

Study and Implementation of a Remote System Drilling and Ponds of ICS / MINE

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ABSTRACT : In order to boost its production and reinvigorate its activities, the Senegalese Chemical Industries (ICS) have planned to set up a remote management system for its wells and ponds. This firm, located in Mboro, 100 km from Dakar, has a significant need for water in the process of obtaining pure phosphate. Hence its numerous wells and ponds located in remote areas; this distribution of installments makes it difficult to exploit and manage the water. Therefore, the ICS have opted for a centralized management of these sites through a remote management system to overcome the numerous difficulties encountered.

This article is mainly a presentation of this remote management system's implementation, ranging from data processing using Allen Bradley's PLC to electrical devices control by exploiting remote modules of the existing installation. An Inter-site communication will be done via the GSM network.

KEYWORDS: Remote systems, PLC, telecommunication, signal processing, FAST, Senegalese Chemical Industries (ICS).

I. INTRODUCTION

Remote management is based on the telecommunication technics and computer processing of data from the network. It allows the transmission of information between geographically remote sites for purposes of monitoring installments and optimization of the process. It empowers operators to ensure a smoother, more economical operation services. This supervision tool is the new solution preferred by the industry with one or several networks of installments that cover a vast territory. Remote management application areas are numerous and vary according to the activity of the company.

It is for this purpose that the Senegalese Chemical Industries (SCI), operating in the phosphate exploitation, processing and export, have seen the importance of using this solution to manage one of their networks.

Indeed, the finished good requires lot of water. This is essential to the operation of the company. Certainly, the SCI have the advantage to be located in the coastal area of Senegal where it has a large reserve of water with a water table very low (between 0.5 to 20 meters). But the rainfall deficit, associated with operation for various uses, have made that water become increasingly rare in these parts. Hence the emergency for the SCI to implement a management tool and optimization of water resources as they have an extensive network of water in perpetual evolution and whose usual management poses huge problems.

However the implementation of a remote management system requires a feasibility of the study aiming at identifying and at defining the objectives, then to choose the necessary means for its realization. It is in this perspective that this topic "Study for the establishment of a remote management system of drilling and basins of the SCI/Mine" has been proposed.

The drilling and basins (30 boreholes and a dozen basins) of SCI are a vast network of water stretching for several kilometers. This water system is one of the most important nodes in the chain of production of the company. It must ensure the availability of water at all time because a lack of water would cause an immediate cessation of the production of the SCI.

Designing such a system that would take into account this vital business aspect, the large number of information to manage on the one hand, the variety of equipments and the constant extension of this network on the other hand, would in no way, be a task without a methodical approach.

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This methodology allows us to develop a work plan from the feasibility of study to the implementation of that system. This article will present in the first part, the draft study by giving the background to the study, the problems and the goals. Then, in the second part, it will explain the solution adopted to design the remote management system and end in the last part with the results obtained with this solution.

II. PRESENTATION OF THE PROJECT

II.1 CONTEXT

The current development of telecommunication technics, computer science and automation, boosted by the breakthrough of modern electronics, offer new prospects to industrialists.

Indeed, the work of industrial agents today is limited to the supervision and control of the installations. The real work is done by API (Industrial Programmable Logic Controller); it is the automation of industrial processes.

It is in this perspective that SCI / MINE wants to set up a system for remote management of its wells and basins.

This choice is guided on the one hand by the limited availability of water and reserves, which vary considerably during the year, but also on account of numerous incidents on the water network, and whose troubleshooting cost a lot of time to the company. Actually the agents struggled to situate the incident, this is due to the extent of the network and the difficulty of the access to the sites.

This loss of time is equivalent to economic losses for the company. Hence, its urgent need to eradicate this type of intervention.

II.2 PROBLEM

Remote management, in fact, all is well clarified through the name: "remote" that refers to "distance" and "management" which means here "control". By this simple analysis we may easily see the major problem to solve in order to set up our system.

Indeed the SCI, having a considerable need for water for their production have put in place about thirty wells and a dozen basins. Some of these sites as shown in **Table 1**, are located several kilometers away from the **PREPARATION¹** which is the supervisory site.

Thus our main concern here is to find a means of transmitting and receiving data from these geographically distant sites.

But how to set up such a device? How do these stations communicate and by what means? All these questions will have to be answered in order to solve the problems posed. From then on, choices have to be made:

- ✓ First, the choice of the type of communication to adopt
- ✓ Then this choice allows us to choose one of the tools to use.

