NEW DISTRIBUTION CONTROL CENTRES IN CROATIA

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ABSTRACT

Because of 20-25 years old control centres Croatian Operator for power distribution system (HEP DSO) contracted the replacement of old SCADA system (based on PDP computers) for 4 (out of 21) control centres in Croatia: Zagreb, Rijeka, Split and Osijek.
These four centres cover the distribution area with approximately half of Croatian customers (470000 in Zagreb, 251000 in Split, 184000 in Rijeka and 145000 in Osijek) making them very important for power distribution.
It was decided that new SCADA system should integrate also DMS (Distribution Management System) functions and be able to work with various interfaces with other systems, but stress was on communication part. The question was how to transfer all existing communication from old to new system without (or at least very short) losing control over the system. Solution was new communication interface (S/COM) specially developed for this purposes.
Its functions can be summarized as:

- *in first phase communication with PDP computer to get all incoming data from objects in the new SCADA system*
- *direct communication with existing objects over ADLP 80 (SINDAC) protocol*
- *direct communication with existing objects over IEC 101 protocol*
- *Communication in LAN with new SCADA system over IEC 104 protocol.*

Communication lines (telephone and radio links) and RTUs will not be changed in the scope of this project.

INTRODUCTION

The story about new control centres in Croatian distribution started in 1994 when existing systems in most control centres was based on PDP computers at that time considered very old and close to end of life time. Due to other priorities (i. e. reconstructions after war) story ends with happy end 10 years later with contract for replacement of old SCADA systems for 4 (out of 21) control centres in Croatia: Zagreb, Rijeka, Split and Osijek.
But, that was just a beginning of difficult journey filled with lots of work, testing, programming, etc.
Main idea of this project(s) is to replace only central part of SCADA system leaving communication part and RTUs (substation automation systems) intact what decreased finances but made problems with conversion of protocols (ADLP 80 and IEC 60870-5-101 on IEC 60870-5-104) and interoperability with new system.
The existing SCADA system consists of several types of old DS-8 RTUs (DS801, 802 and 803), somewhat younger types DS2000, substation computers with digital relays, small RTUs for medium voltage network, fault locators, etc. As communication links they are using own and leased telephone lines, analogue and digital radio links.
As a solution for communication problems, new communication interface was developed and integrated with new SCADA system with communication over LAN over IEC 104 protocol. New communication interface is industrial PC with QNX operating system with newly developed software and hardware and it integrates functions of Front End computer and protocol converter.
First system in HEP DSO is installed and commissioned in January 2007 in Zagreb and according to time schedule all centres should be commissioned until August 2007.
With new SCADA system and communication interface HEP DSO is ready to accept all incoming tasks in newly liberalized electricity market and to renew communication network and substation equipment step by step using various protocols.

TIME SCHEDULES

At the beginning of the Project all activities (design, installation, Factory Acceptance test - FAT, Site Acceptance Test – SAT 1, System Availability Test – SAT 2, warranty…) were planned through Work Statement together with all time schedules which extract is shown in table below.

Table 1: Time schedule for Project

Site	FAT	SAT 1	SAT 2	Warranty start
Zagreb	Feb. 06	Sept. 06	Oct. 06	Jan. 07
Rijeka	July 06	Feb. 06	Feb. 06	May 07
Split	Nov. 06	March 07	March 07	June 07
Osijek	Feb. 07	May 07	May 07	Aug. 07

NEW SCADA SYSTEM

New SCADA system is one of state-of-the-art solutions available on the market for this kind of control centres and it consist of:

- HP Alpha servers DS25 in redundant configuration (on-line and hot stand-by) for SCADA and historical database (HDB),
- HP workstations with one, two or three monitors,
- Intel based web server,
- redundant LAN,
- ICCP/TASE2 interface
- printers, plotter,
- interface to business LAN and
- new communication interface, also in redundant configuration.

Software system is based on HP True64 Unix operating system for SCADA/DMS and Historical DB, Windows Server 2003 for web server and Windows XP for workstations. All SCADA software is installed on Alpha servers, while workstations are used for graphical interface and HMI. Historical database uses ORACLE platform for data storage.
Beside the replacement and modernization of existing SCADA functions, new system will be upgraded with additional SCADA functions, network analysis functions and interfaces to the other systems (GIS, TIS).
System complies to open systems standards and can be integrated with other systems through number of interfaces:

- ODBC for real-time and historical database
- COM/DCOM for application integration
- Web interface based on JAVA runtime environment

Complete configuration of new control centres with communication interface can be seen on Figure 1.

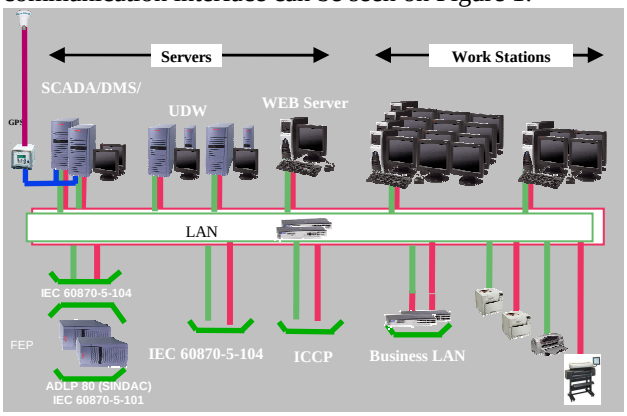

Figure 1 Configuration of new control centres

NEW COMMUNICATION INTERFACE

New communication interface has following functions:

- communication with RTUs and substation automation equipment over ADLP-80 protocol what required development and design of new hardware components to use in industrial PC,
- communication with RTUs and substation automation equipment over IEC 60870-5-101 protocol where it is possible to replace communication equipment, or existing equipment has possibility to use IEC 101 protocol,
- communication with SCADA/DMS system over 60870-5-104 protocol.

