AN EAST-EUROPEAN UTILITY COMPANY'S APPROACH IN THE SCADA/DMS SYSTEMS DEVELOPMENT

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ABSTRACT

The numerical technologies in distribution network control are an essential component for an efficient management, therefore, each utility company should have its own goals and strategy in this field. While numerical protections, SCADA and DA applications and a better control and monitoring level are required by the present business environment, the investments limitations are still an important issue. The paper offers a Romanian utility company's point of view in SCADA/DMS development and its present option and projects. Our engineers conceived a hardware and a software application for a simple SCADA system for the 110 kV substations and a control system for the MV/LV substations allowing SCADA/DMS functions implementation. Integrated solutions towards hybrid and local solutions were analyzed based upon the company's experience. It became possible to emphasis on a sum of conclusions about the cost-effectiveness, reliability, expandability and open structure to further developments of the systems we have up until this moment. Local systems, even if effective for the first period of implementation, prove not always reliable in medium and long term.

INTRODUCTION

ELECTRICA – Muntenia Nord S.A. provides the electricity distribution and supply in the center and east of Romania (Figure 1).

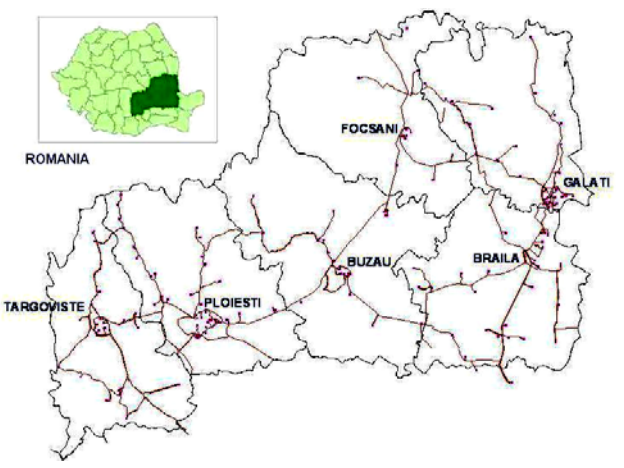

Figure 1. The company's area of activity and the 110 kV power network

Geographically, the company covers 29,765 square kilometers, for approximately 1,300,000 distribution customers, from a total number of 3,300,000 inhabitants in the area. The 110 kV power distribution network consist in 2300 km overhead lines and 121 substations of 110/MV.
The company's power networks are spread across 6 Romanian counties with relatively important towns and various industrial activities, agriculture and tourism. There are two dispatchers for the high voltage network and substations, seven local dispatchers for the medium voltage network and MV/LV substations and one dispatcher coordination office. Some of the most important industrial consumers also have their own 40 of 110 kV/MV substations, coordinated by Muntenia Nord's dispatchers. Likewise, there is a number of 84 Medium Voltage substations (most of them being 20/6 kV) and 9500 Medium Voltage/Low Voltage substations or MV connection points.

We are still facing an important moral and physical ageing of the power installations, occurred especially in the eighties' and early nineties'. Consequently, a very important range of issues in the investments field is represented by the power substation retrofit and modernization, numerical protections, SCADA and DA projects and applications. The documents of the National Regulatory Authority (the independent Romanian system authority), like The Power Network Technical Code, and the present business environment require a better control and monitoring level, simultaneously with the improvement of the power quality parameters.

LOCAL SCADA FOR HIGH AND MEDIUM VOLTAGE

Because modernizing actions for a large number of substations were impossible to sustain, due to fund shortages, this lead to the decision of achieving simple SCADA systems, with local partners or with our own specialists. Firstly, this was feasible for the substations with old remote control panels. This development took several years, and the most significant achievement was fulfilled by the company's IT personnel. The software application uses the Visual Basic language and the Windows XP operating system and allows managing a large amount of information, user-friendly graphical interface and the remote control of the substation. This approach offered the possibility to implement SCADA functions in several substations.

This achievement, with limited funds, offered initially good return in terms of results, as reliability, availability and operation cost. The main process-image of this software application is presented in Figure 2. The main image has the role of a container for the other secondary windows, including the buttons and menu bars of the program, the state and signaling bar.

