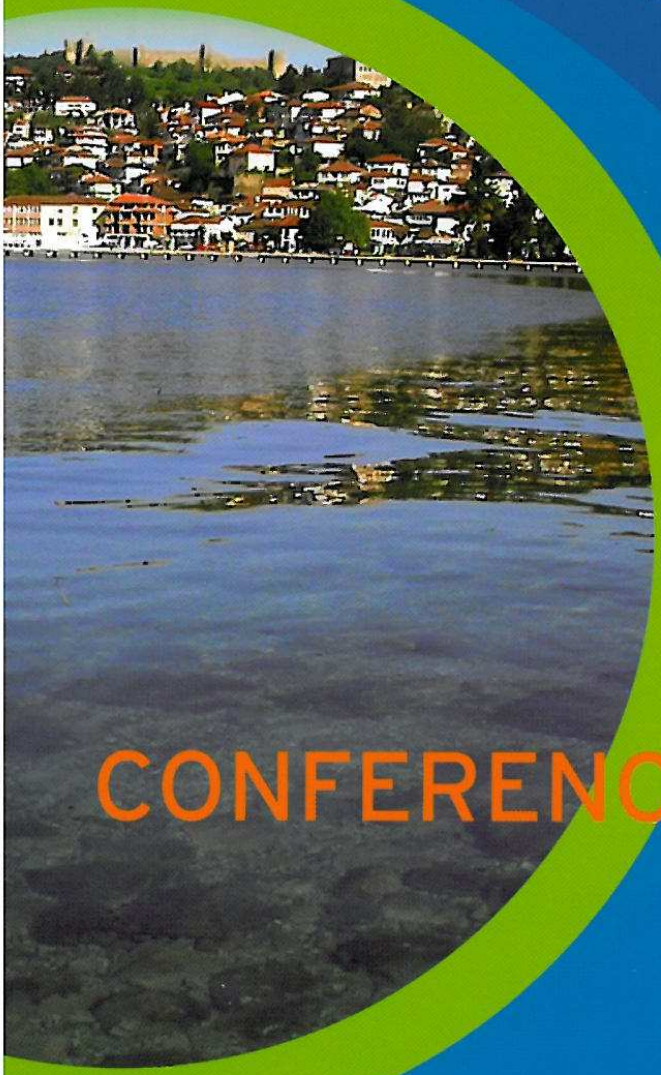
Second International Conference



CONFERENCE PROCEEDINGS

WATER LOSS MANAGEMENT, TELEMETRY AND SCADA IN WATER DISTRIBUTION SYSTEMS

09-10 June, 2008 | Ohrid

USAID

ADKOM

Best practises in construction of telemetry control systems

Jiri Kasparec (sales and technical manager, VAE CONTROLS, s.r.o.)
Rostislav Rezab (dispatching manager, VaK JC, a.s.)

Overview

This paper summarizes experience with installation of telemetry control systems in central Europe. The target is to give the reader the most important information to be taken into consideration before and during construction of the telemetry control system in water supplying companies. It contains general information about the systems and also practical examples from existing installation in VaK JC – Ceske Budejovice region, Czech republic and VHOS Moravska Trebova, Czech republic and their experience with decreasing water loses.

Historical background

Telemetry control systems started to be considered and implemented in water supply companies in Czech republic during 1970s. There were 2 most important factors:

- dynamic growth of industry related with increasing concentration of people in big towns;
- possibility to get basic electronic equipment for acceptable prices.

It should be noted that former Czechoslovakia was a member of "eastern block" so electronics from "western" countries was not available. First water dispatching was built in town Ostrava (in that time around 250.000 inhabitants). It remotely monitored and controlled a few most important water objects. Visualisation of the operational parameters was on a panel using coloured lights. The electronic equipment on the objects enabled simple control operations without direct action of human operator. The objects were connected with dispatching with radio network – this communication way appeared most effective and secure and still most of control systems in Czech republic and central Europe are based on radio data transmittions. The quality and robustness of this system may be documented by the fact that it was in service without further reconstruction over 15 years. Similar systems then started to be slowly implemented also in other bigger towns.

In late 1980s the old systems were mainly replaced by new ones, especially because of capacity reasons. Water objects again based on electronic telemetry stations and dispatchings were already based on simple computers with data interpretation on monitors.

In 1990s started fast development in information technologies and opening of Czechoslovakia (and then Czech republic) to the free market. This meant new possibilities for telemetry systems and water companies started to implement first generation of so called telemetry SCADA systems (further description of SCADA is in following part). Specialised companies in those systems appeared in the market, but not all of them with quality product and experienced staff. For this reason, some water companies tried 2 or even 3 systems before finding the right solution for their operational needs.