These are two fundamental characteristics of our remote management system. But a system based on these two choices would be too general. We must therefore integrate into these characteristics the specificities that arise from the pressing needs of the company so that our system be unique to it. These specificities allow us to identify the objectives of this project.

WATER POINTS	DISTANCE PREPARATION (m)	BETWEEN
F4	1148.16	
BACHE 3813	587.27	
F5	1085.25	
F6	1834.22	
S7	3136.67	
S4	3223.12	
S3	3546.71	
S8	5006.38	

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FC1	5223.41
FC2	5776.46
FC3	5975.68
EXH2	8459.49

Table 1 : Distances between PREPARATION and certain mine boreholes and wells

II.3 OBJECTIVES

Starting from the problems and fixed specificities, we can predict the functions of our remote management system. And so meeting the demands of the SCI

- Limit the movement of their agents
- Limit human interventions
- Ensure continuity of service
- Optimize the water resource that is increasingly scarce
- Optimize the energy

Such a result would enable them to make enormous savings.

In short, to take these requirements into account, the remote management system that we have to establish must be able to:

- ✓ Remote the control of drilling pumps;
- ✓ Check and visualize the status of the devices;
- ✓ Detect, immediately alert and situate incidents that occur on the water system.

III. THE PROPOSED SOLUTION

III.1 The principle of the solution

The solution that we propose is based largely on tools available at the SCI. We will use existing electrical installations and some tools mentioned previously to design our remote system. To explain the principle of this solution, we will use the FAST (Function Analysis System Technique) method.

III.1.1 FAST diagram

This method of internal functional analysis is based on a diagram (FAST diagram) which presents a rigorous translation of each service functions in function (s) technical (and then materially solution (s) constructive (s)). It is built from left to right, in a logic from why to how. Thanks to our technical and scientific culture as an engineer, we develop the product in technical service functions. Finally build the product chosen by the suite of solutions. The diagram consists of rectangles in which are located the functions of circles for the different solutions and at the end of branches for links. The links may be OR ones represented by two arrows (or more) starting from the same origin or AND links, represented by arrows that separate after the box representing the function origin.

Thus our FAST diagram is as followed:

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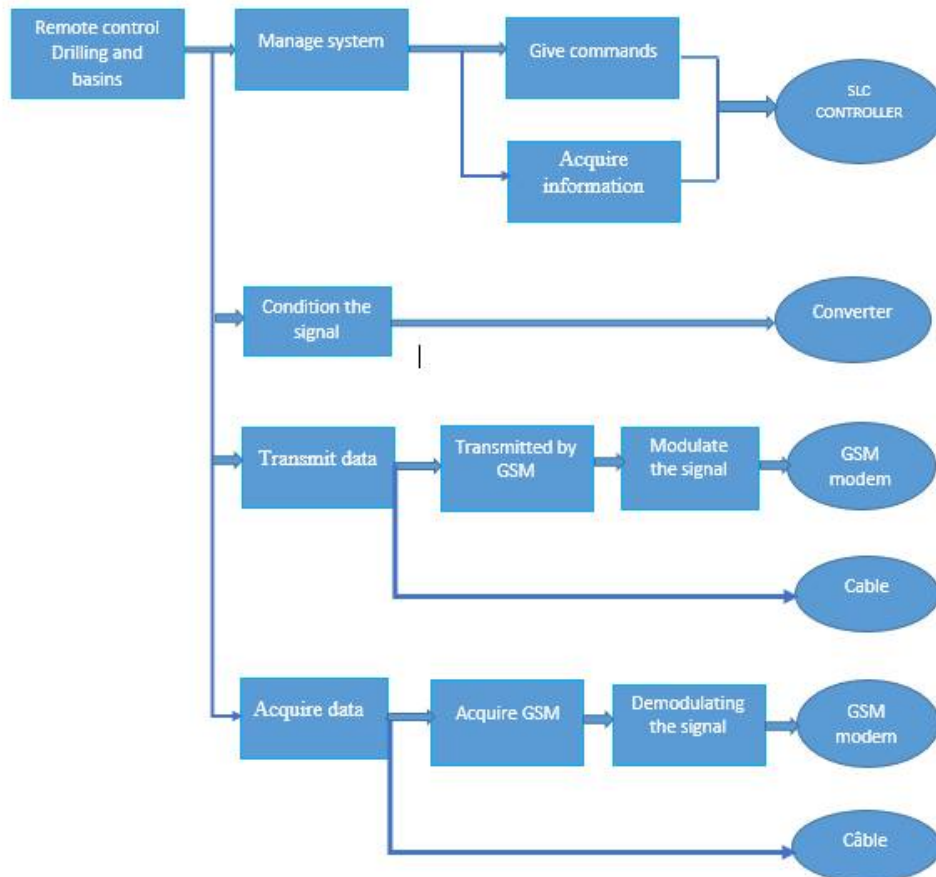


