations;
- reports etc.

All migrated data were introduced into the new SCADA system and tested at the end of phase.

4.3. Preparation of the test virtual environment

During the initial phase of the project, a virtual environment of the new SCADA system was implemented in Končar testing environment for the needs of internal testing of its functionality.

4.4. Factory Acceptance Testing (FAT)

The functionality of the new SCADA software was factory tested in the software vendor virtual testing environment. Segmented data of the existing SCADA system that had been defined in agreement with the Employer were used for FAT testing of the functionality of the new SCADA system.

4.5. Education

An education was performed with the topic bound to the usage of WS500 operator client application for operators as well as several educations for system engineers for individual parts of the system emphasising especially novelties of the new SCADA software package during the performance of the project.

4.6. On-site system installation

After the Factory Acceptance Test, installation activities were initiated at the site - Elektro Primorska Dispatching Centre. Operating Systems were installed together with all the necessary pre-installation procedures such as defining of Basic Input / Output System (BIOS) settings, configuration of Redundant Array of Independent Disks (RAID) and similar followed by installation of necessary server control software as well as "Blade" system itself. SCADA software was installed and configured then together with creation of necessary databases within the system. Finally migrated DE database of the existing SCADA system was entered into the new DE server followed by the first so-called "total data population", i.e. initial entering of data into the real time and historical databases.

4.7. Tuning and testing of SCADA system

From the point of view of implementation, this phase represents one of the most important milestone of the project, since the final configuration of SCADA system is defined and all its functionalities are tested during this phase. It should be emphasised that the communication subsystem were tested during this phase while the existing and the new SCADA system were operating simultaneously on the basis of Končar in-house solution (See Chapter 5). The rest types of data were converted from the existing SCADA system such as SCADA Programming Language (SPL) user applications and similar as well.

4.8. Site Acceptance Testing (SAT)

When the configuration of the new SCADA System reached nearly final operating condition, the final and official site acceptance testing (SAT) of the functionality of the new SCADA software was performed at the Employer's site. The final completeness of the new SCADA System processing database was a key precondition for SAT.

4.9. Testing of new database consistency

After the SAT, the consistency of the new database was tested with so called "off-line simulator" application, one of Končar in-house software solutions (See Chapter 5) that enabled undisturbed testing of the correctness of processing data in the new SCADA system comparing it to the existing SCADA system.

4.10. Taking-over of control of electric power distribution network by the new system

When all the remote stations objects belonging to the control system managed by the existing SCADA System were successfully tested with the new SCADA System, the next phase of the performance of the Contract started consisting of the trial period (availability test period) for the new SCADA System that lasted for 90 days. During the trial period the existing SCADA System was not switched off, but it was operating as a stand-by system. The simultaneous operation of both SCADA Systems was used not only for additional training of dispatchers for operation with the new SCADA System, but also as a final verification of the correctness of the processing database of the new system. After successfully completed trial operation period, all the preconditions for a complete switch off of the existing SCADA system from operation were fulfilled and the new SCADA System took over the control of all the remote stations.

5. KONČAR IN-HOUSE SOLUTIONS USED DURING PERFORMANCE OF PROJECT

Končar developed a splitter – its in-house solution for splitting of communication channels that had the possibility of simultaneous serving both, the existing and the new SCADA systems with processing data not only for the needs of the migration (the transmission period of the simultaneous operation of the existing and the new SCADA system), but also to resolve problems in existing remote stations that did not have the possibility of simultaneous communication with more than one master centre. A processing data simulation method was developed as well that could be used as an alternative or a supplement to the real test, i.e. for initiation of processing changes on the remote control equipment or in the process itself.

Advantages of Končar in-house migration solution are the following:

- Undisturbed control and monitoring of the electric power distribution system;
- No changes of controlled and monitored remote stations;
- Testing of visibility of all the data from all remote stations in the new centre;

- Practicing of operation with the new SCADA interface / system; and
- Savings and shortening of the transition period; testing of the new system database with the simulation method.