As it is mentioned before, to be able to use this communication interface it was required that protocol towards new SCADA system is IEC 60870-5-104. This protocol makes this solution independent of SCADA system and is also reusable in every control centre with similar configuration.
In order to make it work and to test all communication a special import procedure was developed to transfer data (names, types, information object addresses...) from old to new system keeping the consistency of 20000 - 30000 data in each centre intact.
With this procedure all addresses should be correct and needs only check of signals with corrections on the site acceptance tests. All signals, measurements and values can easily be tested during parallel coexistence of two systems and disconnect links from PDP computer only to test commands. After that all communication can be switched to new system and finally store PDP where it belongs, in technical museum.

IMPORT PROCEDURE

Import procedure for transferring data from old to new SCADA system started from so called mdf files gathered from PDP computer database which could be brought to windows environment and transferred into csv files (coma separated values). These files contains data about indications, measurements, accumulators and set points for all process data and are formatted for communication over ADLP protocol.
Since there is significant difference between definition of communication parameters for ADLP and IEC protocols, all existing data are converted to new ASDU (Application Service Data Unit) and IOA (Information Object Address) information for process data, together with new standardized naming convention.
For example, in ADLP protocol process communication address is one digit number of communication unit and RTU address on that unit. In IEC 101 protocol address contains order number of serial port and link address on designated device. Relation between number of serial port and its physical address is one of the parameters in communication program.
Comparison of protocols is shown in table 2.

Table 2: Communication addresses in ADLP and IEC

Protocol	Communication address	
ADLP 80	No. of comm. unit (1-9)	RTU address (1-15)
IEC 101	No. of serial port (1-9)	Device link address (1-255)

In new SCADA system all communication is done over IEC 104 protocol which means that all communication addresses are large 3 bytes and must be unique for whole system. To get correct data in conversion of ADLP and IEC 101 protocol set of rules were implemented according table 3.

Table 3: Default ASDU addresses

Protocol	Default ASDU address in new system
ADLP 80	No. of comm. unit * 100 + address of RTU (101-915)
IEC 101	No. Of serial port * 1000 + link address of device (1001-9255)

Similar to this procedure, all data had to be transformed and new import files were generated. All data was then imported in new system using unique identification of all process information.

TESTS FOR COMMUNICATION INTERFACE AND SCADA SYSTEM

It was really not a big problem to transfer data from old to new system, and test on location (point to point) showed that previously explained procedure was successful, but stress in testing was on interoperability with new SCADA system and all types of substation equipment.
For that purpose in suppliers premises complete test environment was set up consisting of SCADA system, communication interface, RTUs of every existing type (DS 801, DS 802, DS 803, DS 2000, all with communication over ADLP protocol and DSSN 200 with communication over IEC 101 protocol), substation computer with digital relays emulating RTU and communicating over ADLP protocol and substation computer communicating over IEC 104 protocol directly connected to SCADA system LAN.
All this equipment resulted in weeks of testing and fixing of all possibilities that can exist and proved new communication interface to be right solution. All this work evolved lots of engineers and specialists working with new SCADA system, communication part, protocols, substation equipment, etc.

INSTALATION AND TEST ON SITE

When it was brought on site, where everything was prepared for installation before (cabling, protection, UPS, air-condition…), it caused lots of mixed reactions among operators and system engineers. First they were thrilled that something is going on in their facility to help them in work, but as work went on operators stared to fill anxious. The day when they will start learning to work with new system, to understand lots of new functions, and to and cope with much more data and information then before, was coming. After installing of new system, it is always strange to see that 90 % of system room is filled with old system and only 10 % with new one, and also how empty this room will be when old systems is removed (Figure 2).
From operators every day questions were: “Am I capable enough to work with it?”, “Do I need to learn English?”, but also few gave comments like “New system will never be reliably as old one!” and “Pictures and letters are too small, functions are too complicated, we do not need all that information”, and so on.
Breakthrough for operators always comes on the first day of training when they start to click and type on everything in graphical interface for new system and to loose any fear of it.

Figure 2: New and old HW in control centre Zagreb

Figure 3: Operator workplaces in control centre Rijeka

After all that problems and difficulties test were performed for the whole system with exceptional success of import procedure where because there were no errors in new communication addresses, but lots of corrections had to be done in graphical interface where single line diagrams are shown. Most of corrections were made for symbols representing devices and how to represent behaviour of all events: what is alarm, what goes in SOE list, what message has to be presented to operator…

CONCLUSION

The project for replacement of 4 biggest control centres in Croatia is closing to its successful ending. Its story started many years before actual contract and every step was carefully planned and executed from decision to replace only central part of SCADA system and to develop new communication interface and protocol converter, till usage of import procedure and all necessary tests to establish new and replace old system almost without any moment of lost control over equipment in the network.
With this approach HEP DSO is now capable to wisely invest in new communication lines and substation equipment which can be easily integrated to new SCADA system. This solution is already used in new projects for replacement of control centres in Croatia (i.e. for distribution areas Kriz and Koprivnica) and even more experiences are expected before June this year.

REFERENCES

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[3] System design documentation for Control centres, Koncar – KET, Zagreb 2005.