HYDRO-ELECTRIC POWER PLANTS SCADA SYSTEM – APPLIED ON THE SOMES RIVER

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Abstract: The hydroelectric power plants are in a process of rehabilitation and upgrade to ensure optimized operation. One method of optimization of the power production plants is to provide the remote control of all power production units using a SCADA system. The telematic system has a PC-based, two-level distributed architecture:
- *the local level* is in the *control structure,* located on the plant platform, the *connection and communication interface,* located in the hydroelectric power plant control room,
- *the central leve*l located at the territorial dispatcher.
This type of system handles both software and hardware techniques based on PC resources, PLCs, RTUs, smart sensors, actuators, data communication and transfer devices.

Keywords: telematic system, distributed automation architecture, power energy management

1. INTRODUCTION

SCADA (supervisory control and data acquisition) is an industrial measurement and control system consisting of a central host or master (usually called a master station, master terminal unit or MTU); one or more field data acquisition and control units or remotes (usually called remote stations, remote terminal units, or RTU's); a collection of standard and/or custom software used to monitor and control remotely located field data elements. Contemporary SCADA systems exhibit predominantly open-loop control characteristics and utilize predominantly long distance communications, although some elements of closed-loop control and/or short distance communications may also be present.

Systems similar to SCADA systems are regularly seen in factories, manufacturing plants etc. These are often referred to as Distributed Control Systems (DCS). They have similar functions to SCADA systems, but the field data acquisition or control units are usually located within a more confined area. Data communications may be achieved via a local area network (LAN), and will normally be reliable and high speed. A DCS system usually operates significant amounts of closed loop control.

In this paper it is succinctly presented the SCADA architecture built and implemented on the hydroelectric power plants from the Somes River and the way it meats the SCADA system requirements.

2. MAIN FEATURES OF THE SCADA SYSTEM OF THE SOMES HYDROELECTRIC POWER PLANTS

The remote measuring, data acquisition and supervising system achieves the modernisation of the dispatching activities for seven hydroelectric power plants. The newly added telematic system provides to the existing equipment with a remote measurement and control unit, integrated computing systems and digital processing devices.

The telematic system, as seen in figure 1, is structured on two levels:

- **Local control & connection level** –the hydroelectric power plant unit includes transducers, actuators, RTUs (power meters and level measurement blocks) and a PLC used in parameters measurement, supervising and control of the process. The local control level equipment processes the electrical measurements (analog and digital signals) acquired from the electric equipment of the hydroelectric power plants. The digital input signals represent the function status of switching equipment and the real-time protection loops status. The analog signals include electric parameters, such as: voltage, currents, power factor, frequency and energy parameters: active, reactive and apparent power and energies. **Data communication structure** is implemented by a computing system, attached to the local control structure using a serial data communication network RS485 (Modbus and Standard); this level provides the HMI (human machine interface), data logging, events recording, process parameters plotting. The telematic system located at the dispatcher is connected to the hydroelectric power plant equipment using leased/dial-up telephone lines or GSM/radio communication.