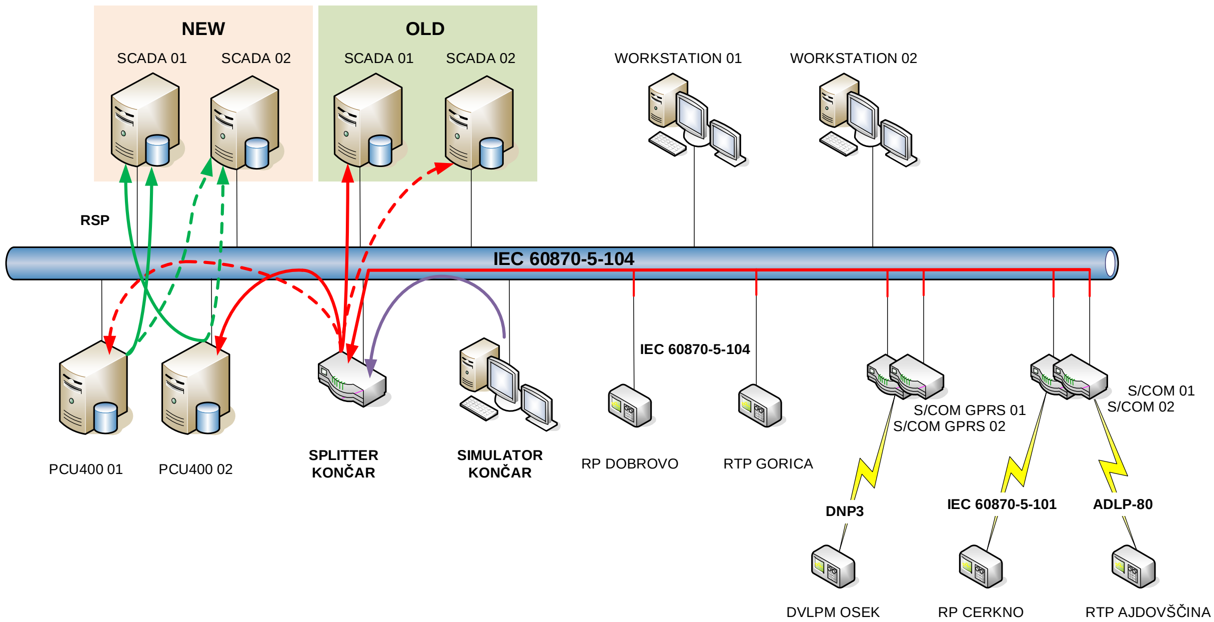

Figure 4 Migration period overview diagram (with underlined protocol types and RTU's examples)

5.1. Communication channels splitter

The communication channels splitter is a software and hardware solution that enables simultaneous serving of the existing and the new SCADA systems with processing data during the migration period, i.e. during the transition period when the existing and the new SCADA system are operating simultaneously. The splitter was implemented into a communication channel between the centre and a remote station making the splitter the superimposed centre for the remote station, while the splitter itself became a remote station for the real superimposed centre.

QNX, the splitter operating system, enabled defining of one real IP address and several so-called virtual IP addresses for the same network card making no significant differences between the real and the virtual IP address for the rest of the network. Therefore new virtual IP addresses for the remote stations as well as its own alias IP addresses were defined in the splitter, two for each remote station (for e.g. IP ADR 1A and IP ADR 1B). At the other hand, real remote station IP addresses, (IP ADR 1, IP ADR 2, etc.) were replaced with temporary above stated virtual IP addresses in both, the existing and the new centre at the same time, during performance of the test. The existing centre used IP ADR XA addresses and the new centre used IP ADR XB addresses. Therefore the usage of the following number of IP addresses within the Employer's network environment had to be enabled prior to performance of the test: 3 x the number of remote station IP addresses + 1 x communication splitter IP address.

The IP address of the Master IEC104 device had to be changed at the remote station side as well, depending on its type, and the communication splitter IP address had to be set instead the old centre SCADA server IP address. In that particular case, the change of remote station configuration was performed remotely from the centre.

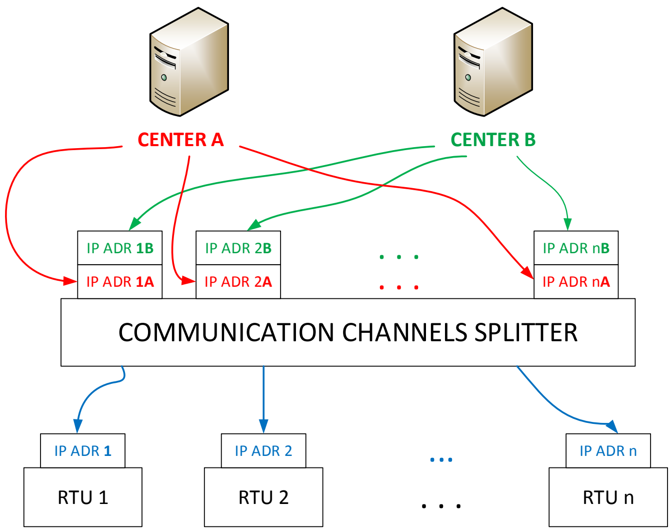

Figure 5 Block diagram of the communication between centres and remote stations achieved over a splitter computer

5.2. Processing data simulation method

At a user request, simulation generates a message for the required point and directs it automatically to the splitter computer for processing. The splitter computer forwards the data to superimposed centres then. In such a way, the simulated datum is shown in single line diagrams and lists not only in the existing, but also in the new SCADA system and it is comprised by reports and calculations and it also causes alarm reactions as necessary. The database entered into the new SCADA system is tested comparing information, processing and similar, i.e. the quality of all the system processing elements – indications, measuring, counters – are being tested.

Preconditions are the following:

- A database print out (of some required segment, i.e. station) is used as a source from the existing SCADA system and it is entered into table calculation software and adjusted for testing; and
- A simulator computer with MS Windows Operating System that communicates with the splitter computer over a local area network.

6. CONCLUSION

The Paper presents a description of the performance of the project of upgrading of remote control system SCADA software of distribution system operator Elektro Primorska in Nova Gorica (Slovenia) with a special emphasis on individual more important phases within the project as well as the usage of Končar in-house hardware and software solutions.

The Employer decided to upgrade the complete SCADA system hardware and software due to obsoleteness of the existing equipment (HP Alpha servers), reduction and gradual ceasing of provision of technological support of the supplier of SCADA applications on UNIX platforms, and also due to functionalities brought by the new SCADA software version.

Končar in-house solutions used during the very sensitive migration process from the existing to the new SCADA system enabled an undisturbed every-day operation of dispatching services and the safety of the distribution network operation control was not endangered in any sense.

The new hardware equipment implemented during the project enabled the continuance of the ordinary and high quality maintenance of the SCADA system hardware part. Not only new functionalities, but also the enhanced existing functionalities of the SCADA software enabled a higher quality operation of the SCADA system having an even higher availability and safety level. Thanks to all the stated facts, the implemented SCADA system has resulted in an upgrade of the quality of every-day electric power network control in Elektro Primorska Distribution Area.

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