DISTANT MONITORING OF AUTOMATED PROCESSES

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Abstract: This paper describes a software experiment dedicated to distant monitoring of automated process. The first part of the paper introduces the context: to monitor a microalgae production system. The second part of the paper presents the first solution using TCP/IP and MODBUS protocols. The third part of the paper describes the actual application: a "client-server" architecture. MODBUS frames are directly transmitted through Internet. The conclusion of the paper introduces new ideas in the field of Computer Integrated Manufacturing and Engineering. Manufacturing and Engineering are collaborative tasks which imply "micro-SME's" located in different countries.

Keywords: Monitoring, network, Internet, MODBUS, client-server.

1. INTRODUCTION

This paper describes a software experiment dedicated to distant monitoring of automated processes. This work has been developed in order to monitor a microalgae production system. The main parameters that must be monitored and controlled in this framework are: CO_2, pH and salinity. The microalgae production system has

For example, if a request frame contains:

- 01 slave number 1
- 04 read binary inputs
- 00 01 start address is 0001
- 00 01 read 1 word (2 bytes)
- 60 0A Cyclic Redundancy Check

the answering frame would be :

- 01 slave number 1
- 04 read binary inputs
- 02 answer contains 2 bytes
- 00 0F data
- F9 34 Cyclic Redundancy Check

The master software is implemented on a real time system OS9 (Fig. 3). A serial link (RS232) and a converter (RS232/RS485) enables bi-directional communication between the master and slaves.

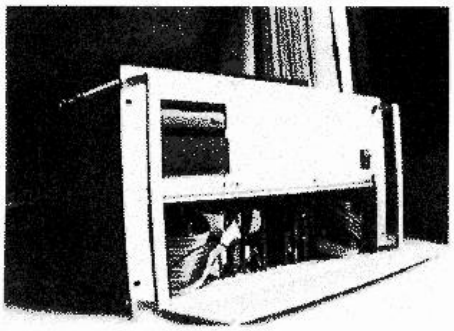

Fig. 3. OS9 Real Time System.

The OS9 real time system is equipped with an ethernet link that enables telnet connection from anywhere on the ethernet network. Since ethernet and Internet use the same TCP/IP protocol, it is immediately obvious that a telnet connection can be made from any point where an Internet connection exists.

In addition, the HTML language offers basic primitives to implement telnet connections in a hypermedia document. This language offers facilities for direct connection on a distant machine which is linked to the fieldbus. Unfortunatly this solution does not guarantee secure data transfer since it is not directly possible to encrypt data. This implies that anybody would be able to send frames to the different slaves. This is not acceptable in an industrial environment.

3. A CLIENT-SERVER ARCHITECTURE

The second experiment has been designed and developed according to a "client-server" architecture.

MODBUS frames are directly transmitted through the Internet from a distant UNIX machine (the client) to a distant Personal Computer (the server) running LINUX. (Fig. 4).

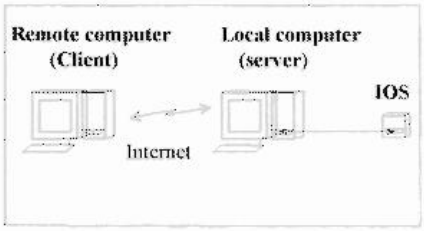

Fig. 4. Location of client and server.

This approach enables us to encrypt MODBUS frames before transmission. TEA (Tiny Encryption Algorithm) is a short program that was chosen to allow secure data transfer (Wheeler and Needham 1994).

A typical « client-server » architecture is described hereafter (Fig. 5).

The Personal Computer is in charge of communicating with the IOS through the field bus.

The client sends the MODBUS frame to the server. The service executed by the server is to send and receive MODBUS frames on

the fieldbus'. Once this service has finished, the server sends the answer to the client.

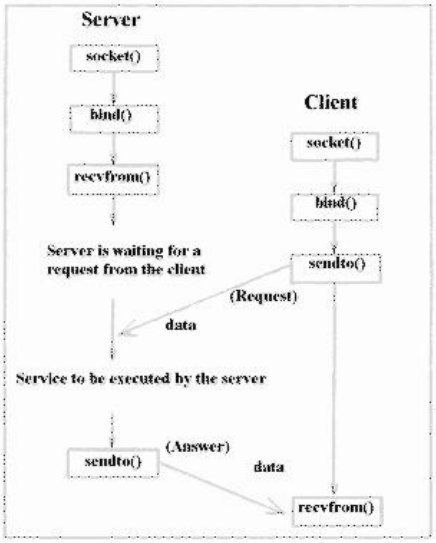

Fig. 5. Client-Server basic principle.

A special interface using the MOTIF library has been designed on the distant UNIX machine (the client) in order to read and write MODBUS frames.

This second solution improves security as it enables us to encrypt MODBUS frames before sending them to the Personal Computer.

