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CONTROL AND MONITORING OF SISTEMS HEATING WITH SCADA

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Abstract— SCADA (Supervisory Control And Data Acquisition) systems represent applications trought which we can collect datas from a system in order to control and monitorise that system. So SCADA is in fact technology that gives the user the posibility to acquire data from one or more remote equipments and send a limited set of control instructions to those equipments. The purpose of this writing is a study of SCADA systems exemplified by a heating system.

Keywords— control, industrial process, informatic system, monitoring, real time, SCADA.

I. Introduction

NUMERICAL process control equipment represented a significant step towards reducing the gap between outstanding results offered by automatic systems theory and techniques applied in practical management of industrial processes.

The particularities of programming computer systems for monitoring and/or management in real-time industrial process are determined by the following conditions:

1) the posibility of the system to respond instantly to random signals that come from the process;
2) the ability of the system to receive data directly from the process and / or transmit them directly into the process by non-standard peripherals (analog to digital converters, digital-to- analog converters , etc)
3) the requirement for "the real time" is when the system is busy with some proper operation of a particular event, to be strictly correlated with the time and other events occurring in the industrial process;
4) to solve the contradiction between the ability of the system to perform at some point one program and the process to be "served" in n points simultaneously; in other words, the system must face simultaneous development of different specific parts of the process;
5) the possibility of programming all types of process (continuous or discrete);
6) *the existance of elements of efficient testing and debugging of the programs [1].*

Therefore, to schedule a real-time application, the programming language used must contain three types of instructions:

1) Instructions that enable programming the mode in which the events start in the process;
2) Instructions that specify where the events take place in the process;
3) Instructions that refer to time or time range in which the events take place in the process [2].

The instructions from the first category form a set of basic options that can be used without real time from the system. The other categories of instructions are specific to work in real time and form an extension of the basic language. They can be obtained via the interrupt system mode (event venue) and real-time clock (time or time in which the events take place in the process)

SCADA is the technology that allows the user to collect data from one or more remote equipments and send a set of limited instructions to control that equipment.

A SCADA application has two elements:

1) The process/system/machinery you want to monitor a control—this can be a power plant, a water system, a network, a system of traffic lights, or anything else.
2) A network of intelligent devices that interfaces with the first system through sensors and control outputs. This network, which is the SCADA system, gives you the ability to measure and control specific elements of the first system [3],

SCADA include the operator's interface and concrete data of manipulation of the application.

SCADA has functioned for a long time independently from other numerical systems and the fact that he was a real-time system, was not important. More and more SCADA systems appear that run on schedule or on request. Today SCADA combines both elements in real-time and pre-programmed operation.

For the SCADA systems real-time operation means updating control systems to change in the process. Strictly speaking, real-time command is the one that do not let the system to have a dead time between the reception of the process measurement and the control signals. In reality, all control systems introduce some delay [4].

Those who place no measurable effect delays are generally known as real-time systems.

In contrast to these systems there are the preprogrammed systems (sequential). Most systems that control continuous process operate in real time. Most times specific inertia system is much higher than the response time of the control system which makes possible to consider this is done in real time.

Another important element in the projection of SCADA systems is the choice of scanning period to the needs of the process and must be done by professionals who know the effects of delays in the system.

The reaction speed depends on the characteristics of the system and it can be controlled from the order of seconds, in the case of power systems, to the order of hours, in the case of oil extraction field.

Practically, real time means that the delay time of the system is not so large as to introduce it into the control obvious effects. For this reason, most SCADA systems are considered real-time control systems even though they may be highlighted some delays.

Both for MTU (Master Terminal Unit) and for RTU (Remote Terminal Unit) having a numerical system and having to communicate with each other is important to select the communication protocol. The most common SCADA communication method is the so-called master-slave. In this protocol a single machine (MTU) is able to initiate communication. MTU calls a RTU, gives instructions, asks for information and controls RTU to respond. Then MTU expects the answer. RTU responds as soon as communication MTU is finished, then stops and waits for input. MTU then switches to another RTU and goes through the same procedure. RTU can't initiate a message; it can send a message only if ordered to do so by MTU.

II. Analysis of SCADA systems through the heating systems

Exemplifying SCADA systems can be made through a water heating system consisting of three boilers that operate and are powered by natural gas, with the following initial conditions:

1) Each boiler is equipped with two valves: one for cold water and one for gas;
2) The main water and gas pipes are also equipped with one valve;
3) The gas pressure is considered to be ideal;
4) Two pressure sensors will be put, one on the cold water inlet and one on the outlet hot water;
5) There will also be some pressure sensors in each tank, respectively within each cylinder;
6) We must take in to consideration the case that in one of the boilers, the water is stopped, but gas stays on increasing the pressure in the tank;
7) We must take into account the cases in which one of the boilers, gas supply stops. Cold water will affect the resultant output of the entire system [5].

A. Software used

In order to establish this system we decided to use "Trace Mode 6" free license valid. The program can be obtained at: http://www.tracemode.com/products/dev/scada/ [6].

The development environment allows, among other things, creating, simulating and monitoring SCADA systems and generating documentation and reports. The program at the same time may generate executable controllers.

