CONCEPT OF A MODERN SUPERVISING AND REMOTE CONTROL SYSTEM – FLOW COMPUTER

Abstract: Implementation and development of a Supervising and Remote Control System (SRCS) become an imperative for all the companies taking care of their own progress in the field of production (transport, distribution, etc.) automatization. Therefore, the company SRBIJAGAS paid great attention to a system developing, especially considering its importance for natural gas transport and distribution under conditions of reduced supply.

With introduction of very precise and accurate metering devices an automated invoicing to the consumers becomes a fact. Flow computer enables this option and much more, which will be detailed described in this paper.

Our supervising and remote control system become one of the most important tools, not only to our Dispatching center, but also to management responsible for natural gas transport and distribution regime planning. Very detailed archive and a lot of tools for data monitoring and processing enable easier anticipation of consumption trends, particularly concerning demand swinging over the seasons.

The price of the system, together with the maintaining and development costs, is fully justified by the advantages it provides.

Key words: 1. Supervising 2. Control 3. Transport 4. Distribution 5. Flow Computer

1. INTRODUCTION

The company SRBIJAGAS has implemented it’s SRCS almost twenty years ago. Some of the equipment implemented then is still being used, performing its defined function efficiently. Due to a proper designing and development of SRSC as a whole, we made accorded operating different generations of equipment possible and consequently bridged a technical period of two decades without being enforced to change the complete equipment every time we performed a reconstruction of our system. All we needed was to provide our new stations with advanced equipment or one technology level below, according to investor’s demands. We can note, without being pretentious, that the development of the equipment in this field – equipment for the data acquisition at the station as well as communication equipment and communication media - was led simultaneous to the development of our supervision and remote control system. Achieved progress in server and network/grid technology enabled creation of sophisticated SCADA software modules as well as much easier and faster supervision and remote control database browsing. Our system is far from state-of-the-art technology, but we can freely point it out that efforts are continually being made, hopefully successful, to create the system able to meet all the requests and necessary improvements, within defined budget.

For the purpose of easier design and development of the SRCS, we divided our system into subsystems - software and hardware in the first line. It might seam to be too common, but it enables an easier system operation monitoring and partially independent development under conditions of flexible approach in construction of these two systems. The SCADA software is written in such a way providing new station to be added easily, without change of other modules and regardless of the station’s hardware, communication equipment and medium for connecting data station with the Dispatching center.

2. SRCS Software

SRCS software includes three basic subsystems: communication software (with acquisitive-controlling software), desktop and server software, normally comprising also a database with archive for the last couple of years.

Communication software (with acquisitive-controlling software) requires a good knowledge of the communication protocol for the equipment of the station. Microprocessor module for data acquisition and supervision can perform various operations depending upon use of the particular code. Microprocessor modules we use mostly support some of serial communication protocols. Based on commands and ACSII symbols, they recognize any request issued. Communication software takes also responsibility for request
transmission to the relating device by proper addressing of the relating remote station. To design that software, it is necessary to get acquainted with the applied communication protocol, communication medium, as well as with a method by which the network devices communicate with one another as well as with the server and microprocessor part of the equipment. It also requires design of proper routing tables, which are mostly part of a network equipment setting. Desktop or application software is an interface to the end user. For this part of SCADA software is especially important to be conceived right and provide to its users (Dispatching center and natural gas transmission and distribution managers) to find and use system performances easier.

Database or archive is the part of server software. It is suitable for search and various analysis provided by the software.

Essential for easier control of the system is a simple control software. There is also the possibility of software networking and dispatch at all computers on the network having assigned privilege to use SCADA software. Issuing instructions and control are functions much more complex than supervision. Therefore, a strict user authorization system is needed.

3. SRCS Hardware

Hardware equipment can also be divided in three groups, which facilitates system design and assembling.

There are acquisitive-controlling, communication and server equipment. [1]

Acquisitive-controlling equipment is placed within the station. Interface to the process equipment is designed to collect physical quantity equivalents (direct current, impulse sequence...) and micro switch state, as well as to issue instructions and specific control signals in accordance with requests the Dispatching center sent through the SCADA system software. This equipment is not designed to issue automatic commands or control the system, since each assembly is equipped (where needed) with the appropriate module (fire protection valve, shut off valve).

Serial interface to the communications equipment enables communication with the rest of the system, i.e. receiving requests and sending data according to them, whether data acquisition, issuing requests or control.

Regarding its placement, communication equipment is most dispersive, with elements placed in Dispatching center, telecommunication centers all along the communication path and at the remote station. This equipment has to comply with disposable communication medium. We use classic rented connections – twisted pairs, as well as fiber-optics, radio-links and are about to start using GSM network with appropriate GPRS protocol. Communications equipment should provide communication and proper request routing to related stations within previously determined period or – in case communication cannot be provided – to indicate failure. Communication equipment includes modems (optic, baseband and voiceband modems, GSM-GPRS modules, radiofrequency modems …) and routers with serial interface.