4. CONCLUSIONS

These experiments were technology driven. That means that the industrial needs were not clearly expressed at the beginning of the project. A grant from the European Union (PACTE program) gave us the opportunity to demonstrate the industrial interest of networks to SMEs.

One of the main results from these experiments lies in the fact that now the company proposes enthusiastic and constructive developments:

- wait for new versions of MOSAIC or NETSCAPE that will enable us to encrypt data ;
- use the LabView software as the man/machine interface on the remote computer ;

A second conclusion from the paper introduces new ideas in the field of Computer Integrated Manufacturing and Engineering. Manufacturing and Engineering are collaborative tasks which imply "micro-SME's" located in different countries.

In this framework, the functions of a company and its partners are located in different sites (Fig. 6.) :

- Olhão : microalgae production system,
- Porto : management of the company and process engineering,
- Brest : automation engineering and product R&D.

On the one hand, it requires new organisation and new skills in the company, in order to make the best use of new communication technologies and new services.

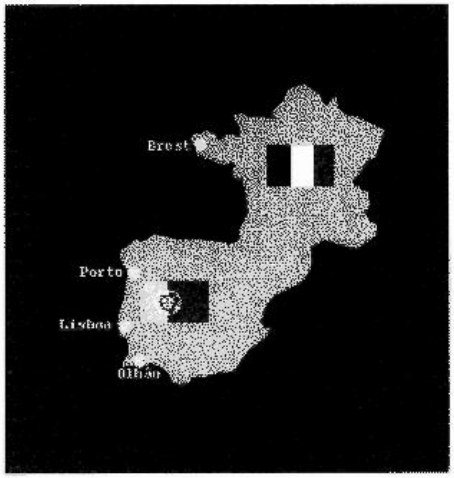

Fig. 6. Location of partners.

already been equipped with PLCs and sensors. The control of this system has been designed and developed using sequential flow charts.

Our target in this study is to experiment with the use of the Internet in order to provide distant monitoring. Two solutions have been developed :

- first, using the World Wide Web development tools such as HTML (HyperText Markup Language) and MOSAIC (or NETSCAPE) to view the results;
- second, using a «client-server» architecture implemented in the C language.

2. USING THE WORLD WIDE WEB

At the microalgae production system, data acquisition is simulated using a IOS (Fig. 1.).

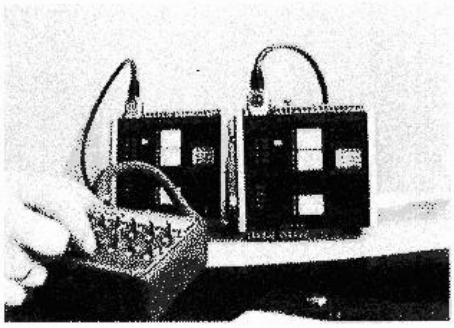

Fig. 1. Input-Output Station (IOS).

IOS enables the acquisition of analog and digital data from sensors, and enables local decisions through digital outputs and basic software functions.

IOS are slaves which are connected to a master computer through a fieldbus (Fig. 2.). The dialogue between a master and its slaves is achieved using the MODBUS protocol.

In this kind of network each IOS is a slave that answers requests from the master.
The master can send :

- a request to a partcular slave: request/answer mode,
- a common order to all slaves: broadcast mode.

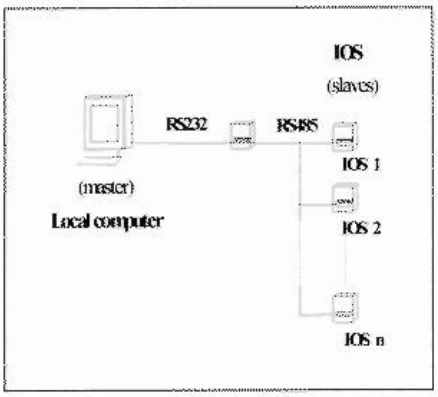

Fig. 2. Master computer and slaves.

Generally the master takes charge of four main functions :

- data exchange between slaves;
- man/machine interface;
- communication links with other computers;
- downloading of software or parameters to the slaves.

MODBUS is a master/slave protocol that supports only one master per network.
MODBUS defines the syntax of all messages that are emitted or broadcast on the network.

This syntax is hardware independant and enables communication between different types of equipment. MODBUS messages are composed of frames that contain the following information:

- slave identification;
- function code, data address;
- data to be transmitted or broadcast;
- Cyclic Redundancy Check.

On the other hand, it improves the reactivity, the time to market and added value, for example :

- information can be shared between product R&D, process engineering and automation engineering;
- management can obtain real time data from the production plant, and then make decisions regarding sales (quantity, delay, etc.);
- setpoints can be directly downloaded to the production plant.

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[1] **Mission: Develop and explore new technologies for the large-scale production of compounds from algae.**

[2] **Available on :**
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