An advantage offered is free documentation available for the program.

B. Implementation

The first step is to create components.

It is assumed that the valves are controlled digitally, this will create each valve in part: it will have a visual representation, namely source code that is how it works. Below we illustrate an example of a valve with two possible positions (closed and open) [6].

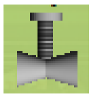


Fig. 1. Valve with two positions

```
PROGRAM
  VAR_INOUT Comanda : REAL; END_VAR
  VAR_INOUT Deschidere : REAL; END_VAR
  VAR_INOUT FinalActiune : REAL; END_VAR
  VAR _OPEN : REAL := 2; END_VAR
  VAR _CLOSE : REAL := 1; END_VAR
  VAR _PREDEL : REAL := 100; END_VAR
  VAR _NO : REAL := 0; END_VAR
  VAR _STEP : REAL := 2; END_VAR

  if Comanda == FinalActiune then Comanda = _NO;
  end_if;
  if Comanda <> _NO
  then
    Deschidere = Deschidere + _STEP;
    FinalActiune = _NO;
  end_if;
  if (Deschidere >= _PREDEL) then
    FinalActiune = Comanda;
    Comanda = _NO;
    Deschidere = 0;
  end_if;

END_PROGRAM
```

To order during simulation components, will create dialog boxes that their condition can be altered. Illustrated below for valve control box described above.

In order to define the operation of the system it will be defined input parameters, output and operation for each active element.

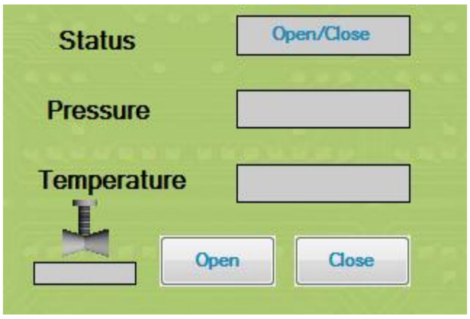
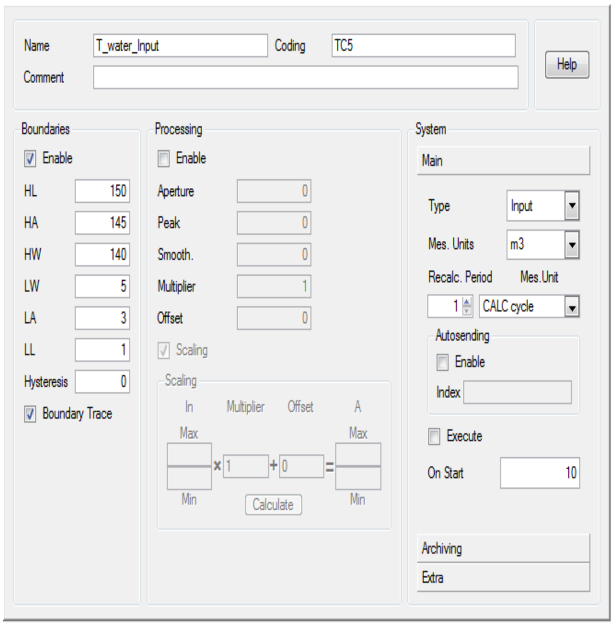


Fig. 2. *Command box*

For example, for the cold water supply, the input data will be defined as shown below.

Fig. 3. The input data for water distribution

Retain most important datas:
HL – (26, HL) – Absolute superior value;



HA – (28, HA) – alarm superior value
HW – (30, HW) – warning superior value;
LW – (31, LW) – warning inferior value;
LA – (29, LA) – alarm inferior value;
LL – (27, LL) – absolte inferior value;
On Start – intial value

After all components have been designed and programmed, it will be created a new file with the command Create Component -> Screen, which will be positioned components;
Press the "Save RTM" for compilation
Press the "Start Profiler" for running the simulation.

