BENEFITS OF SCADA SYSTEMS WITH EXAMPLES IN AGRICULTURE

BENEFICIJE SCADA SISTEMA SA PRIMERIMA U POLJOPRIVREDI

Vladimir BUGARSKI, Perica NIKOLIĆ, Dragan M ATIĆ, Ilija KAMENKO
Faculty of Technical Sciences, 21000 Novi Sad, Trg Dositeja Obradovića 6, Serbia
E-mail: vladimirbugarski@yahoo.com

ABSTRACT

The authors would like to draw attention to the increasing need for supervisory control software in agriculture and other industries. The possession and use of SCADA (Supervisory Control and Data Acquisition) software today has become a necessity. This paper is intended to show all the benefits of this software. SCADA systems allow for acquisition, storing and analyzing signals from the field. Today such systems are increasingly present on the market. Special attention is given to examples of SCADA systems in agriculture. One chapter presents examples of developed and tested SCADA systems in production of soy flour and grits and textured soy proteins, in a plant for the production of mineral fertilizers, plant for the production of vegetable oil and in cold storages. All of these SCADA systems are implemented in various facilities in Serbia. The paper also describes the authors' experience in creating, testing and commissioning of SCADA systems.

Key words: SCADA, Agriculture, Control, PLC.

INTRODUCTION

In the last ten years we have witnessed tremendous changes in the technology of control systems. Computer equipment and software packages launched onto the market enable a wide range of the possibilities for the process visualisation. It is important for an industrial plant to have a reliable software package for signal acquisition and control. However, a large number of industrial plants do not use these advantages although in many plants a special attention is paid to the controllers that directly manage the production processes. Programmable Logic Controller – PLC are almost always replaced by the latest versions, which can be interpreted more as a need for purchasing new machines (along with controllers) than as awareness of advantages of the latest technology. Conversely, supervision and control system should have Human Machine Interface – HMI which is replaced slowly. The systems for collecting data and control at the higher level are called SCADA (Supervisory Control and Data Acquisition).

The managing elements enabling reliable starting, monitoring, managing and stopping of any machines or processes are necessary for machines and devices in the process of manufacturing. Control logic used to be conducted by relay technology, wired contacts and spools. The main disadvantage of this approach is that any change in the control logic requires significant actions on the wiring. In industry there is a strong presence of obsolete SCADA systems. Their maintenance is slow and expensive and thus inefficient. Today we can substitute old systems with modern SCADA systems where controlling algorithm is carried out by the software that allows fast and cheap changes and upgrading. Control logic is stored in the internal memory of the computer, and it is independent from the equipment and wiring and can be changed at any moment by programming device and appropriate software. In addition to the price and speed as important criteria there is a modern system relying on modern database, report creation systems and alarming systems. This paper attempts to explain all the advantages of modern SCADA systems hoping that the trend of replacing old systems by new ones will continue with a faster pace so everyone will benefit from it.

This paper presents SCADA software which is placed in the top of the control hierarchy (Bailey and Wright, 2003). The basic purpose of this SCADA system is to collect all important data from the process (Stuart, 2004). This is managed with the help of the PLC. In fact, the PLC communicates with machines, drives and instruments in the field and then supplies the SCADA system with the necessary data. SCADA on the basis of these data shows the state of the plant to the operators. On the other hand, operators have the opportunity to control the drive, with using SCADA again, and set the reference values in the PLC.

System configurations showed in this paper are based on specialized SCADA software WinCC (Windows Control Center) and WinCC Flexible which are both products of Siemens, but they also may be conducted on any other configuration tool. The
systems shown in this paper are from several locations in Serbia. There is SCADA software for controlling the process of manufacturing fertilizers in Fertil Factory in Backa Palanka. Then, SCADA system is present in Elixir Food frozen food plant in Sabac. There is an overview of supervision and control system in the plants for manufacturing soya flour, semolina and texture soya proteins in Soya Protein Factory in Becej. The last example refers to the SCADA system for controlling oil production in Victoria Oil Factory in Sid. All these systems were implemented, put into operation and maintained in the last few years. The authors of this paper will present their experience in projecting, realization and maintenance of these systems.

Further information on the realization of SCADA systems can be found in (Bugarski et al., 2007; Bugarski et al., 2008; Bugarski et al., 2009a; Bugarski et al., 2009b; Bugarski et al., 2010).

MATERIAL

Hardware Configuration

The supervision and control process at the higher level in modern SCADA systems is often carried out by PC computers. All the examples from this paper were carried out on one or more than one PC computers with Windows XP operating system. These computers are placed in a command room and usually have more than one screen of higher resolutions. SCADA computers communicate with PLC via MPI, PROFIBUS, Ethernet or another communication (Clarke and Reynders, 2004). Practical applications of linking SCADA and PLC systems and cost analysis may be found in (Nikolić et al., 2009; Nikolić et al., 2010a; Nikolić et al., 2010b). When there is a need for the SCADA system in the plant directly by the machines, Touch panels are usually used instead of PCs. Touch panels have better IP protection and they are resistant to dust, vibrations and moist that can exist in plants. Controlling is carried out on panels because visual contact with a machine is needed. Unlike Touch panels, the complete SCADA is placed in the command room which can be separated from the plant.