Fig 1: FAST diagram

III.1.2 Diagram description

As shown in the FAST digraph, our main function is "Tele-control wells and basins", it's the expected function of the final product. What we want to actually implement is a product that can remotely control the drilling and basin of the SCI. To design such a product, the FAST diagram tells us to find solutions to the four following technical features: "Managing the system", "Condition the signal", "transmit data" and "Acquire data".

These solutions are obtained by reading the FAST diagram from left to right and by asking the question "HOW?" There to, for:

- "Managing the system", we must be able to give commands (to control drilling pumps) and acquire information (coming from the different sites). So here, the opted solution is to use a PLC SLC.
- 'Condition the signal': some information that we use here are not suitable for the remote management system communication devices. So packaging is needed i.e. adjust the amplitude (weak) and the (numeric) type of signals has the ability of devices. So let's use a converter whenever this is necessary.
- "Transmit data" function after the conditioning we have to transmit the signal. This transmission can be done either by cable on the small distances only or through the GSM network. A modulation of the signal is necessary for transmission through GSM where GSM modem.
- The function 'Acquire data' acquisition of information is necessary in order to oversee the water network. It is also either directly by cable for short distances or by GSM using the same modem GSM but for a demodulation this time.

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III.2 Architecture of the solution

First the water network will be divided into four sites (NDIAKHATE, KEUR MOR FALL, TOBÈNE, FACTORY) each managed independently from the other by a slave automaton (SLC) assisted by deported modules. The four sites will all be under the control and supervision of another master controller (SLC) located in the PREPARATION. Then for the communication network we will use the GSM network and finally the transmission of data from the network to the controllers and from the controllers to the network of modems for which GSM will be used. These modems are of two types: modems masters for the local Center and slave modems for wells and basins (see following figure).

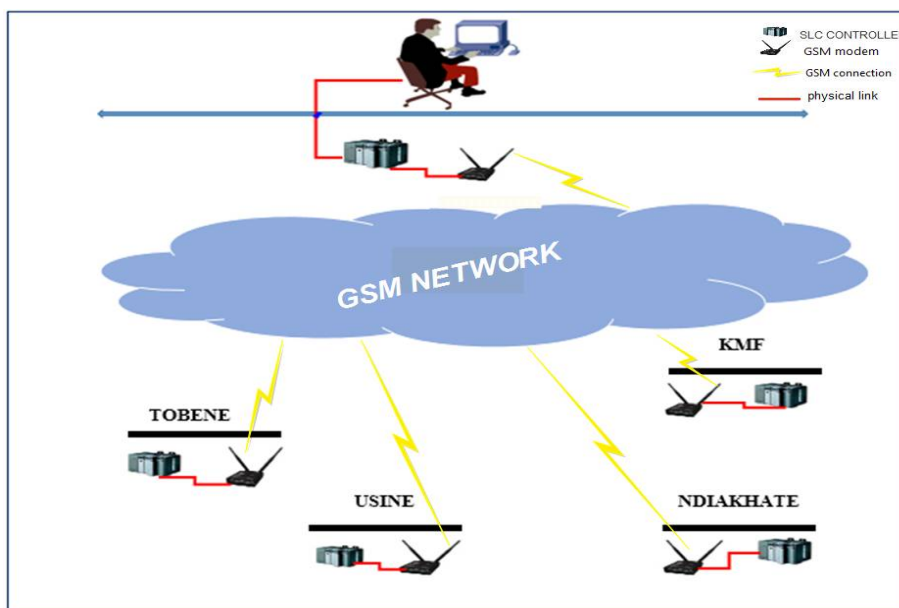


Fig. 2: General Architecture of the remote management system

The following figures show the detailed architecture of the four sites.