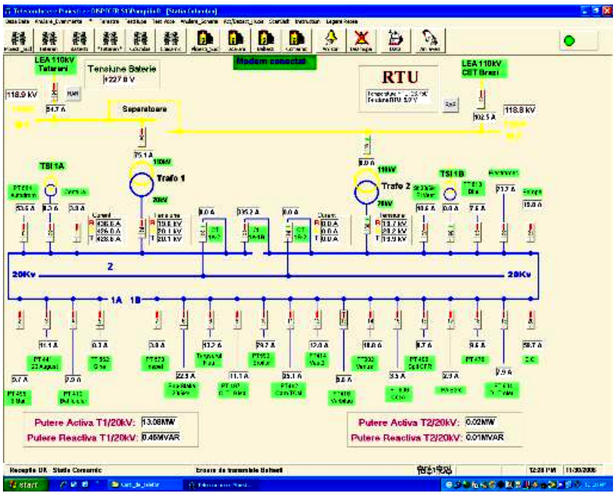

Figure 2. Main process-image for a 110 kV substation

There is also the possibility to display the information referring to the data transmission mode and reception quality in other windows of the program. The application enables the event recording and processing. In case that it is useful to watch the parameters variation for a time interval, the active power, voltage and current variations can be visualized for the chosen period, under the form of a graph or a table. If the computer screen is busy with one substation, and occurs an event in another substation, this will automatically become foreground. If several events occur simultaneously, they range in a waiting queue to be approached in the order of importance. The switching devices are controlled with a "select before operate" method. Each of the operator's actions is registered in the database, chronologically, together with the events caused by the reception cycle.

In the MV network (20 kV) a number of remote controlled reclosers and sectionalizers were placed in the most important overhead lines in the last years. The remote control package and software is provided by a local firm, on a Windows 2000SF platform, but remains the problem of integrating the application in a SCADA concept. For reclosers and sectionalizers, the use of GSM signal was accepted.
The latest achievement in the company's MV network is a control system for the MV/LV substation with the configuration presented bellow.

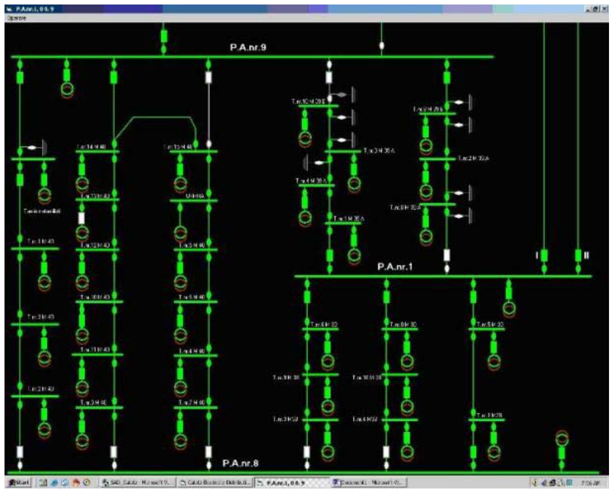

Figure 3. HMI of the SCADA/DMS in MV network

A controller in the MV/LV substation creates the link with the process. The system is conceived for multi-user and multi-tasking operation, on a OS 9 operating system, with an external memory of 256 Mbytes.

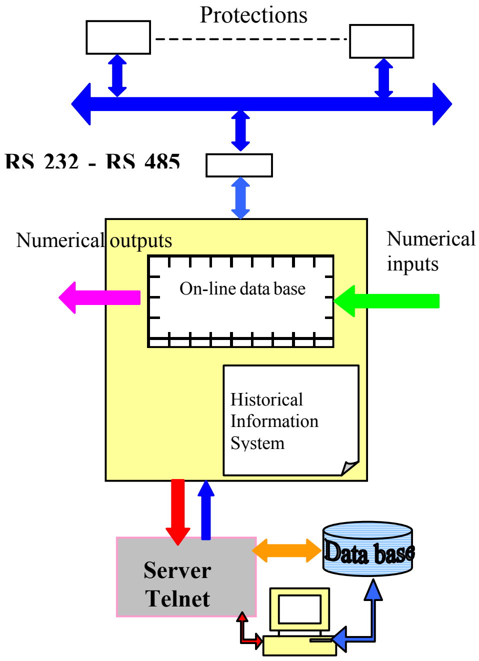

Figure 4. MV control system architecture

The Telnet virtual server is a Java application for the management of the communication with the controllers and the process. It provides text-messages acknowledged by the OS 9 operating system, and, in the same time, provides start-up and monitoring sequences for the controllers. The relational data base is MS SQL 2000 type, on Windows XP, with tables modifiable on short, medium or long term, function of the specific sort of event, data, technological process or diagram. The equipment and the software are offered by the local provider, the task of configuration being fulfilled by our staff. The on-line communication with the process platform and the controller is done through a virtual server, making possible the operation of a large number of controllers with a single virtual server. In the Control Center's server (computer) are implemented three essential components :the virtual server Telnet which adjust the commands-controls to the operating system (OS 9), the SQL 2000 relational database, and the HMI applications for DMS. Concerning the DMS functions only some features are implemented. The single-line diagram up-date is achieved in short and medium period, consequently to the state of the switching devices. A dialog window will appear on screen for any switching operation, and security interlocking are operational. The Power Flows and the Topology Management are functions under different degrees of implementation. Synthetically, as system components we distinguish the followings (Table 1):

