Management strategy of emergencies and events in the monitoring of water distribution in Paris

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Abstract For water distributors, management of emergencies and the follow-up of events in real time represent an essential aspect of their work. Proper management of this information makes for optimization of its use and enables one to avoid a large number of problems regarding water supply thanks to improved reactivity and more precisely-focused action.

Since 1992, Sagep (Société Anonyme de Gestion de l'Eau de Paris) to whom the City of Paris has entrusted responsibility for its water supply, has equipped itself with a computerized real-time monitoring system. Initially, this system processed 5,000 pieces of real-time information, which permitted monitoring of the 1,600 km of drinking water pipes and made possible distribution of the 650,000 m^3 of drinking water consumed daily by Parisians.

In 1996, given the enormous progress achieved with regard to information systems and measuring devices installed in the pipe networks, the Scada at Sagep was modernized. This made possible the integration of the fresh information necessitated by developments in the supply system of the City of Paris, plant renovation, new sensors, the traceability of events and water quality follow-up.

These developments led to the integration and management of 17,500 pieces of real-time information, over three-quarters of which are made up of emergencies or events. It seems clear that it is impossible to manage such a mass of real-time information in the absence of a rigorous processing strategy. To exploit this set of data in optimal fashion, Sagep has developed a system of management of emergencies based on three thrusts: identification, qualification and processing.

Keywords Events; management strategy; monitoring; Paris

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The process of identification

The process of identification represents a strategic phase in the management of emergencies and incidents. It is at this moment that an emergency or an anomaly is detected. Within the framework of water management in Paris, this is a very complex phase, since it concerns over 2,700 parts spread over the network with a potential of more than 15,000 emergencies or incidents. Not all of this substantial set of data presents the same critical nature and, on occasion, it is only a combination of signals that will determine the critical nature of a situation. Therefore to make proper use of this mass of information, a two-fold signaling structure has been established.

A vertical structure

The initial aspect of the latter consists in a hierarchical regrouping of the data or the vertical structure of these same.

This structure makes use of the physical and geographical organization of the command and control system. The parts are dispersed within Paris and concentrated locally on a first PLC level. The data at this initial level are then recollated by a second PLC level which transmits them to the central system.

All the emergencies and incidents are structured in accordance with this pattern. At the level of each branch of the tree diagram, it is possible to access all the data appertaining to this branch. In this way, starting with a part, one can access all the components of this part,

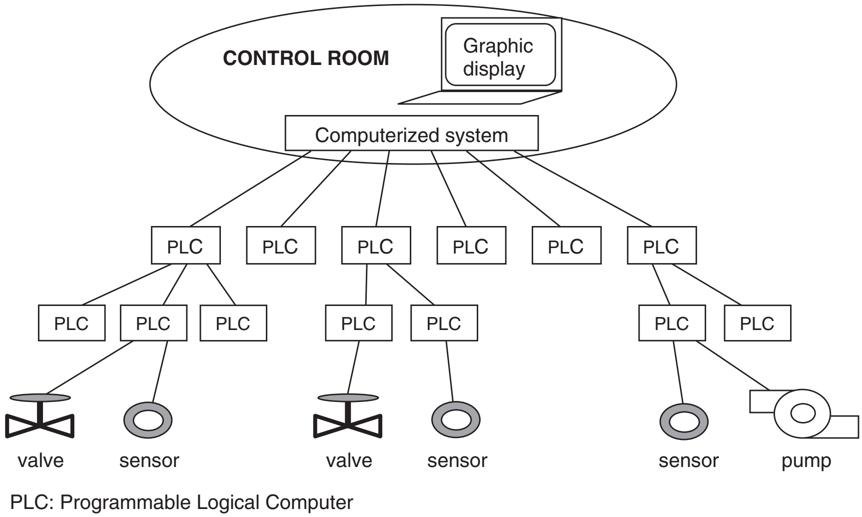

Figure 1 A vertical structure

and similarly, starting with a first-level PLC, access all the attached parts and all the components of these parts and so on.

This structure also makes it possible to transfer a malfunction downwards, when a first-level PLC malfunctions and prevents command and control of the parts attached to it, with the result that the information relating to downtime is passed on to the parts affected.

In addition to this initial vertical structuring of information, there exists a horizontal structure.