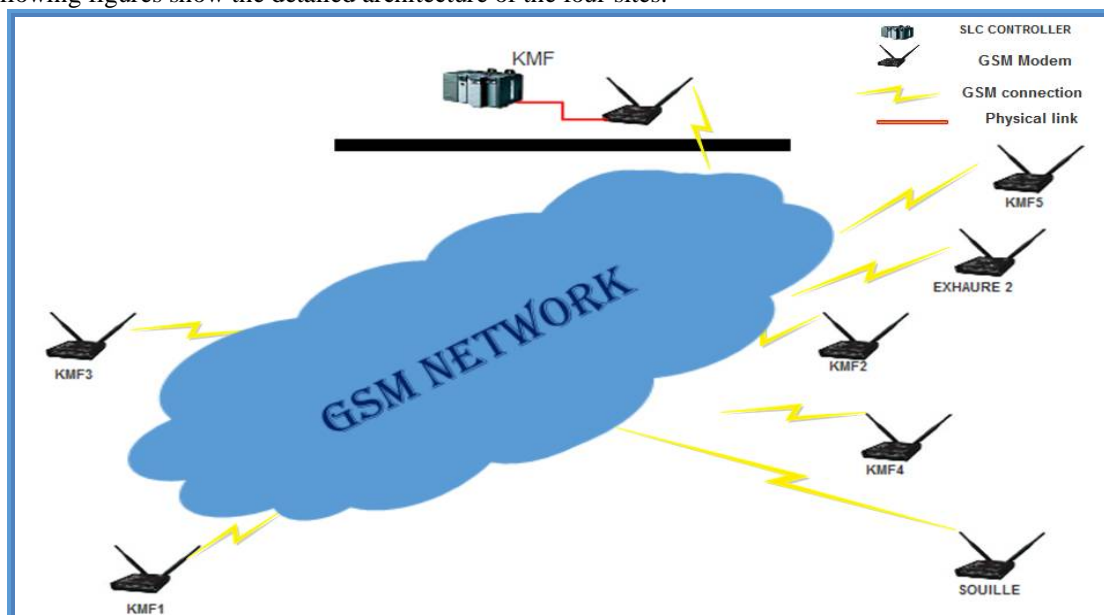


Fig.3: Keur Mor Fall (KMF) site Architecture

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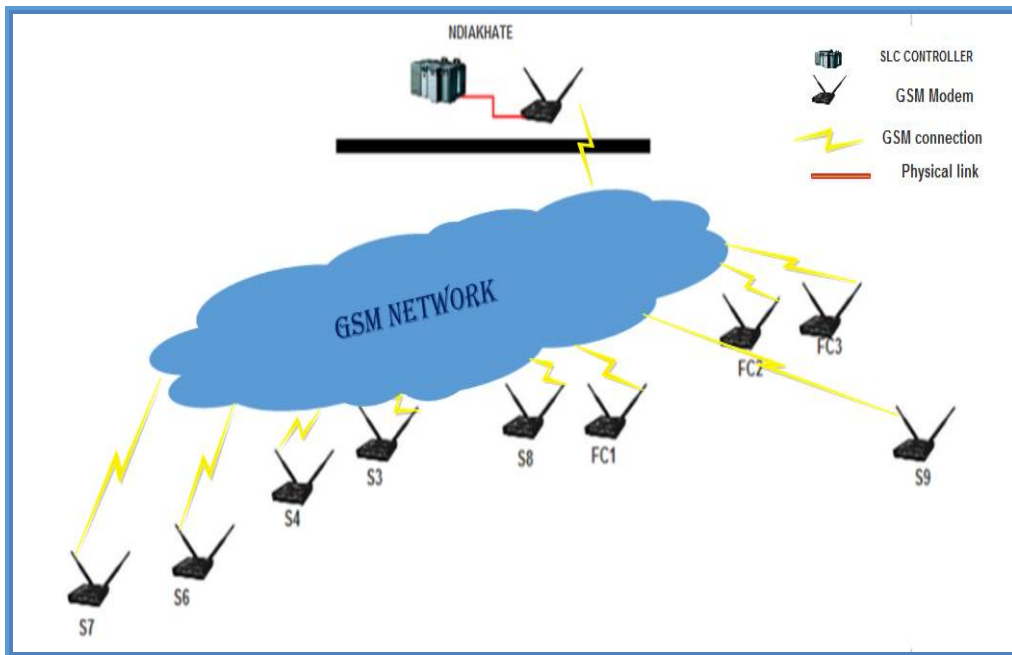