The server in Dispatching center runs all the SCADA software applications, server operation system however provides connection of the authorized users.

The system is constructed as a classic client-server system, which means that all the applications are being performed at the server, in distinction of client layer, which can only list results of application performed, whether they want to list actual data, brows the archive and make different analysis or issue commands and control the system.

Figure 1 shows the complete SRCS, with related data accesses. Additionally to the access upon LAN inside the company premises, we provide also the access from local centers over the secure Internet connection, and public phone and GSM network. The access through the GSM network is based on the WAP with GPRS protocol. Besides a www-site we also have got a WAP-site.
4. End Station Equipment

Important role of flow computer and its introduction into SRCS is described through the review of different station equipment generation in the text below. This review indicates that the flow computer performances imply module performances all together.

First system generation for supervision and remote control in SRBIJAGAS was implemented twenty years ago. Measuring and collection of status indications are standard procedures, integrated detector-transducers were applied, with characteristics indicated through the processing of standard direct current signal or closed contact indicating status changing. [2]

Standard direct current from physical quantity transducer is primarily being converted into voltage, than digitized in 12-Bit AD converter and adjusted to the RS-232 standard for serial communication within micro processor part of the device, where all the data are being collected into one set as information with data block from the related station. Derived digital signal is being frequency modulated and transmitted (1200 bps) to the central location by polling respective station from the Central station in SRBIJAGAS.

These stations are equipped with mechanical corrector. Measuring of actual and total flow (total volume) is consequently more complex. Impulse low frequency signal from the mechanical corrector is being separated at the point where the impulse frequency is proportional to the actual converted flow. Impulse integration device converts this signal into direct current, with linearized allowed range of converted flow from 0 mA to 20 mA. [2]

Regulating valve control signal is analog output signal from 0 mA to 20 mA, inverse estimated providing the regulator is maximum open for the current from 0 mA and closed for the current from 20 mA. Within this current range, allowed consumption rate, i.e. opening of the flow regulator and direct current does not occur linear.

In the first line, this system has got a large number of independent, external conversions. Each of them includes a fault. Summation of absolute maximum values of these faults makes the total absolute fault. The maximum fault occurs by the signal preparation for AD conversion, i.e. by converting current
into voltage provided for 12-Bit AD converter input. The AD converter receives the signal over relay contacts. These contacts are never ideal, as it comes to a not negligible voltage decrease. The converter itself has got an inherent system fault ½ LSB, not too big, but big enough to be considered. The fault issue is more complex in conjunction with flow measuring, since the impulse signal is being converted into current signal and this assembly shows its own fault at integration and linearization of dependence of outgoing current from ingoing impulse frequency.

Based on all above mentioned, we can underline the fact that this system features are very advantageous considering monitoring of general values for related parameters, but we can also point out the necessity of system improvement for the purpose of very precise measuring, such as invoicing natural gas consumption to the consumers.

We innovated almost all of the stations with the equipment of the new generation. There are only several stations left. Parameters from these stations are not so important to system operating. Dispatching center uses these parameters to monitor major trends in gas transport.

Second system generation is based on the industrial PC controller as a system basis. Concerning metering and indication, the rest of the system stays the same; changed have been made in the field of acquisition only.

Controller applied is actually an industrial PC platform with Pentium processor at 100 MHz, having cards with inputs and outputs for analog and digital parameters. Since the controllers are the same like for the previous system generation, these inlet and outlet cards are designed for acquisition of standard direct current from 4 mA to 20 mA. Inputs are very flexible, of course, and can be programmed for other current ranges if necessary. All the software required for data processing is available at the PC platform. There is a modem connection to the Center by rented line and the station answers on request.

Comparing to the previous system generation, we found that current-voltage conversion and AD conversion are improved.

Designing of the third system generation introduces compact microprocessor acquisition modules and communication modules for data transmission within a local area as well as at longer distances than with RS-232 serial connection. It provides also a multidrop, connecting devices to a few relative adjacent locations using special communication module according to the protocol RS-485, converted at the DCE-input to the RS-232 protocol. Without request, device output is in status of high impedance. There are various device types at the market, providing better solutions, especially concerning direct usage of the PC cars for implementation of this technology.[1]

Fourth system generation introduces flow computer as a SRCS basis.