Nowadays all the water supplying companies in Czech republic use telemetry control systems and biggest task for today (for them and for the system suppliers) in this area is to utilize the systems the most effective way and use secondary functions of the systems. The trends are described in appropriate part of this paper.

Principles of telemetry (SCADA) control systems

For good understanding the following text it is necessary to clarify meaning of some names:

- telemetry control system – a group of technical and program equipment which enable remote control of technology units, usually from one control point (dispatching). Standard operation of the system is automatic, the main task for operators is to react on unexpected situations.

- SCADA – abbreviation of Supervision, Control And Data Acquisition – it means integrated system which provides all these functions "under one roof". When talking about control or dispatching system for water companies nowadays, usually is mentioned SCADA system.

In this paper is mostly used term "control system" for shortening the text.

Control system typically consists of three functional parts:

- remote telemetry stations (RTU) – placed on individual water objects. Their task is to make local automation of the processes, monitor the technological values and send the data to central dispatching. They also consider pre-programmed alarm values and in case of alarm they send alarm message to dispatching. They have programmed control algorithm and (in standard operation state) work as independent units.

- communication between RTUs and dispatching – this part of system ensures safe transmittion of all the information: data and alarm messages from RTUs to dispatching, commands and configuration messages from dispatching to RTUs.

- dispatching – central point of the system. All the data from the system are collected here and consequently are sorted, interpreted to the operators (dispatchers) and stored for further usage in future. Typical modern dispatching consists of server with communication modules, and workplace for dispatchers with computer workstations. Dispatchers have usually full access to the system, including possibility of remote programming of the RTUs and other configuration tasks. For access to the data can be authorised also other persons and their access rights may be limited (from full access to read only access). Remote access via Internet is also possible.

Further description of the useful functions of the control systems are described in part "Most effective ways of using the system".

Conditions for successful installation of telemetry control systems

Successful implementation of telemetry control system is not easy job. It is recommended to respect at least following conditions:

- considering of control system from first phases of water object project – key factor. Many technology specialists forget it and then cause delays on implementation of the control systems;

- defining of requests at the beginning of project and stating them in contract – responsible persons in water company should know what they want in real. It is recommended to define the requests very precisely also in contract to have the tool against possibly not reliable supplier;

- requiring of fulfilling the declared functions – after implementation the supplier is not very often asked to declare promised function. If it is not controlled, the user can be in future disappointed with the system. This is typical for low cost solutions;

- modularity and scalability – modern system must enable step – by – step installation for optimalisation of the invested money;

- independency on system supplier – water companies have usually highly experienced people in the technology. If the system is easy configurable and open to user, then the water company can do much of the job itself and does not need further additional services from system supplier. Cost of ownership is then lower;

- safe data transmittion - different communication ways should be compared. Most secure is using private radio network (or if possible private computer network). The user is then independent on any other service provider (for example on GPRS network provider);

- do not accept low cost solutions – it should be considered that the price of ownership is not only the price of system supply. In low cost solutions are not typically included all the system features, even often not full software licences, the system is not easy to maintain and has low possibility of co-operation with other systems. Their price may in the result make the final cost much higher than originally declared;

If the conditions are not respected the implementation may become a "nightmare" for involved persons from water company. Typical result can be longer period of implementation, not as quality solution as expected, low possibility of system enhancement and bad co-operation with related systems (for example company information system). All the factors cause much higher final price of the project.

Most effective ways for using the system

As stated in its name, control systems has basic function to control automatically the technology units and this way save human work and prevent human mistakes. But modern SCADA based systems offer much more possibilities and it would be wasting of money not to use them. Most important "secondary" functions can be summarised in following list:

- further usage of the data – control system acquires huge quantity of technological data from water distribution objects and also data from water treatment plant and waste water cleaning plants. All the data can be stored at central dispatching, may be analysed and used for optimalisation of the water network and technology operation;

- decreasing water loses – today very important issue in all developed countries. Analysis of acquired data may help dramatically decrease water loses without big further investitions. More about this topic is described in "Case studies" below;

- electronic operational registration – control system can automatically sort data from specified technology units, accept manually inserted data (for example from chemical analysis) and automatically create reports for internal usage in water company and also for external subjects (typically for local authorities). This relates especially to quality of drinking and waste water;

- planning service actions – the plans may be incorporated in control system and available for all authorised users. This may prevent any misunderstandings and incorrect action on pipelines. Also it brings better possibility to inform public about the outages of the water supply (for example on web pages, telephone information on "hot line");

- monitoring of parts lifetime and of materials and energy consumption – information can be put into system manually or automatically, depending on possibilities of particular equipment. For example electricity consumption, working hours of pump can be ready by the system automatically, consumption of chemicals (chlorine etc.) are inserted manually. Then it is easy to create reports charts, graphs with the data in timeline and work with them;

- integration of drinking water supply and sewage dispatching – this is actual trend in countries with developed telemetry control systems. Why to have 2 independent dispatchings when the function is the same?