C. Final Design

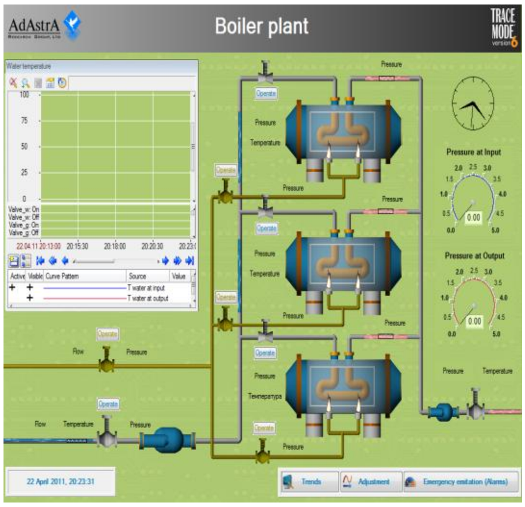


Fig. 4. The final design for the system

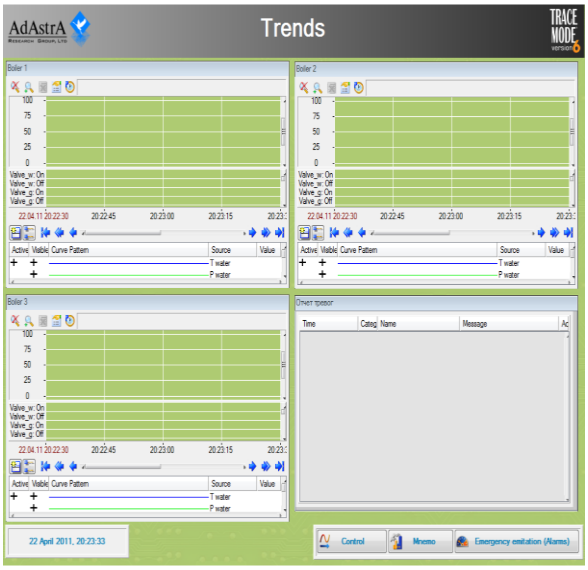


Fig. 5. Evolution of temperature and pressure for each cylinder

D. Monitoring

By accessing the view mode "Trends" we can observe the evolution of the temperature and pressure in each tank.

A concrete scenario

1) *It will follow the following scenario:*
2) *Start the simulation;*
3) *Allow the system to run for 120 seconds;*
4) *After passing the 120 seconds stops gas supply to the first tank;*
5) *The system is allowed to run an additional 120 seconds;*
6) *Observe the evolution of the water temperature at the outlet of the system.*

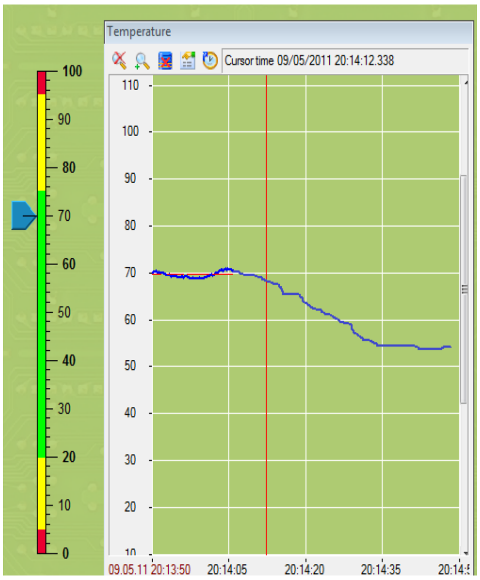


Fig. 6. The evolution of the temperature of the water at the outlet of the system

E. *Statistics and reports*

To test the system and create reports as accurate as possible it will "stress" the system by implementing several situations: overheating, differential pressure, cold water outlet, etc.

These can be obtained by opening and closing suitable valves. States is observed under these conditions boilers view mode "Trends".

F. *Implementation*

After the system has been tested in simulation conditions can be physically implemented system; Trace Mode is capable to generate structure control circuit:

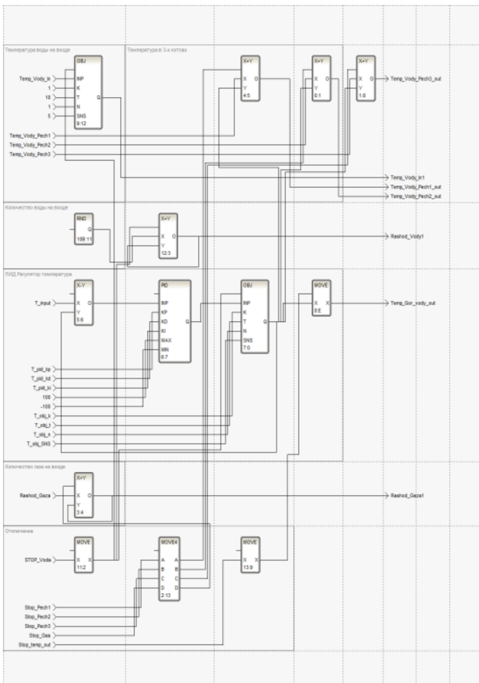


Fig. 7. Structure control circuits

III. CONCLUSION

SCADA is not a specific technology, but a type of application. SCADA stands for Supervisory Control and Data Acquisition — any application that gets data about a system in order to control that system is a SCADA application.

A SCADA application has two elements:

1) The process/system/machinery that needs to be monitored - this can be a power plant, a water system, a network, a system of traffic lights, or anything else.

2) *A network of intelligent devices that interfaces with the first system through sensors and control outputs. This network, which is the SCADA system, gives the ability to measure and control specific elements of the first system [7].*

SCADA systems are very useful when it is necessary to control and supervise complex systems, being able not only to work items in the system, but also to warn about various warnings, and at the same time can perform simulations in which the user can observe a ideal operating system [8].

Below we present some of the advantages of SCADA systems:

1) Access quantitative measurements of important processes, both immediately and over time

2) Detect and correct problems as soon as they begin

3) Measure trends over time

4) Discover and eliminate bottlenecks and inefficiencies

5) Control larger and more complex processes with a smaller, less specialized staff [9].

SCADA is used around the world to control all kinds of industrial processes — SCADA can help to increase efficiency, lower costs and to increase the profitability of the operations.

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