Fig.4 : NDI AKHATE site Architecture

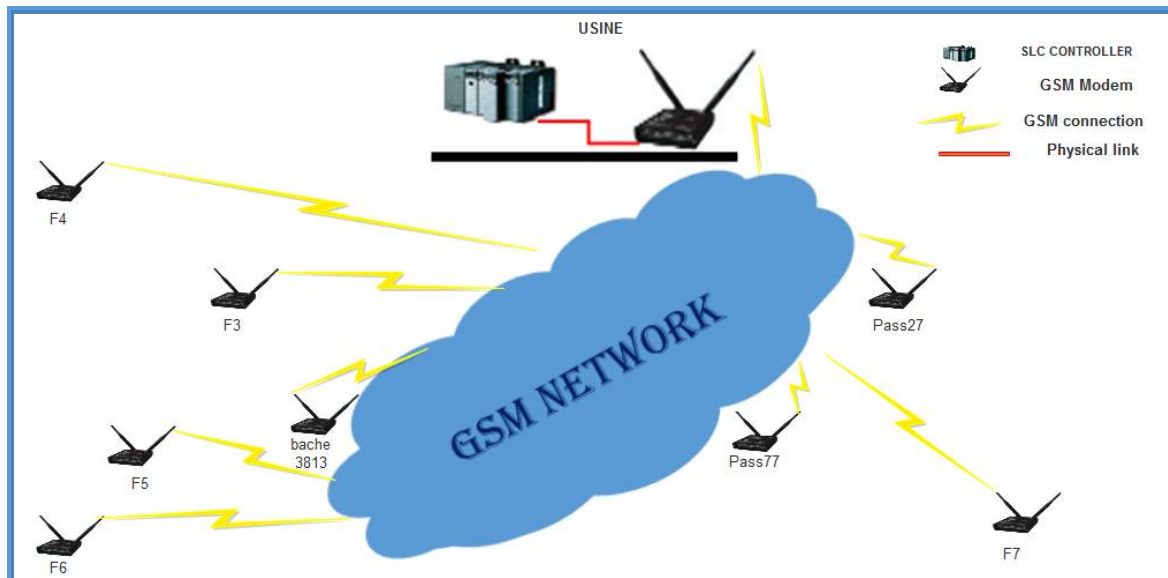


Fig.5 : USINE site Architecture

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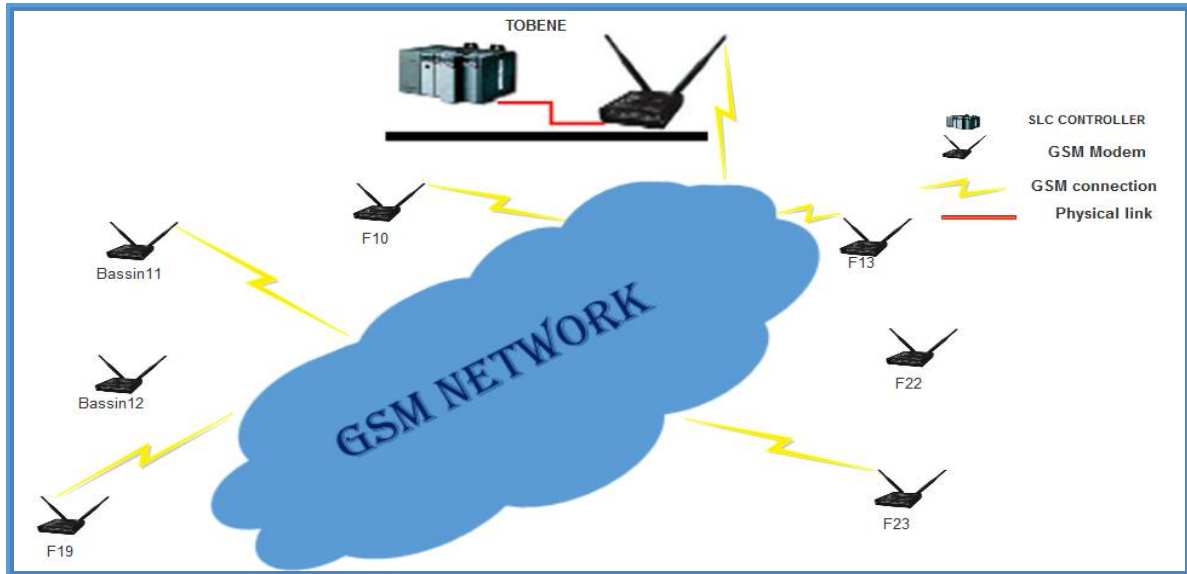


Fig. 6 : TOBENE site Architecture

IV. RESULTS

This section first presents the structure of logic programs that shows the program's start-up and stop of the pumps on the one hand and the acquisition of data on the other. Then it presents the Synoptic supervision and end of the tests carried out.