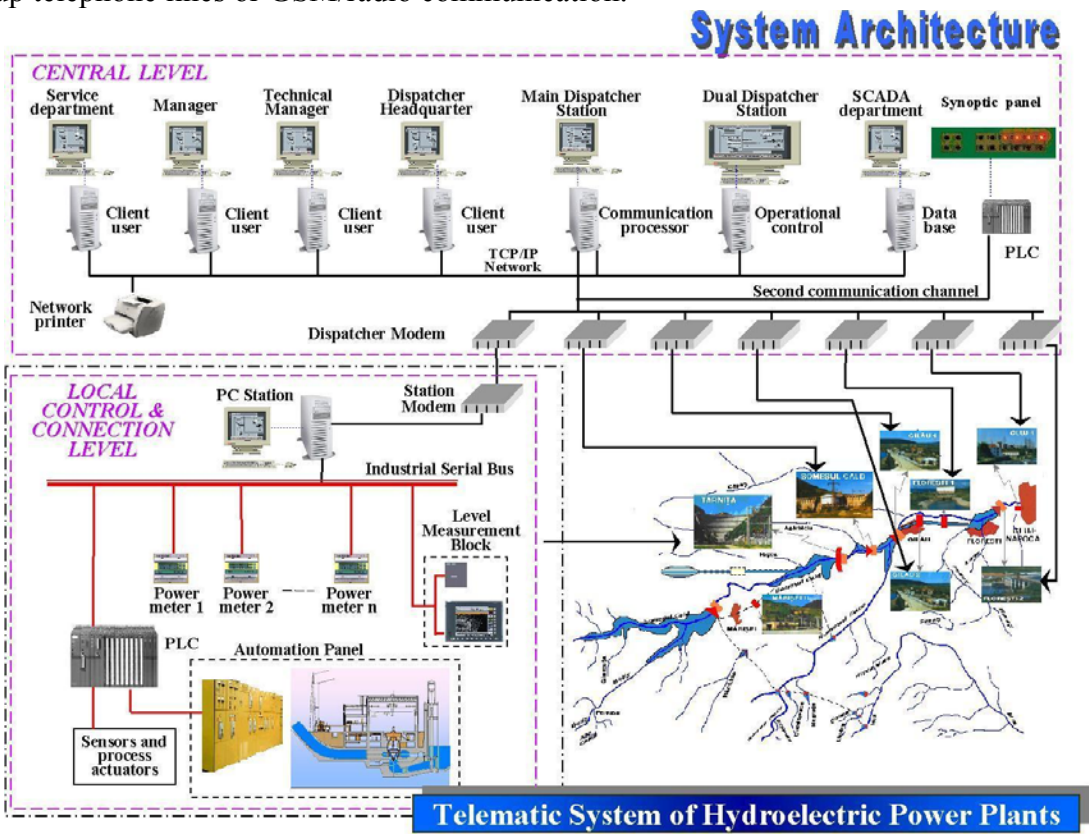

Figure 1 – Telematic system architecture

- **Central level** - a SCADA type architecture system implemented at the electric power plant headquarter (dispatcher). This consists of an Ethernet computing systems network using TPC/IP protocol under the Windows operating system. Each computer from the network is dedicated to a special department (see figure 1). There is a Main Dispatcher computer, that is the communication processor, connected to the local level by multiple-port interfaces, which manage the seven communication channels. The Dual Dispatcher computer is the acquisition data base host. Concerning the remote operating process the two dispatcher station are equivalent. The other network computers ensure the visibility of the measured parameters, own for each department, but cannot generate commands and remote control for the hydroelectric plants.

3. FUNCTIONS OF THE SCADA SYSTEM OF THE SOMES HYDROELECTRIC POWER PLANTS

The SCADA system of the hydroelectric power plants provides the following functions:

- data communication
- data acquisition
  - digital signal representing power switches status, equipment functional status, relay-based protection loops status, substation distribution units, binary and control loop functions, utilities status
  - analogue parameters representing electric parameters, powers, energies, flows, pressures, water-levels
- digital and analog measured value processing for operative alarming
  - checking its pre-programmed limits
  - checking its transmission correctness

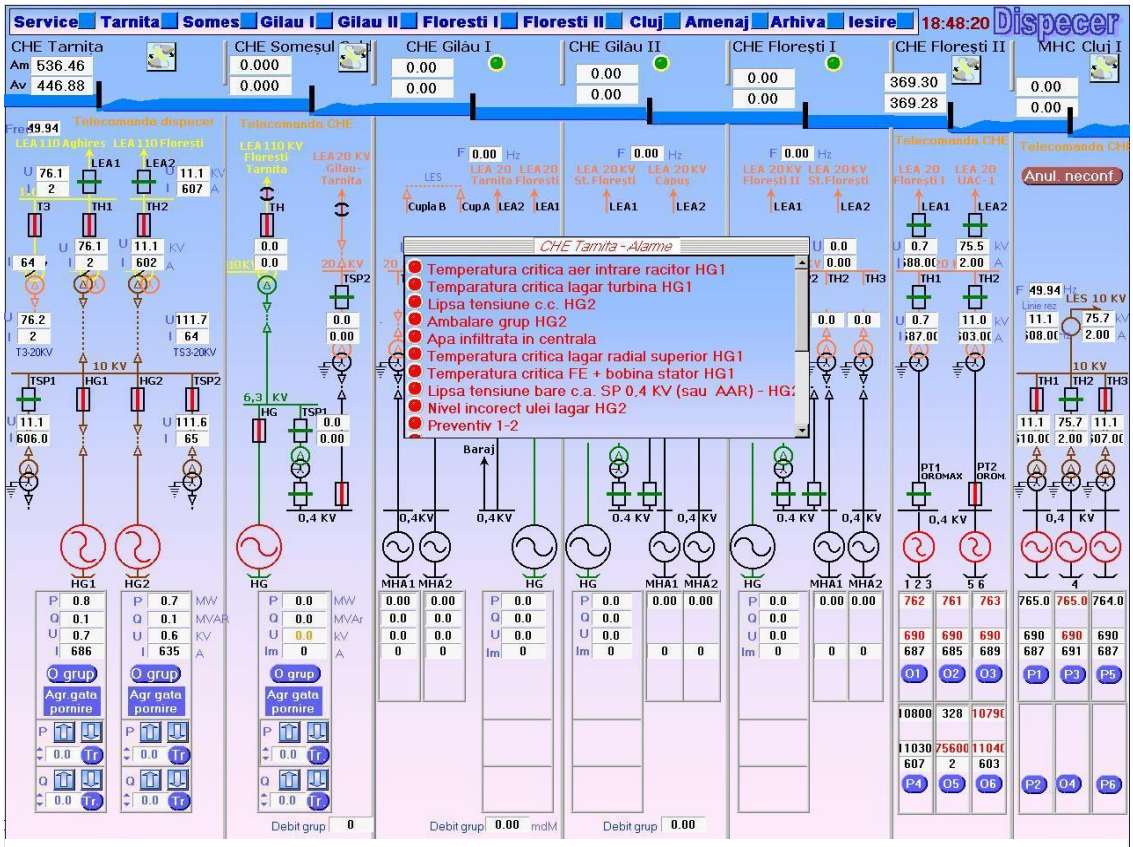

Figure 2. Global synoptical diagram of Somes river hydroelectric plants

- remote operating functions
  - remote operating command management
  - commands execution visibility assurance
  - main type commands: power switch connect/disconnect, programming setpoints for active and reactive power, hydroelectric generators power on/off
- remote plants visibility - real-time hydroelectric power plants and substations dispatching
  - current status of the main remote operated elements and alarms are represented on the global synoptical panel on a wide display connected to Dual Dispatcher Computer (see figure 2)
  - operating user interfaces for each substation based on dynamic electric diagram
- digital and analog parameters recording at process status relevant time intervals (historical data acquisition and report files)
  - historical files displaying in graphical or spread-sheet format, selected by the operator
  - actuators operating time used in service and maintenance management
- security job is assured by the private Intranet network and by a multilevel access password system of the critical operations

4. SOMES HYDROELECTRIC POWER PLANTS SCADA SYSTEM REQUIREMENTS

The control of the power plants includes many tasks distributed to hydraulic engines, electric generators, specific power and voltage controller units, connecting devices, control loops and utilities. The SCADA system for the Somes valley hydropower stations and the dispatching unit is designed, manufactured and implemented by IPA Cluj Subsidiary specialists. It covers a large geographic area that is why it must meets a lot of important requirements:

- **Openness.** The telematic system is open and includes different computer based hardware equipment, managed by software application developed under programming environment from different suppliers. It can operate with other systems from different departments such as: production management, service and maintenance, national energetic dispatching system, water resources management.
- **Adaptability.** That means that the system is able to configure its components according precise requirements, even if these are modified during the lifetime of the system. The Somes SCADA system offers the possibility of configuration for:
  - automation equipment components such as: digital input/output, analog input, communication transfer parameters, data acquisition parameters, dynamic screen controls
  - hydropower plant parameters such as: power, voltage and current limit values, control loops parameters.
- **Real time system.** The SCADA system provides the measured data values and event sample to the remote operator within a very short time to ensure its relevant processed actions in time. The Somes telematic system provides each second a new measurement from each supervised hydroelectric plant.
- **Data security and reliability.** A private Intranet network at central level of the SCADA Somes telematic system supports these requirements. Therefore the system eliminates the access of the intruders the remote operation computer. For the safety reasons between the radio modems (in free frequency domain) and leasing line

modem communication the second one was chosen. The data organization and management is an other way to improve the system security. The first step of processing is to store the measured values in a real time database, which may ensure an accurate observation of the system status and in the same time it is a non-volatile support for the permanent historical database. The historical database contains encrypted data. There is a custom own database type format but is possible to convert the data into standard formats according to the system requirments.

- **Friendly user interface.** An important requirement for the user is for the interfaces to be as friendly as possible. The modern programming environments ensure valuable tools but it is the programmers who design the screens. A task requested by this design is to include data with equal significance so as to avoid a screen overloading. Another task is to create friendly and reliable images. An example of such a user interface in the SCADA system for hydropower plants on the Somes river is shown in figure 3.

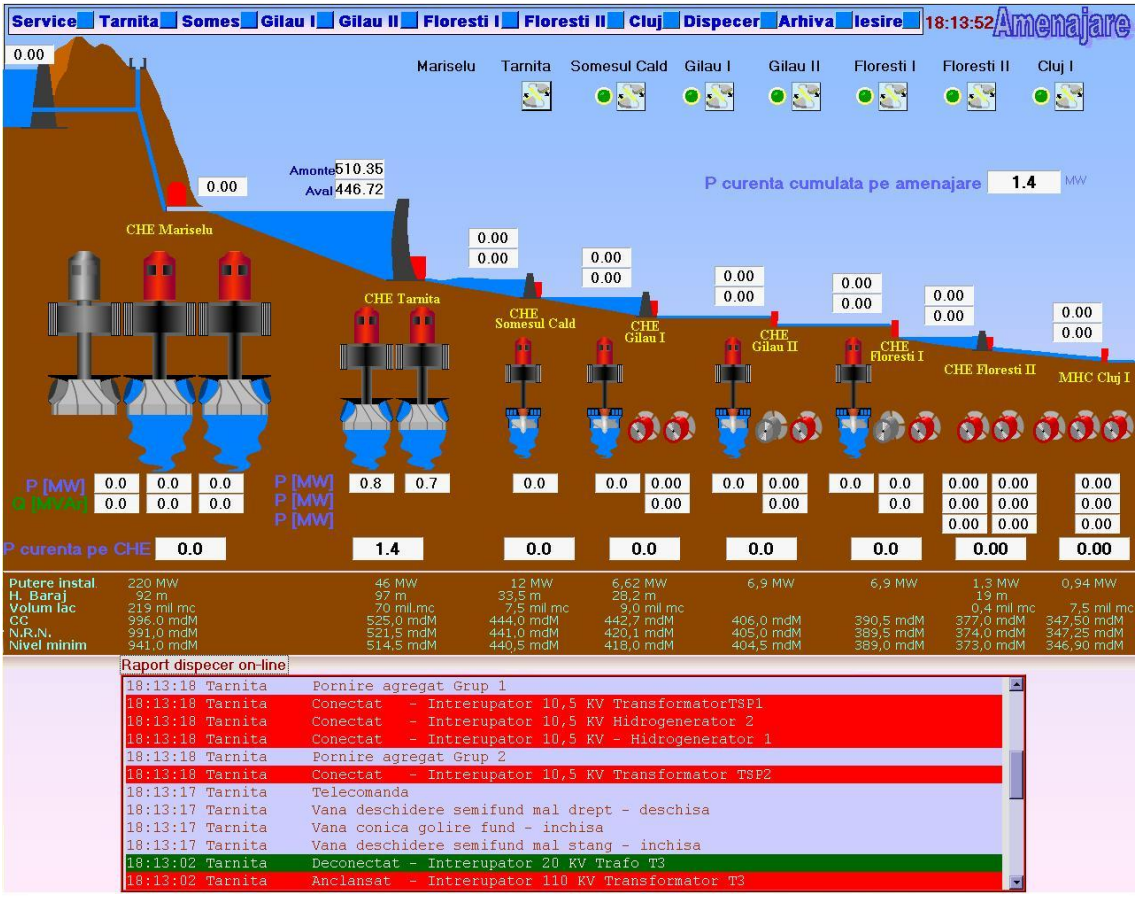

Figure 3 - Dispatcher user interface with synthetic data from Somes River plants

- **Availability and correctness**. The system has to rapidly detect the network faults. In a dedicated user interface the Somes SCADA system presents the availability of the plants, the status of the modem communication channels, industrial serial communication channels, PLCs, power meters, level measurement and other external devices.
- **Selftest module**. A different component of the Somes SCADA system is the sefttest module that indicates or isolates a defective device or subdivision. In order to detect its corect functionality, a special test is done with each separate element. In case of error the component is declared nonfunctional and the system works without it.

5. TECHNICAL SYSTEM CHARACTERISTICS

The Somes SCADA system assists the valley control operator to manage the different plants according to the power schedule; it ensures the dams control and reservoir level regulation. The main features indicating the system dimensions are:

- Digital logic inputs: 1040 (expandable in modules of 64)
- Digital logic outputs: 288 (expandable in modules of 16)
- Analogue PLCs inputs: 112 (expandable in modules of 16)
- Analogue ASCII inputs: 2100 (expandable in modules of 35)
- Number of control loops: 48
- Number of local controlled smart units: 74
- Number of communication channel: 30
- Investigation rate: programmable between 1s and 1,5 s
- Variable duration of commands: programmable between 10ms and 2500ms
- Communication speed: 19200 bauds
- Number of user screen: 298 (between 30 and 44/ module)
- Medium controls: 200 per user display (dynamic 30/user screen)

6. CONCLUSION

Flexible architecture allows the easy upgrade of the system by the increasing of number of new workstations and of new local controllers (PLCs or RTUs and third part smart transducers). Continuous development of the power plant's configuration and functions is possible without disturbing the initial system.

Sharing live data between applications or/and file servers across the enterprise, visualizing data are essential tools towards a better data user access and towards the possibility of communicating the results to others. The network supervising system will have the task of sharing monitored data with other groups in the company for data storing, Web publishing, or offline analysis. The monitoring system uses industry standards such as Ethernet with TCP/IP and OPC (OLE for Process Control) in order to share data with the entire enterprise, from the dispatcher to the power station floor, due to its low cost, high speed, and multiprotocol ability.

7. REFERENCES

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