A horizontal structure

This involves a classification of information as a function of its theoretical importance in regard to the operation of the hydraulic network. This theoretical importance is defined as a function of operating objectives such as quantity, pressure and the quality of the water distributed.

Within this classification, the components receive a mark ranging from 1 to 5 according to their importance and nature.

The highest level within this classification is level 1, which brings together all the information indicating whether a part deemed important or necessary for operation of the network is unavailable to the operators. This concerns such parts as control valves and pumps. The information indicating whether the minimum pressure thresholds are no longer respected is also included in this level. This level of information represented by information of an urgent nature must not in any event be disturbed by too great a flow of information. Thus the concentration PLCs represent high-level alarms. For example, a control valve may be rendered unavailable by a low battery threshold, a defect in the effort limiting device or a malfunctioning in the angle encoder. This item of information is not transferred to level 1; the unavailability alone of this valve will be mentioned, while details of the malfunction will be available on another level.

The second level relates to “water meters”, that is to say the entire system of water metering. At this level, the defects in the equipment concerned become apparent but sophisticated defects are also to be found. These latter are the result of calculations thanks to which the quality of the measurements made can be monitored. One of the sophisticated defects used is the “impulse drift”. Present-day flowmeters measure flow on a continuous basis and are associated with volume integrators. These send out a signal to each 100 M3 integration. The PLCs to which these machines are attached are provided on the one hand with a measurement of instantaneous flow and on the other with volume impulses. These PLCs then integrate the measurement and compare it with the volumes shown by the integrator. In the event of a substantial discrepancy between the two items of information, an alarm signal is sent out.

The third level concerns the information relating to the information concentration nodes. This particular group is important for it shows up the malfunctionings in communications nodes. Loss of communication with one of these sites results in a loss of information with regard to a set of parts. However, this loss of information does not mean that the parts concerned have become unusable. They can remain functional but usable only by staff who have approached the part. Malfunctions capable of affecting these nodes are of several types: loss of the computer link connecting them to the centre, loss of supply current, malfunctioning of the PLC, etc.

The fourth information level relates to the quality of the water transported and brings together all the incidents or malfunctionings affecting the chlorine, turbidity and other sensors.

The final level combines all the other as-yet-unclassified information. It is essentially made up of subdetails of the previous information While the general defect in the pump is to be found at the first level, level 5 will display the suction defect and the electrical fault in this same part. Direct use of this level is not made by the operators in the command and control centre but remains essential as far as the service crews are concerned.

The whole of this organization of information on a vertical and a horizontal level has made possible the setting up of visual codification as regards the command and control system. As part of this codification, the organization of alarm signals by level (horizontal structure) is always available to the operators. A graphic band is constantly present on the monitoring screens and symbolizes this presentation by level.

The second aspect of the visual codification is the presentation of the network components.

This codification taken as a whole aims at the extraction of a meaningful item of information amidst an information flow, with on average 4,000 incidents occurring daily. When this meaningful information has been identified by the operator, it has then to be qualified with a view to effective processing.

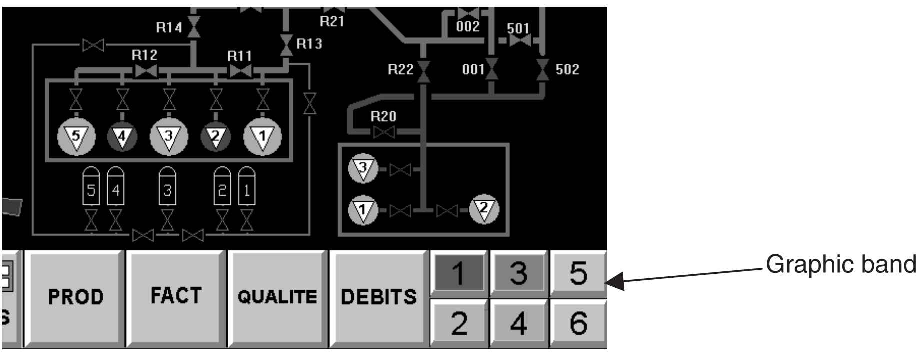

Figure 2 Part of a monitoring screen

Figure 3 Visual codification sample

The qualification of emergencies and incidents

The qualification phase of an emergency is a capital phase as regards optimization of its proper treatment. Proper treatment of an emergency consists in providing swift substitute solutions together with correction of the malfunctioning, without excessive disturbance to the operation of the network. To achieve such proper treatment, the identification phase, thanks to its classification, makes possible initial orientation in the direction of the relevant departments. Sagep has structured its service crews by area of expertise so as to be in a position to call on specialists in precise fields of action. This crew structure makes for swift intervention. The departments have been structured according to five major thrusts:

