Telemetry for water networks

**Water**, a vital resource for human activity, must be drawn off, treated, transported and after it is used, returned to nature clean. This process, now automated, is subject to very demanding quality, environmental and productivity constraints.

The stakeholders responsible for producing and distributing water are looking for automation partners capable of taking charge of all the systems and proposing solutions that encompass all of the phases from installation and operation to maintenance.

**Water treatment process**

Most of the time, water sources are far away from consumption points, so to guarantee dependable water supply in all seasons, it is necessary to multiply the supply points. This results in processes that utilise extended infrastructures and create specific water business needs. Fig. 1 illustrates the water cycle, which comprises two phases, often independent:

- Production of clean, drinking water
- Recycling of waste water

**Constraints of the water treatment process on automation**

Without getting into a detailed analysis of the specific needs of each customer, we can outline the the constraints that determine the automation architecture. Table 1 summarises the main constraints.

The process typology guides the choice of the architecture, which will be different for the two phases of water treatment:

**Production of clean water**

At all stages, from catchment and purification, through transportation and storage, to consumption, water must be monitored and bacterial proliferation must be regulated by the use of additives (chlorine). The complexity of the system arises from the large volume of information to be processed – resulting from multiple check points – and from the regulation needed throughout process. The various the process units are independent to some extent but monitoring of all the units must be centralised. The connections between units are often temporary, lasting only the time it takes for the required information to be exchanged.

**Recycling of waste water**

In this stage, automation is concentrated in the treatment stations. Waste water collection and disposal are seldom supervised by automation. The automation profile at this point is similar to that of industrial processes.

Two architecture profiles fulfil all of the needs mentioned above:

- Systems structured around a central process. A portion of the infrastructure units are permanently connected, generally via the public network or a proprietary network. The other part of the infrastructure is intermittently linked and this involves telemetry. The design of the central system, similar to those found in industry, must take this point into account.

- Telemetry systems. All of the links between remote sites are periodic and characterised...
by exchanges which may be triggered by cyclical polling of the central system, or at the operator's request, or by the transmission of data from a site to the central supervisory system upon the occurrence of an event.

The rest of this article will emphasise the specific problems relating to this type of system.

Telemetry

Independent units, little human presence on the sites and large distances are determining factors for the systems, which are generally structured in three levels (see Fig. 2):

- Centralised control, whereby the different sites may be remotely supervised and monitored via a central SCADA (supervisory control and data acquisition) system and, as an option, other units and maintenance people may be informed.
- Links: The system must store information locally, establish communication, either cyclical or event-driven, and transmit the information. According to the criticality of the data to be transmitted, it is sometimes necessary to provide media redundancy to deal with communication contingencies or to differentiate the receivers. The maintenance specialist is informed by GSM, whereas process follow-up data are sent via a public STN (switched telephone network) line at the operator's request. Since connections are cyclical, the SCADA used must manage the modems and communications. Time-tagging of events must be done at the source and the data must be stored, waiting to be read. The modems need to be capable of operating in both master/slave\(^1\) and master/master mode.
- Local control-monitoring provides all of the automation, electrical distribution and protection functions required for the operation of the process. This system must be capable of supplying the information required for control. In the event of a failure, it must not only inform, but also ensure a minimum of continuity of service (downgraded mode).

Main functions expected

Without being all-inclusive, the list of the functions below represents the majority of the needs encountered:

- Data acquisition (status, measurements, counting, etc.)
- Time-tagging of events
- Processing of events
- Automatic transmission of events to the SCADA and maintenance operator
- Publication in logs, curves, mimic diagrams and reports.
- Transmission of information on incidents
- Remote monitoring of the process and installation
- Management of maintenance crew operations at the (SCADA) or front-end communication level or even via a system embedded in the product
- Reduction of maintenance time and costs remote diagnosis of the components (variable speed drives, PLCs, protection relays, instrumentation, etc.)
- Updating of the application software or automation software
- Access supervision and authorisation (badge readers)

Specific features of the links

Each installation configuration entails specific constraints relating to operation and also to the types of communication available and the regulations in effect. Like any other type of communication system, telemetry utilises the transmission media available and standard protocols according to needs.