Table 1. MV SCADA/DMS system components

Application software	On-line communication between process and Control Centre
	Function applications
Operating system	Logger
	On-line data base
	I/O devices
	OS 9 kernel
Hardware	Controller
	Process interfaces

THE LOCAL SOLUTIONS LIMITATIONS

As the new technical trends reached to us, we realized that the achievement of an almost hand-made SCADA system cannot represent our goal and this action has its own limitations. After implementation we experienced a number of failures, the troubleshooting rate for a single substation with proprietary solutions reaching, as an average, a Mean Time Before Failure, MTBF ≤ 500 hours. In this number we implied only the hardware components and the software problems, not the communications lines. The MTTR (mean time to repair) can be considered 4 hours, thus, the operational availability results:

$$A = MTBF/(MTBF + MTTR) \times 100 = 99.21\ \%$$

According to this availability level, the failures time reach to an average of 70.1 h/year for a single installation (substation). By multiplying the time with 16, the number of 110 kV/MV substation driven in different variant of proprietary solutions, the failure time is about 1122 hours per year. The total down-time becomes more relevant after the evaluation of the expenses involved (70 000 €/year for maintenance and repair). The substations are not in the same area, therefore three different teams for repairs and maintenance are necessary, with 5-6 substations for each team. Even if the repairs cost was not extremely high, it has a growing trend. Resuming for our local system, we offer a simple "for"/"against" analysis. As arguments, we count:

- It was achieved and developed mainly by our own staff (hardware and software), with minimal costs;
- For a period, offered important savings in operation and maintenance and allowed a better control of the substations;
- It was directly adapted to the dispatchers procedures and specifications;
- Offered the possibility for training and to distinguish the system requirements limitations, both from the user as from a designer perspective.

But, we found limitations for the local systems such as:

- ✓ The fact they don't use a standard protocol;
- ✓ A local systems has limited development as SCADA and no DMS functions;
- ✓ Reliability and scalability of the software applications are bellow of the modern systems;
- ✓ The IED's and RTU results from an unreliable manufacturing process and the failures of the components have a growing trend;
- ✓ Finally, any of these systems creates dependence upon components, developing and service staff, and soon the maintenance and repairs become difficult and unreliable.

Whatever promising results this approach has given, especially in short-time savings in operation and maintenance, it rapidly turned, in few years, in a so-called "legacy system" [2] that must be adapted to an integrated concept, using standard protocols, such as DNP, IEC 870-5 series, or the latest IEC 61850. We are continuing to use local systems in substations of less importance, but we plan to integrate the HV/MV substations in a company's DMS/SCADA concept using adequate protocols.

TOWARDS STATE-OF-THE-ART DISTRIBUTION CONTROL SYSTEMS

The company strives now to reach towards new state-of-the-art control systems, and some of the projects shall be briefly presented further-on (Figure 5). The system configuration will be structured in three distinct levels:

- ❑ The substation level – the use of the IEC 61850 protocol in a FO-ring LAN, like in Figure 6, we consider it optimal for redundancy and reliability [1]. In the Ploiesti area, there is now one 110/20/6 kV substations with a ring configuration under commissioning (a RS 485 cable ring);
- ❑ The branch level – 4 branches connected as shown bellow. The paper's space do not allows the presentation of the branches configuration, each of them being close as in the Fig. 5 drawing, with the 110 kV substations at the lower level and the company's control centre at the higher level;
- ❑ At the company's level the designed system (Figure 5) with redundant dual LAN Ethernet, on TCP/IP.