Although SCADA packages are developed by many producers there are similarities in their architecture. The basic components of all SCADA systems are Tag Management, Graphics Designer, Alarm Logging, Tag Logging, Report Designer, etc.

The examples from this paper include PLCs from Siemens series S7-300 and S7-400.

SCADA software

Well-configured SCADA software should follow the functional organization of the plant and may be observed as a set of graphic screens. There is usually one (or several) initial screens where the image of the whole plant is presented (Fig. 1). This screen serves only for supervising the plant and the main parameters of the process. If the plant is large, there may be several images showing certain parts of the plant. Controlling the machines (switching the motor on and off, opening and closing the valves) is available to the operators by clicking the left button of the mouse onto the appropriate machine. If the additional protection is needed, the actions of the operators may be coded so only the operators who know the password may perform the action.

Usual colour animations of machines are: green when the machine is working, dark grey when it has stopped and flashing red when something is wrong (Fig. 2). Except for the main pictures, operators can monitor the picture with trends of analog values (Fig. 3), picture displaying all alarm messages (Fig. 4), a separate image for monitoring the engine work hours (Fig. 5) and a picture which presents the consumption of the drives (current, voltage, active and reactive power, active power factor, frequency, etc.) shown in Fig. 6.
Fig. 2. Colour animations in Soyaprotein

Fig. 3. Trend of analog values in Soyaprotein

Fig. 4. Alarm messages in Elixir Food
DISCUSSION

The main reason for introducing SCADA systems is to have all the collected information from the plant in the central place. The variables of interest are stored in the database and can be accessed via trends (Fig. 3) and tables. The critical states of the processes are defined by alarm messages that can be put into the archive in the database (Fig. 4). Another big advantage is controlling the whole plant from one place. Since SCADA systems work under Windows operating system, every interface to external applications is available. It is possible to create reports in a simple way and then they can be printed via installed printers or kept in the desired format of data for processing and distribution.

Although the SCADA systems offer a wide range of options, it is sometimes difficult to make the right decision in choosing equipment and ways to configure the software. First of all, when choosing PLC and SCADA system, think about connection between them. PROFIBUS for example will give you higher transmission rates and allows more devices on network then the MPI. On the other hand, PLC with integrated PROFIBUS-DP interface is slightly more expensive than the one without it. Then...
consider Ethernet or PROFINET which give the highest transmission rates, but Communication Processor can significantly increase the cost. Then, the second choice is operating systems for PCs. For example, if you need SCADA software on three PCs there are several possibilities. Should we take one PC as Server and other two as client machines or all three PCs should be stand-alone systems or something in between? Well, some things must be understood. The license is commonly charged for a number of tags and for a large number of process variables is not a negligible item. In this case, server-client combinations should be considered to reduce the cost. However, it should be also understood that in this case we need extra license for server-client communication and more server machines usually need Server operating systems to work and they are also more expansive than regular operating systems. One more thing must be taken in consideration. A client cannot run without server so if there is any malfunction on server no client will work. This is why authors will encourage you to take stand-alone applications when having up to three PCs and up to 8000 process variables, and to consider server-client combinations in other cases.

When operating, the SCADA communicate with PLC and exchange the values. Although majority of the SCADA systems will allow you to address directly inputs and outputs of the PLC that is not a good solution. The authors, from their own experience, advise you to always use the Data Blocks for communication between the PLC and SCADA. Yes, you will need more of PLC code and memory and even Scan Cycle will grow, but you will surely have a safe control system. The reason is that PLC should be the device that performs directly control and SCADA should perform only supervisory (indirectly) control. PLC is the device which implements the interlocking diagrams and that is why the PLC should be the only device to directly turn on/off machines and/or open and close the valves.

The advice and recommendations are given based on experience in the above mentioned realized systems, and they are good for systems of similar scales. SCADA in “Fertil” Factory is SCADA with one PC with 4 monitors and 1500 process variables. Web Navigator and SMS modem enable access to SCADA through Web network and SMS messages. These systems only give the monitoring and no control because of safety. In “Elixir Food” Factory SCADA is implemented on 2 PCs. One PC has full functionality for operators to control the system and the other one has implemented only monitoring and is designed for technologists. It is 1000 process variables SCADA. In “Soyaprotein” Factory SCADA is installed on 2 PCs as stand-alone applications. There are also 6 touch panels in the field with mini SCADAs on them. Touch Panels are used for control and SCADA PCs mostly for monitoring and storing data in database. SCADA have 2000 process variables. The fourth SCADA system described is the largest one because it has 3 PCs as stand-alone applications and each PC has 2 monitors and SCADA has 6000 process variables.

**CONCLUSION**

This paper presents the examples of SCADA systems that are efficiently applied in several industrial facilities. The configured software is tested and put into operation in real plants. Such software packages provide users with a reliable supervision and control system. Modern SCADA systems help us to overcome the disadvantages of old systems. These systems are reliable, safe and can be changed and upgraded by additional configuration. The possibilities that SCADA systems offer to users are much more important than the price of their implementation.

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**REFERENCES**


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