IV.1 Logic Program

Logic programming is done with the **Ladder** language, used by our SLC automatons. The operation of the pumps is the same, we have therefore adopted the same program at the level of different drilling, only the nomenclature changes.

IV.1.1 Start and Stop pumps

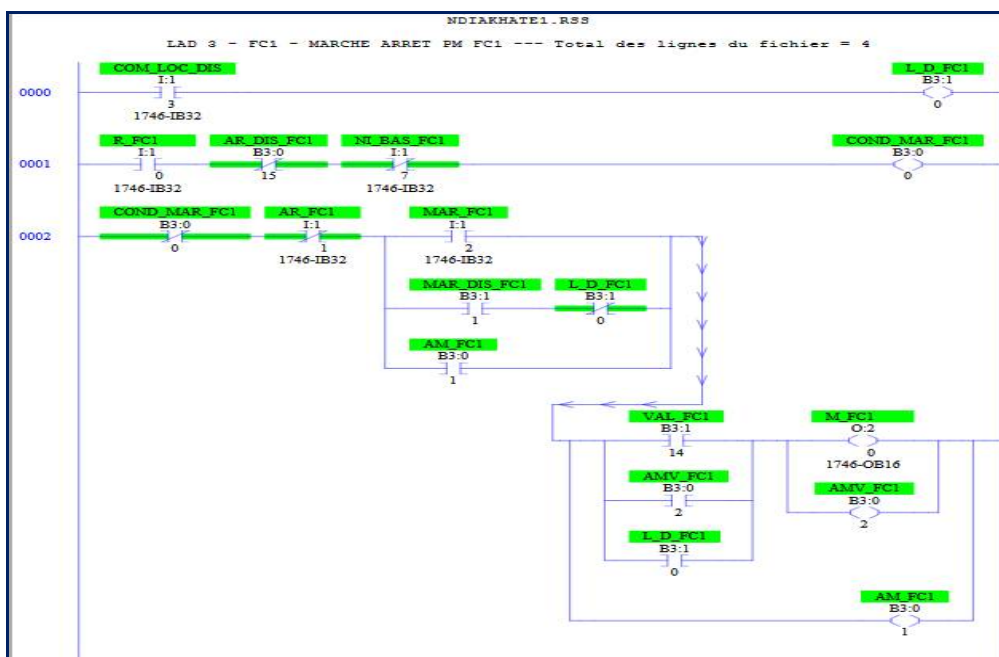


Fig. 7: Example of a program start & stop pumps

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➤ Nomenclature

R_FC1: Contact of the thermal relay of the pump FC1²

COM-LOC-DIS: Local-distant command

NI_BAS_FC1: The low pump level sensor FC1

AR_: ARRET

MAR_: On

AM_: Auto Maintien

VAL_: Validate

L_D_: Locally Remote

➤ Functioning

The operator has two possibilities to control his site. Using a switch that has two states "0" for remote control or "1" for local control:

- Remote: to start the pump the operator first presses the MAR_DIS_FC1 button, then the output AM_FC1 becomes true; then for safety purposes it must press VAL_FC1 for validation, thus M_FC1 which must activate the pump becomes true.

The stop is done by pressing the AR_DIS_FC1 button.

- Locally: the operator presses the push-button MAR_FC1 to start the pump. Here the validation step is skipped, in fact as the operator is on site it is considered that he has already taken all precautions before starting the pump.

AM_FC1 present at the input ensures the line continuity when the operator releases the pushbutton.

The stop is done by pressing the pushbutton AR_FC1.

IV.2 Data Acquisition

IV.2.1 From pumps and basins

The SCP instruction allowed us to acquire the data from the basins but also from the pumps. Its description was already made above (in the section "the instructions used"). In this case, the input signal is a 4-20 mA analog signal from the drilling flow meter F1 at our FACTORY site.

IV.2.1 Acquisition of defects

The faults have been programmed following the logic of the TOR. Therefore we have acquired by assigning each fault to one bit of the PLC.

IV.2.2 Supervision Synoptic

As described above in [16], industrial supervision at the central station is the final stage of remote management. It allows to see remotely the different sites of the factory thanks to the synoptic. We realized these with RSView32 software (Fig. 8).

At startup, the screen below appears and the operator must identify himself before entering the supervision system. As already mentioned, we have two user accounts: Administrator and Default (see **Monitoring Architecture**).