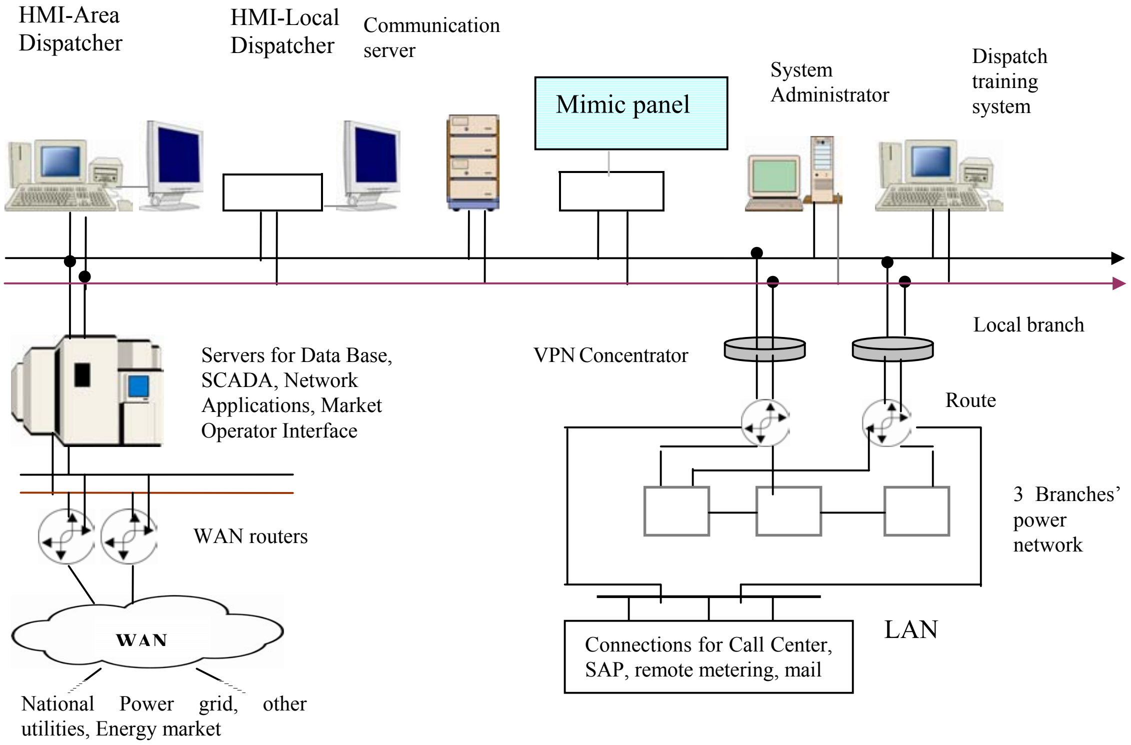

Figure 5. The control system configuration at the company level

The use of the data support must provide reliable operation and a good performance/cost ratio. The new systems will have a modular and distributed architecture, to allow up-grades and adaptations to future needs.

CONCLUSIONS

In the last two years, the fund limitations seems to become less restrictive, the business environment becomes dynamic, and we hope this trend will continue even stronger after the recent Romania's EU integration. A more daring approach in the investments for modern SCADA/DMS systems might be the right way for this moment. Based on our previous experience of less-reliable control systems, the company gradually adjusted its policy in the field, from simple and mostly local systems and integrators, towards future state-of-the-art integrated systems. The trend for the future SCADA achievements is the integration of the overall system from the bay level to the company's control center with fast data handling and reliable operations. The integration of different devices in a interoperable system structure with, preferably, the latest standard protocol, IEC 61850 and 870-5 series will be an essential requirement of our utility company. The systems architecture must be modular, redundant and scalable to allow upgrades and replacements of some functional blocks without affecting the basic operation.

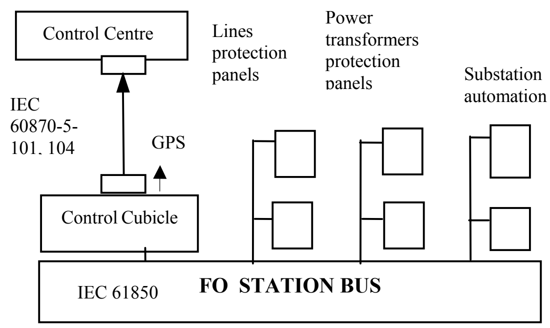

Figure 6. 110 kV/MV substation configuration

REFERENCES

[1] C. Hoga, G. Wong, 2005, "Communication according to IEC 61850 – Reliability at high speed", CIRED, Turin, Session 3 Technical Reports, 47/1-4.
[2] D. Ossenblock, R. Derkinderen, 2005, "How to integrate new technologies and legacy systems", CIRED, Turin, Session 3 Technical Reports, 50/1-4.
[3] A. Illo, M. Reischbőck, F. Jaklin, W. Kirschner, 2005, "DMS impact on the technical and economical performance of the distribution systems", CIRED, Turin, 41/1-5.