1. The metrology measuring department specializing in processing of flowmeters and water meters.
2. The data processing department specializing in command and control systems.
3. The electricity automatism department specializing in PLC's and electrical systems.
4. The network departments specializing in pipes and water distribution installations.
5. The maintenance department specializing in the maintenance of the remaining equipment, network parts and sensors.

After identification, the command and control centre operators transmit the alarm signal to the department they deem competent to deal with it. In parallel with this, they set up a substitute operating strategy to compensate for the malfunctioning that has been observed. The type of strategies put in place can differ considerably depending on whether a problem concerns a network part or an alarm signal relating to a minimum pressure threshold, for example. Only experience and the situation in which the network finds itself at the time of the malfunctioning enable one to determine the substitute solution.

When the competent departments have taken cognisance of this alarm signal, they study the details of the information provided by the command and control system and visit the area concerned in order to confirm the initial diagnosis. On the basis of the additional information they will supply to the operators at the command and control centre, the corrective strategy with regard to the malfunctioning will, if necessary, be refined. This represents the feedback phase after verification of the diagnosis. This palliative action strategy resulting in possible correction of the immediate action allows a very big ability to face an observed malfunctioning. At this level, correction of the malfunctioning has not yet begun. Only substitute solutions have been put in place when this has proved necessary and possible.

The treatment phase

Several parameters are taken into account during the treatment phase: the importance from the point of view of network operation, the length of time required for repair and the type of intervention. These three essential parameters govern this phase. Malfunctioning of a part that is strategic in operation terms will be dealt with on a priority basis, and indeed even in the case of a burst pipe or the malfunctioning of a supply valve, the operation of the network will undergo modification. Correction of a malfunction is then a decision agreed on by the service crews and the network operation centre. Such collaboration plays an essential role inasmuch as other emergencies may at the very same moment affect other parts used in operation of the network. A choice as to the order in which malfunctions are dealt with must then be made.

The pattern of information can be represented as follows.

Minor incidents will be dealt with once major incidents have been corrected. Malfunctions as yet uncorrected are noted as such both in the command and control system by use of visual flagging or messages, and in a "day book" system, which corresponds to the management report issued by the command and control centre. This dual entry is necessary to permit transmission of the information from one operation crew to another. When the

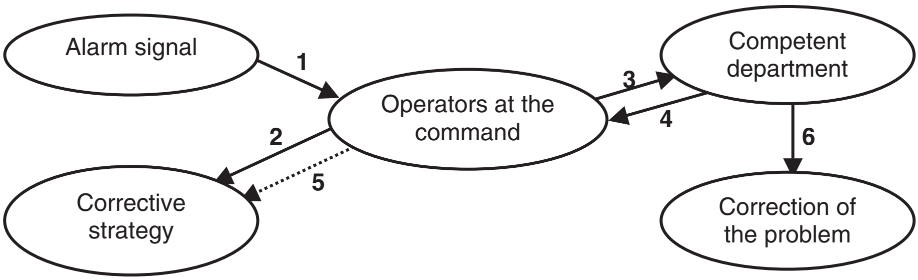

Figure 4 Schematic representation the pattern of information

problem has been entirely resolved, the flags are removed from the command and control system and the information is noted down in the management report.

Conclusion

The system that permits command and control of the City of Paris distribution network has become considerably more complex in recent years. This finer-scale knowledge of the network has also resulted in greater difficulty with regard to identification of a meaningful alarm signal for network operation.

Thanks to the setting up of an information management structure based at one and the same time on a process of computerized classification and powerful internal expertise, Sagep is able to achieve total control over its information system and to correct in very short order any malfunctioning observed.

To be absolutely effective, the strategy put in place must be complemented by intense dialogue and great flexibility with regard to action. This is the price that has to be paid if correction of the malfunctionings observed in the installations is to be effective. Setting up of this system and its constant evolution now enables Sagep to continue development of the command and control installations of the Paris water supply network.