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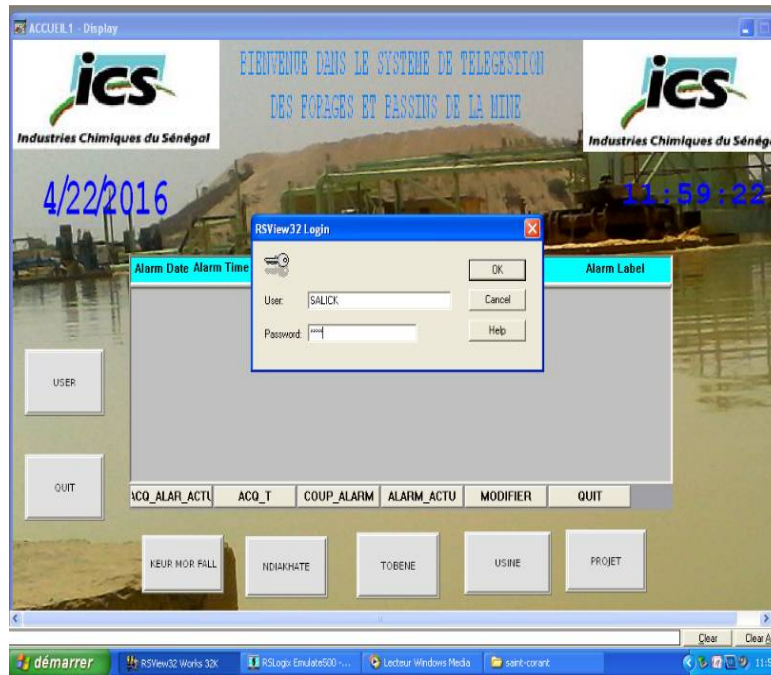


Fig. 8: Home page

After identification, the operator can, by clicking on the button bearing the name of a site, accede to the supervisory screen of the site. For example it accedes to the screen below by clicking on the button « NDIKHAHATE » (Fig.9).

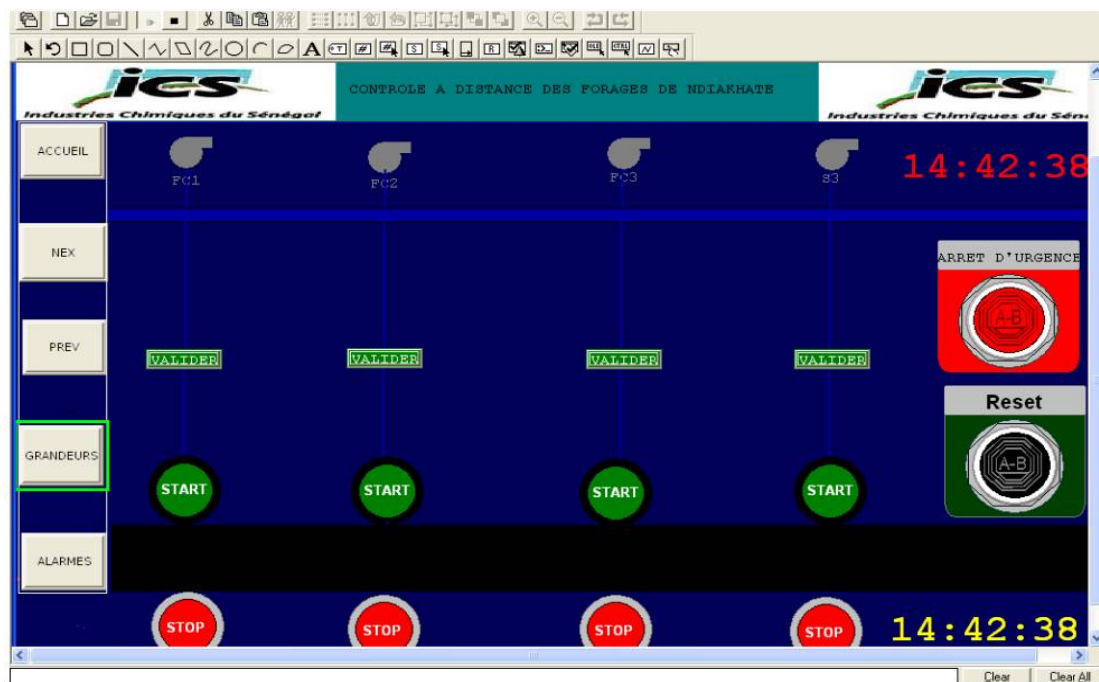


Fig. 9: Supervision DIAKHATE

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On this screen, the operator has several options:

- Start, Stop, pumps
- Return to the Home screen
- View the next or previous screen
- Consult the electrical quantities of the pumps
- View alarms
- EMERGENCY STOP: allows to stop all drilling of the site
- RESET: allows to return to the initial state of the site

IV.2.3 Tests of the program

After the programming and the installation of the supervisory synoptic, it was necessary to pass the tests and the validation of the results. Thanks to two tools, we first tested the RSLogix Emulate 500 virtual PLC and then a physical PLC through a test bench.