Communication transmission media currently used:

- STN (switched telephone network) lines or proprietary lines, with a rate of 64 kbps
- Analogue wireless links with or without a user licence

Note1: In master/slave mode, the terminals only reply when polled, whereas in master/master mode, they can transmit data upon the occurrence of events.
A global need

Faced with the need to optimise the solution, decision-makers must deal with very different cost and environment-related constraints spanning the complete installation usage cycle, including design, investment, installation, operation, maintenance and sustainability. These constraints naturally lead to seek support from partners who can deal with the matter as a whole and are capable of working with contractors and integrators. Preference is given to a sole provider to guarantee the consistency and maintainability of the chosen solutions.

According to its policy, the company collaborates with a large number of integrators and has created the Alliance partners’ network. This singular feature offers customers the power of a major group combined with the flexibility and proximity of a specialist, enabling tailored turnkey solutions using the finest technologies.

To both facilitate selection and offer optimised solutions, the offering is structured in the three levels described above and shown in Fig. 2:

- Control is ensured by SCADA software, supervising either a group of independent stations, or integrated in a master process which controls the satellite sites.
- Links are managed by telemetry modules in the SCADA Pack RTU range which perform multiple functions such as communication, archiving and automation monitoring. The range of configuration products and software are integrated in the architectures presented in the following section. Schneider Electric advocates the use of DNP3. This widely used communication protocol is well suited to electronic messaging needs. Time-stamping functions are included to meet specific water treatment needs.
- Control-monitoring includes, for each station, products such as PLCs, controllers, variable speed drives, circuit breakers, protection sensors and monitoring systems. To help customers select, Schneider Electric has optimised some “preferred architectures”.

Fig. 2 gives a succinct illustration of three examples. Readers are invited to refer to specialised documents or contact the company for a fuller understanding of the solutions proposed.

Preferred architectures

The objective is to propose consistent, interoperable and suitable solutions to cover all specific water treatment needs. Based on industrial standards and acquired experience, each “preferred” architecture has been designed to optimise investments and reduce operating and maintenance costs. Existing installations may therefore be easily updated without requiring major modifications or revisions of the architecture. Implementation does not require any specific training or particular knowledge, and the solutions may be easily implemented or modified.

In the event of a problem, given the simplicity of the architecture and the possibility of real time fault information, the causes can be quickly identified without having to call in highly qualified engineers. All of the data used in the application can be easily configured and saved in a non-proprietary data database that can be utilised by other software.

As a partial illustration of the offering, three “preferred” architectures are presented in Fig. 2:

- **P1 architecture – Compact solution** – This architecture is structured around a SCADA Pack RTU module and M340 PLC incorporating both communication and data storage functions. IEC61131-3 Workbench and Unity Pro configuration software packages, operating with Windows 7, is used to easily configure the products. This architecture is very simple to implement and is well-suited to small lifting stations.

- **P2 architecture – Optimised solution** – An Altivar 61 variable speed drive including a “controller inside” PLC board is the heart of this solution. With this system, several pumps can be managed by a single variable speed drive. Ready-to-use software applications are proposed. This architecture is specially dedicated to multi-pumps systems such as pumping and booster stations.

- **P3 architecture – Modular solution** – This architecture, capable of handling the most complex local applications is based on the M580 range of PLCs, its panel of software tools and interoperability among the various components such as SCADA Pack RTU telemetry modules, user interfaces, variable speed drives and video monitoring, which allows digital recording from the supervision station. This architecture supports the “transparent ready” concept which offers total transparency between the products, the supervisory system, and even the automation systems of other stations.

Application of telemetry for pumping stations in Tunisia

- **Origin**: The project consists of providing a telemetry system for the regulation of six pumping stations connected to the same reservoir.

- **Solutions implemented**: The system architecture (Fig. 3) consists of six pumping stations. Each one comprises a SP334E telemetry module including a PLC, a SP357E module for the reservoir and a M580 PLC for supervision linked to a SR2MOD3 wireless GPRS communication interface. The clusters are started and stopped in a specific order according to the flow rate and pressure measurements transmitted by each one.

Since the reservoir site has no 220 V network, the SP357E is powered by a battery charged by a solar panel. The sizing of the source provides for days when there is no/ insufficient sunlight.

The customer benefits are the automation of the structures and total self-regulation of the drinking water supply network works without any human intervention. For the operators, the grouping all the alarms on a single site (supervisory system) improves the installation’s effectiveness and availability. Simple access to data such as events, alarms and measurements reduces operating and maintenance costs.

This article has been shortened.

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Note 2: Each unit does not have a fixed address; the address is assigned to each connection automatically by the web server.