SCADA SYSTEM APPLICATION IN WASTEWATER TREATMENT PLANTS

[1]N. Ciobanu, superior lecturer, [2]V. Buțanu, [1]N. Secrieru, assoc.prof., PhD., [1]D. Ungureanu, assoc.prof.
[1]Tehnical University of Moldova
[2]SC SALONIX-TEH SRL Moldova

1. INTRODUCTION

Network collecting and evacuating of wastewater from Moldova, including Chisinau, spanning hundreds of hectares and is a compex hierarchical distributed of inputs and outputs. The modality traditional management and maintenance of these complexes is very inefficient, impossible. From the analysis of this complex, just based on the study of other information sources [1-6], found it advantageous to implement a management system, enabling the state to identify complex data acquisition, to plan and control this complex in any conditions. The whole complex is divided into several zones, where different processes occurs. In each area locally it will perform a data acquisition on the allocated processes and convert these digital data for the process parameters regulation by a microcontroller, using actuators and/or transmit data and alarm signals at a higher levels. The implementation of the SCADA system will have a positive impact on the operations, maintenance, process improvement and savings for these wastewater treatment plants (WWTP). The Municipality of Chisinau annonced implementation of a program modernizing the water supply and wastewater services in order to improve living conditions, reduce health risks for its population and to prevent excessive exploitation of natural resources and environmental pollution.

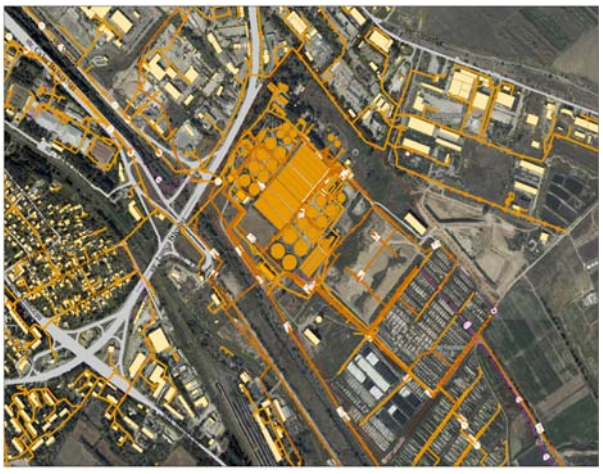

Figure 1. The Chisinau wastewater treatment plant.

This paper will discuss the system's evolvement, the architecture and it will demonstrate the system's successes in monitoring the sewage and sludge collection/distribution systems and wastewater treatment plants, complying with the requirements on the discharge, and effectively reducing the operations and maintenance costs.

2. SCADA SYSTEM ARCHITECTURE FOR THE WASTEWATER TREATMENT PLANT

The Chișinau wastewater treatment plant (Chisinau WWTP) is located southeast of the city, approximately 7km from the city centre, beside the River Bic into which the final effluent is discharged. With the low flows and the fact that it is within the city area, flowing ultimately into the Black Sea, under EU standards it would be classified as a sensitive watercourse (fig. 1). The wastewater flow to the works is approximately 152,000 m^3/d, considerably below the works design capacity [7].

Studying the structure, capabilities and parameters WWTP Chisinau and taking into account the needs of the objects in discussion, initially we will formulate the basic requirements for conceptual SCADA system (fig. 2). The SCADA system shall provide a strategy for Real-time solutions that shall go beyond SCADA, offering the end user access to an open and enterprise-friendly data management system. Included in the SCADA system's family of products shall be a Graphical User Interface (GUI), a fully integrated Real-time subsystem, and a fully integrated Relational Database Management System (RDBMS).

The SCADA system shall also provide for easy and open integration with third party application software via non-proprietary industry standards. The SCADA system shall allow the user of the system the flexibility to accommodate diverse business applications. The SCADA system shall provide capability to extend Real-time data from the

field to the enterprise by providing access to operational and historical data anytime, and anywhere.

The SCADA system shall allow corporate information systems and specialized applications packages access to the SCADA data. The SCADA system architecture shall utilize non-proprietary industry standards all to enable transparent connectivity to other hardware, software, and networks. The objectives of performance, flexibility, expandability and open access are fundamental in determining the utility and longevity of any SCADA system. The SCADA system shall utilize a software architecture that allows functions to be mobile, flexible and robust. It shall also permit distribution of processing among different SCADA system components to optimize overall system performance.

The SCADA system shall conform to the concepts of a distributed information system. Components must have the ability to share historical and real-time data between independent systems and geographical locations. This shall enhance the overall system reliability and functionality by providing shared access to components and applications. The distributed system shall provide configuration options that allow multiple systems to share telemetry data, alarming, eventing, telecommunication, and control functionality. User permissions and security restrictions regarding all aspects of the system shall propagate seamlessly across the SCADA system's distributed architecture.

It is proposed all computers in the SCADA system shall connect with each other using the latest industry standard Local-Area Network (LAN) and Wide-Area Network (WAN) technologies. Multiple LANs, WANs, bridges, servers and routers shall complement each other to meet the requirements of system performance, reliability, security and expandability. System peripherals shall connect either directly to the system's LAN, through servers connected directly to the system's LAN, or attached to workstation parallel or serial ports. This shall allow access to any device from any computer in the system with the appropriate access authority. The system shall provide support for distributed network equipment such as networked printers, networked PC's, and mass storage/backup devices (fig. 3).

The SCADA system shall be configured using industry standard, unmodified, hardware and software. The hardware and software supplier's standard products shall constitute the primary components for the system. The system shall not be dependent upon specialized, unique, or proprietary equipment or software available from only a single supplier to the greatest extent possible.

The system shall provide bi-directional item-by-item replication of data between systems. To handle the large amounts of data being exchanged between

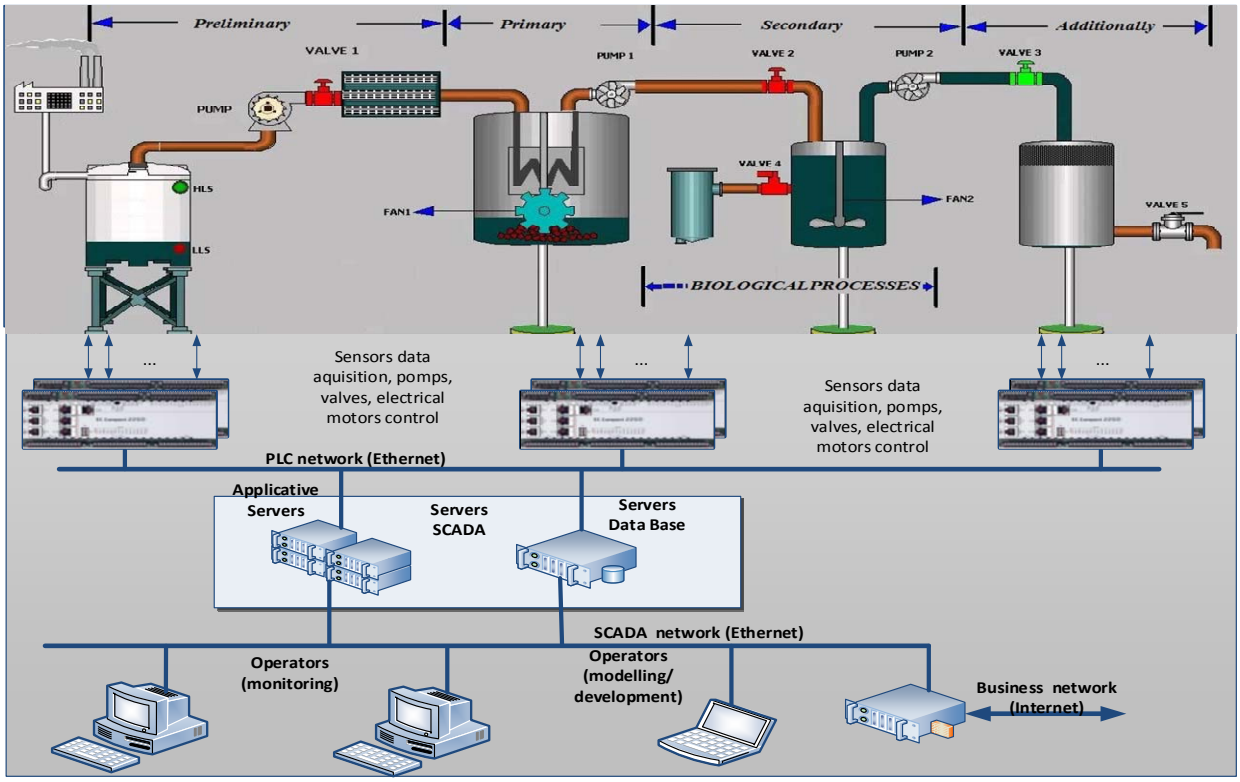

Figure 2. The conceptual WWTP plant SCADA architecture.

systems without requiring excessive WAN bandwidth usage, Real-time data shall only be shared between those systems with defined relationships. It shall be possible to define these system relationships to share all records or only specified fields within records. To further reduce the network load between locations, it shall be possible to store historical data locally by each system. The system shall support a controller friendly method (such as a single push button or dialog box) to change the operational state of the system.

From the other hand, the network configuration shall provide a simplified network model that shall allow dual redundancy, yet it shall look like a single virtual LAN to the user. The redundancy model shall be both robust and self-healing. When a single component fails, that component's partner shall take over without impacting the rest of the system. Single virtual LAN robustness shall be achieved through the provision

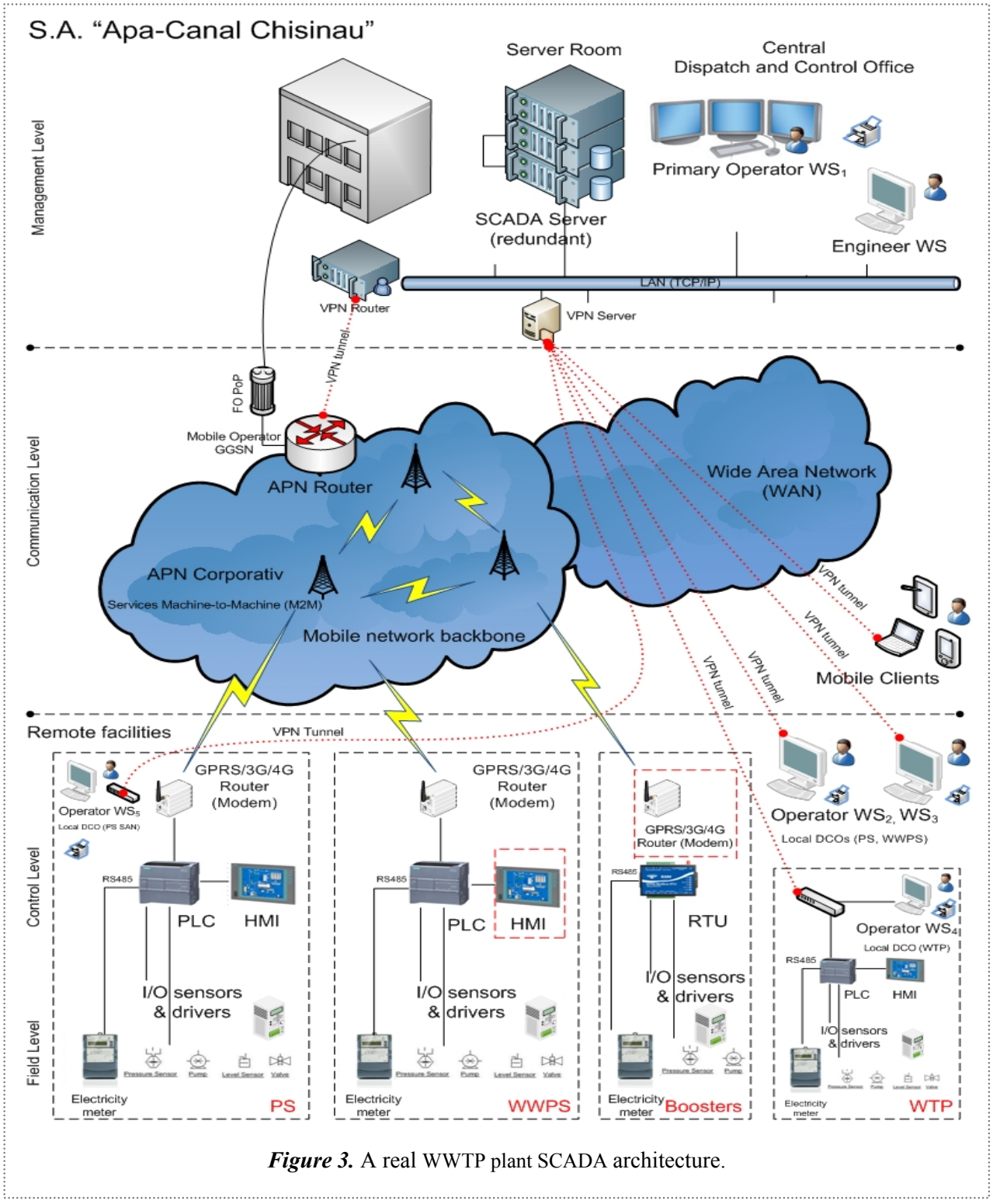

Figure 3. A real WWTP plant SCADA architecture.

of:

- Dual intelligent redundant switches;
- Each switch shall be interconnected, providing the advantage of network communication between cards and redundancy in case of the failure of one card.
- Dual intelligent redundant network cards
- The use of intelligent cards and drivers shall provide for the cards to sense when a network or the other card fails, resulting in the healthy card taking over.
- Floating IP addresses
- For a pair of redundant servers, a single address shall be assigned to the active server. This shall allow connectivity to active servers without having to know what physical machine is currently active.

The system shall provide a fail-over mechanism that shall be an inherent part of the SCADA system. The system shall provide critical task monitoring by health monitoring software to ensure system robustness. Monitor processes periodically shall ask critical software components to check in. If the critical component fails to check in, that one component and all its sub-components shall fail-over; all others shall stay live.

Based on the conceptual architecture, we propose real architecture of SCADA system for WWTP Chisinau [5], taking into account its characteristics and distributed geographical structure (Fig. 3) .

A SCADA System's components are comprised more CPU's (PC's and Servers), PLC's/RTU's, I/O Subsystems, Video monitors, Field Sensors, Control Devices (fig. 3) and lots of software that drives the I/O, runs the control algorithms, generates control outputs, displays graphics and monitored values, senses alarm statuses, and stores the monitored points in a series of data files that can be archived and recalled at a later time for analysis or process verification.

Control systems with multi-level architecture usually built on object principle, when the structure of the system selects a similar structure of the automation object, and each subsystem is local, that is, feedbacks are closed within this subsystem [8,9]. Each local subsystem performs a separate function that, given the logic of the whole system. Object principle of construction can simplify the design of a multi-level and to ensure its structural/ architectural reliability. The philosophy of the design shall be simplicity and reliability such that the equipment shall have long trouble free service with low maintenance cost, low energy consumption and low disturbing impact on the environment.

CONCLUSION

SCADA system is used to describe a multitude of computer-based control systems that allow operators and facility personnel to monitor and control a facility's equipment either locally or remotely. The SCADA system will automate much of the control process such that WWTP plant operators can focus on other task. The propsed SCADA systems will give the users/operators flexibility to manually control the equipment where desired. SCADA systems are also installed to collect and store information for reporting, trouble-shooting, maintenance indications, and much more. There are some advantages to having the proposed SCADA system, such as:

- Ability to significantly reduce operating costs, while improving system performance and reliability;
- Costly after-hours alarm call-outs can often be avoided since a SCADA system will indicate the nature and degree of a problem;
- Since data is continuously recorded, operators do not have to manually read and record meter readings on a daily basis.
- Operators do not have to keep track of hundreds of log sheets as any data recorded on the SCADA system can be downloaded and accessed at their convenience.

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