By forcing and switching bit, we were able with RSLogix Emulate 500 to load and test the entire program. RSLogix Emulate 500 is actually a software designed to test and debug all Ladder logic programs before commissioning; Based on Microsoft Windows, it can emulate one or more SLC 500 processors. Thus it allowed us to predict the operation of our program and to test the synoptic designed on RSView32 with the logic program in Ladder.

Then, we tested fragments of the same program using a test bench consisting of a SLC 5/4 PLC of LEDs representing the outputs (digital and analogue) of buttons (simple, push-buttons and switches) Representing the inputs (digital and analog). Thanks to this system, we were able to.

V. CONCLUSION

After the automation of industrial processes and then the remote control of the latter, large companies like ICS find more and more tools such as tele-management that allow them to optimize the cost of their production and improve the quality of maintenance. Several technics and tools are used to design a remote management system. Thus, in order to avoid excessive investments and not to exceed the threshold of complexity, a very thorough study should be made to define the problems posed in order to set the objectives.

This study allowed us to propose and implement a remote management system. This solution revolves around materials that SCI agents are used to handling. This choice of materials is motivated by the desire to facilitate the integration of the product in the industrial system of ICS.

Tests allowed us to validate all the programs that were developed with the RSLogix 500 software. These tests made it possible to see that our solution reaches the objectives. However, tests on communication between controllers and on GSM modems are necessary.

Today, remote management systems have become indispensable in the industrial world, not only because of their advantages, but also and especially because of the rapid evolution of its components. This rapid evolution due to the breakthrough of technology facilitates the management of industrial networks at lower and lower costs. Indeed from the use of the antennas from their beginning and today the GSM network and soon the UMTS and the EDGE, the tele-management systems do not cease evolving by increasing the rate of transmission of the data. Moreover our system is in this perspective because its communication medium can easily migrate to the UMTS or the EDGE by replacing the modems. Our remote management system would also be more effective if combined with a video surveillance system.

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REFERENCES

- [1] Office National de l'Eau Potable du Maroc: Cahier des clauses techniques générales relatives aux marchés de travaux d'eau potable « Télégestion » Tome 4, Version 2, Octobre 2010.
- [2] Laurent Rabier : Revue « Télégestion : des outils incontournables pour mieux exploiter les ouvrages de gestion de l'eau » N° 331 - L'EAU, L'INDUSTRIE, LES NUISANCES , 30 Avril 2010.
- [3] Fondation de l'eau : Les Cahiers Techniques « La télégestion des réseaux » Limoge Juillet 1989
- [4] Rockwell Automation, Allen-Bradley: Processeur SLC 500 sur châssis

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

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- [5] Rockwell Automation, Allen-Bradley: Jeu d'instructions des SLC 500 et MicroLogix
- [6] Rockwell Automation, Allen-Bradley: SLC 500 Modules d' E/S analogiques
- [7] Allen-Bradley Company: « La famille des automates programmables SLC 500 » Janvier 1995
- [8] Rockwell International corporation « Control the Future Today with Allen-Bradley's SLC 500Processors Small Controllers for Big Applications » USA, Mai 1997
- [9] Rockwell Software: Guide pratique de RSLinx
- [10] Rockwell Automation Technologies, Inc. : « RSView32 User's guide » USA, Juillet 2011
- [11] Simon ZNATY: « GPRS: Principes et Architecture » EFORT 2005
- [12] Simon ZNATY : « GSM : Global System for Mobile Communications Architecture, Interfaces et Identités » EFORT 2008
- [13] www.lacroix-sofrel.fr: Accessed on 28 April 2016
- [14] ww.scav-csva.org/SCAV-CSVA 2015: Accessed on 09 May 2016
- [15] www.informafun.free.fr :La fibre optique Accessed on 09 May 2016
- [16] Salick Diagne, mémoire de DiéteI 2016