- integration with GIS (geographical information systems) and with modelling systems – thanks to wide communication possibilities, modern control system can share data with other systems. Their effectivity is then much higher.

Case study no. 1 – telemetry control system in VaK JC (Ceske Budejovice region, Czech republic)

This system today covers area about 10.000 km^2, includes 250 objects with 1 main and 6 subordinate dispatchings and ensures water supply for 340.000 people. It was build during years 2000 – 2004 and it was put in operation in sequences – according to availability of invested money and readiness of the water objects for the control system.

The dispatching is run on 2 servers – one main and one hot stand-by for highest security of data and operation. In case of main server failure, the other has all the data available and the system operation normally continues. The servers are also space – distributed. One is located next to dispatcher room and the other in water treatment plant, about 20 km away. The connection is over private WAN network. This makes another level of security.

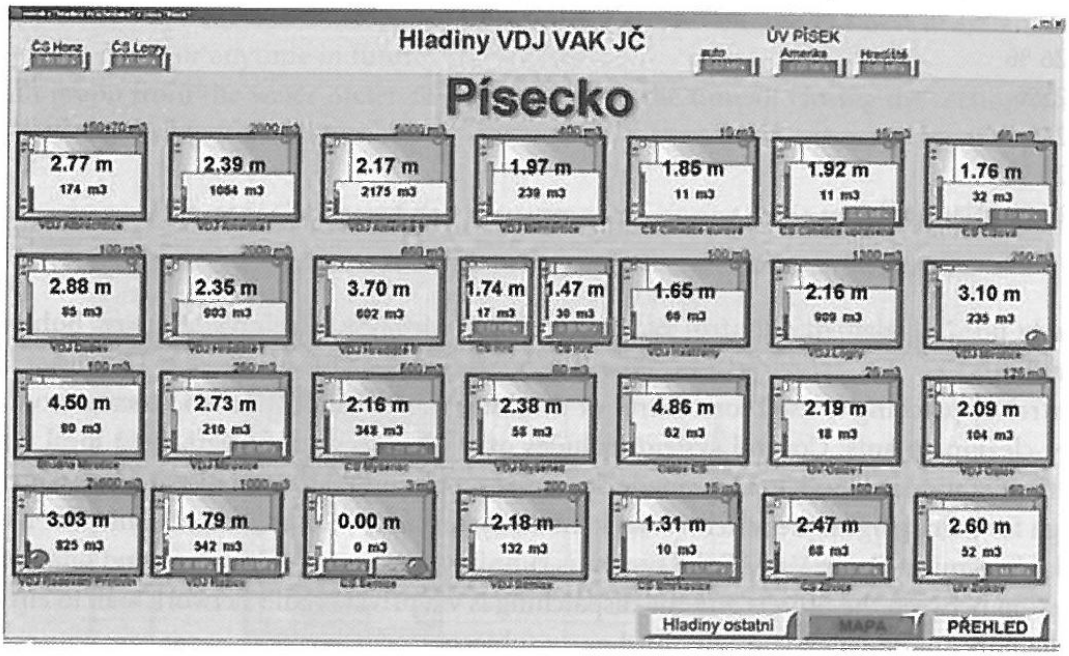
The connection between dispatchings and water object is via private radio network. The biggest advantage of this solution is again high level of security and independence on any service provider (internet, GPRS), especially during emergency cases (for example floods) the reliability of provided services is not guaranteed but private radio network still works the same.

Picture 1: Main dispatching room in VaK JC

The system is running fully automatically with supervision of the dispatchers. The total staff of dispatching system is 20 people:

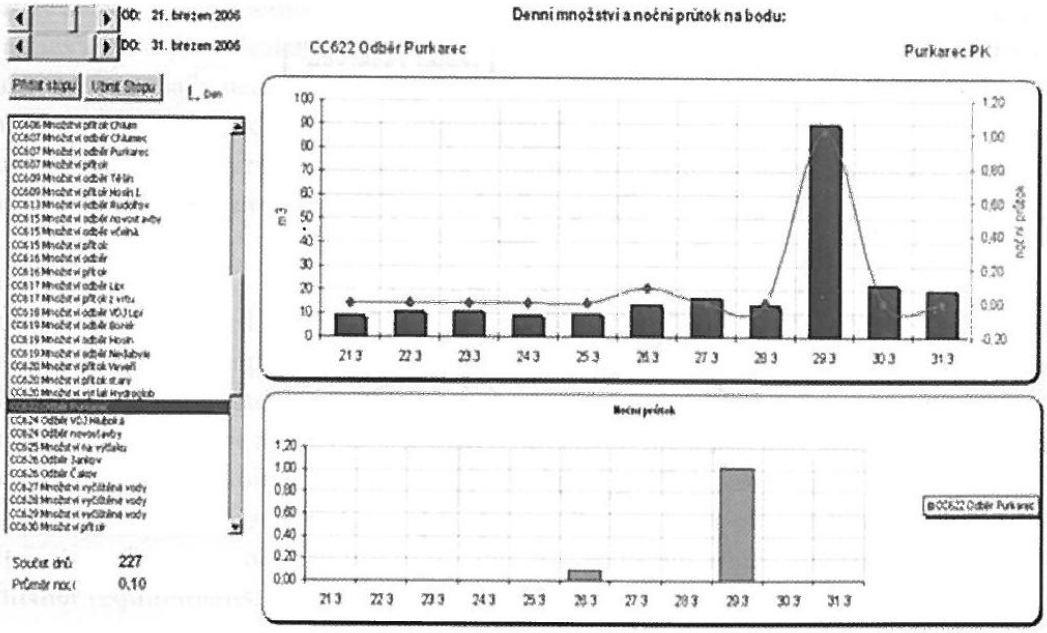
- 5 people involved in searching for water leakages. 3 of them are field technicians, each equipped with 15 portable data loggers and with electronic sound corelator.
- 9 people involved in control system (dispatchers + technicians)
- 5 technicians
- 1 manager

Picture 2: Overview visualisation of water reservoirs in area of town Pisek



Searching for water loses is a combination of office work and work in terrain. In office is typically systematic work with maps and schematics – planning the pipe services, looking for possible critical places and, of course, analysing data from control system. Typically is analysed correlation between lowest night flow and total daily consumption in specific places. The graphical output from control system for this analysis is shown on following picture. Left vertical axis is daily consumption and right is minimum night flow. It is clear that on 29.3. some leakage appeared. In this case it was immediately located and repaired so the following days are again similar like before the leakage.

Picture 3: Graphical output from control system showing relationship between minimum night flow and total daily quantity



The results of decreasing the water loses in VaK JC with using the control system are summarised in following chart:

2004 – 26 %
2005 – 25%
2006 – 24%
2007 – 23 %
2008 - 20 % (planned)

Case study no. 2 – telemetry control system in VHOS Moravska Trebova (Eastern Bohemia region, Czech republic)

This central dispatching is used for control of drinking water distribution and local automation for 2 waste water cleaning plants. Control system includes over 40 objects and originally 3 local dispatchings. According to operational experience was made decision to make only 1 central dispatching, which appeared to be enough for managing all the water network. In the system is also incorporated control of 2 waste water cleaning plants. Similar like in VaK JC the system is running on 2 servers (one main and one hot stand-by) and connection between the objects and the dispatching is via private radio network – all to ensure highest possible reliability and independence on third party subjects.

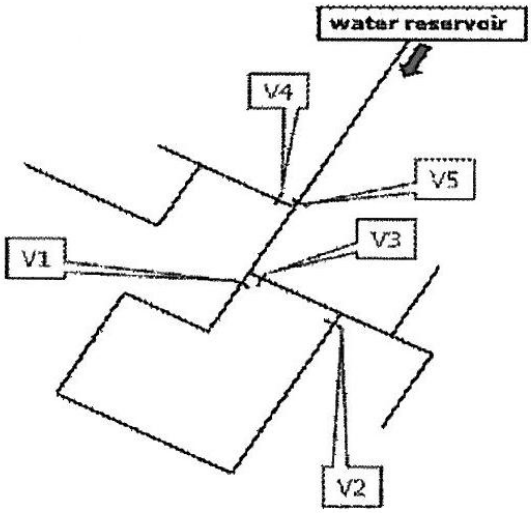
Besides other functions the control system is also used for searching for water loses. Today their practice is "sections closing" which brings very interesting results, considering how easy the method is. Let's look at typical example how is the process made.

First conditions for correct procedure:

- correctly working valves (to be able to close the sections);
- correctly working water meter with connection to dispatching;
- good knowledge of the pipe system and ability to prepare plan of closing sections;

The process is done at night to be able to expect almost zero consumption. The valves are closed in 15 minutes sequence, beginning with V1 and finishing with V5. After 15 minutes the valves are in 15 minutes interval opened again. The 15 minutes interval appears according to experience as long enough and also does not make the procedure too slow.

Picture 4: Example of area ready for "sections closing"

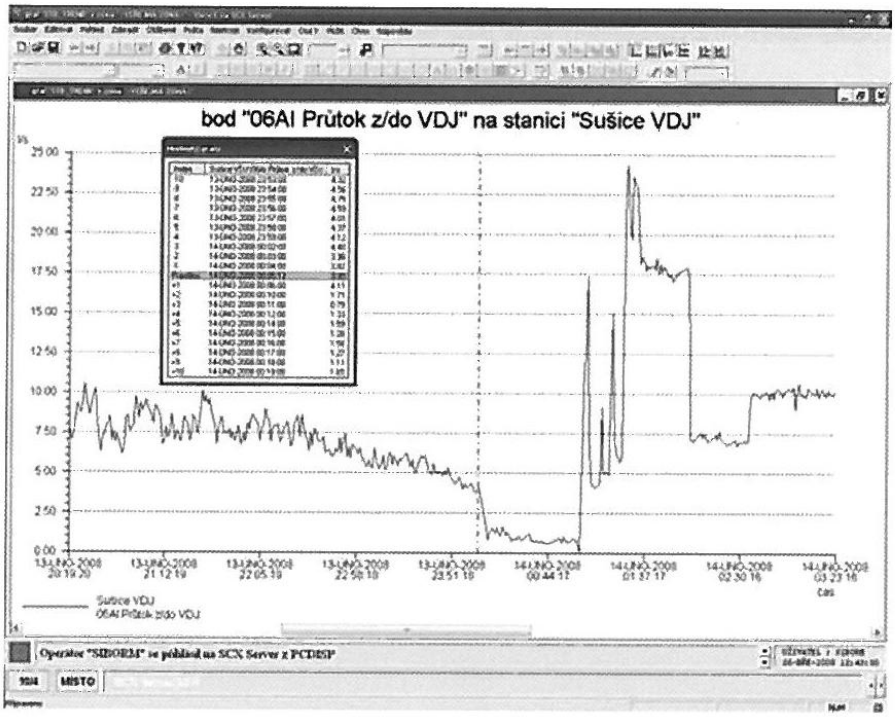


The dispatchers are present on dispatching only during daytime. At nights there is only "stand-by" worker at home who receives alarm SMS in case of problem. He can connect from hope PC or laptop to the dispatching (with full access rights) and make appropriate actions. During the night with "sections closing" he

also does not have to be present at the system. Field technicians simply close and then open the valves in specified times and sequences, the results from flow meter are automatically saved in system and may be analysed next morning or anytime in future.

The result graph from the water meter changes rapidly at the time of closing the section with possible leakage. It is clearly visible from picture 5.

Picture 5: Changes of flow on water meter during sections closing



In the time marked with vertical line was found water leakage approximately 2,4 litres per second. Because the sections are not very big, for experienced field technician is then easy to localize the leakage.

Biggest advantages of this method is its simplicity and low cost. Also experienced technicians can easily predict localities with highest leakages (oldest pipelines etc) so at the beginning the effectivity is very high. Disadvantages are especially necessity to close the pipeline and stop water supply to the customers with following consequences – rust and sediments in pipeline.

The results of this method are very satisfactory – during first year the loses dropped more than 10 % and in following years about 2 % every year.

Resume

As a result can be confirmed by practical experience that correctly chosen, installed and utilised control systems do not bring only the possibilities to control and monitor water objects, but offer plenty of functions which can rapidly increase their effectivity.

Most important is that there are persons involved directly in the particular tasks – decreasing water loses, electronic evidence of operational data etc. Another critical point is selection of system which offers high modularity, wide spectrum of additional services and wide spectrum of user functions (independency on supplier). It is strongly recommended not to use low cost solutions which appear in most cases as not fulfilling the further requirements. The payback period of correctly chosen and used system can be estimated as units of years.