Implementation of flow computer has innovated design of the SRCS pursuant to outstanding precision performances obtained by unique calibration of the device and internal signal conversion. Displayed data are contained also in the data block being received from the flow computer, through the serial port, and delivered to the system for processing. It enables invoicing and other operations requiring precise measuring based only on the SRCS. [4]

5. Flow Computer – Basic Features

Flow Computer is a kind of specific microprocessor platform with all characteristics of industrial PC platform. The main parts of the flow computer are processor, memory (in most cases flash memory), communication ports with interfaces to the communication equipment and media as well as on acquisition parts of the facility. Very important parts also are pressure and temperature meters (sensors and transmitters) and very high frequency impulse (HFI) integrator. HFI are emitted from a turbine. Power supply is arranged mostly by separated batteries with very long durability (more than three years) or using public network 230VAC with AD/DC conversion. Flow computer software is closed and only with proper interface could be arranged to change basic parameters for gas consumption metering (not energy, but gas flow!). It could be done using front panel of the flow computer or using PC with proper interface.

One of the most important characteristics is proper case for the device. In some circumstances it has to be placed in the hazardous area and basic knowledge about using devices in that kind of process is necessary. The device imploys following very strict rules on fire and explosion protection. The declaration about this feature is provided by the producer.

The most important function of the flow computer is to correct gas consumption using the data about gas pressure and temperature and impulse from turbine meter HFI to get corrected data. It has to
use also some other data connected with gas characteristics. Data could be displayed on front panel display or to be browsed using PC and flow computer interfaces on it. Display is also constructed in battery saving manner.

Data about gas working pressure and temperature are inputted locally and there are two types of it:

First type of flow computer gets data about pressure and temperature directly from turbine meter. Data about pressure comes from impulse line and about temperature from Pt100 or Pt1000 sondes. HFI impulse conductor is also connected to flow computer directly from turbine meter.

Second type of flow computer collects the necessary data about pressure and temperature from its transmitters. This type of flow computer could not be placed in hazardous area because it gets necessary data in form of electric current. It could be powered from public power supply network.

Flow computer, as it was said before, has its own memory and can store data for some period depending on the memory type and size.

6. Flow Computer in SRCS

Proper decision and good cooperation with producers are very important to facilitate all possibilities available in this kind of device. The most important for making proper SCADA system is to have all facts about communication protocol built in flow computer. The most of the modern flow computers in addition to basic data about normalized volume, pressure and temperature have more options with analog and digital inputs and outputs for reviewing data from other devices and also for regulating (flow regulating) and for sending commands (block valve, fire protection valve...). This feature enables to flow computer to become the most important (in some cases the only one) microprocessor device of the remote end station, with all possibilities for gas facility control and regulating.

For proper flow computer activation it is necessary to take care of communication interface. Wide range of flow computers has got RS-232 port or RS-485 port and some of them have got both. USB interface is very rare and nowadays there are some types of devices with Ethernet interface, which is very interesting in combination with industrial Ethernet PC platforms.

Devices we apply have got serial interface (RS-232 or RS-485) and special range of logical levels for battery consumption saving. Because of that, there is a special kind of active electronic device to adjust mentioned logical levels for PC serial port.

Some of the flow computers provide more than one or two serial ports in one device. If there are several serial RS-485 ports it could be used for multidrop, so that one communication (DCE) device can connect all of them to the central location. The routing could be arranged with proper flow computer addressing or with routers configured for that purposes. In this case flow computer receives acquisition string or command string as ASCII symbols. This routed network is very important to avoid line collision (some of the flow computers can not have its own address-older version) in a case when more than one device attempts to take the line. Described situation is characteristic for network behind the communication device (modem) to gas facility.

In front of the communication device (from modem to central location) we use X.25 layer 3 network for addressing and polling remote station. This kind of network may look like obsolete, but it is very useful in a case when the set of information relaying is not so big. Serial port of the most flow computers has 9600bps as the highest bit information rate and this is the highest speed we use in communication with particular station. The gap time between two pollings is also accommodated with this bit rate. This X25 network is our private network and this is also very important in maintains.

As the matter of facts, we have plans to upgrade our communication network into the " network of all networks " – IP network with Internet protocols. As we mentioned before, we have twenty stations connected to the system using GPRS protocol over GSM network. It was very difficult to develop because of special characteristic of GPRS protocol and modems as well as characteristic of flow computers.

Some of flow computer producers provide communication parts included in the same casing. Communication module could be GSM, dial-up, synch/asynch serial protocol – voiceband or baseband modems, radiofrequency modems, optical interfaces...Producers try to give complete solution with all-in-one devices.
Next feature built in flow computer could be gas chromatograph, to obtain gas components and quality on site.

7. CONCLUSION

In addition to its importance for the gas installation and pipeline system safety, flow computer and data it provides could be "number one" within an Integrated Information System. The Integrated Information System is the main goal of ICT Department in SRBIJAGAS. Automatic invoicing based only on data from flow computer is the main course in this field. Flow computer could be the main part of this system integration.

BIBLIOGRAPHY: