

Scada of distributed systems through multiple industrial communication protocols

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Abstract— This research consists of validating the functionality of a SCADA system of distributed systems, connected to different communication protocols, by sending and receiving data from different field devices, generating their graphs of variables, analysis, diagnosis and decision making; the control and supervision tasks in the plant are carried out in real time, through this research consolidates all levels of the automation pyramid, integrating protocols and interfaces of industrial communication such as Modbus RTCP/IP, Profinet, Profibus DP and the AS-i Actuator Sensor Interface, WinCC_Advanced was used for monitoring, control and data acquisition; centralizing the different processes of the different areas of the company, such as proportional hydraulic systems, PID composite controls of physical variables, energy quantifiers and guaranteeing reliability in the operation of sensors and actuators; the control is performed locally from HMI's and remotely from a control room, in a fast and timely manner; the generated database is stored in a data logging, which can be viewed on the main PC or from a mobile device, monitoring and storing the states of variables, databases, historical and alarms; for analysis and decision making in the maintenance, operation and production of an industry.

Index Terms— SCADA, Modbus TCP/IP, Profinet, Profibus-Dp, AS-i, WinCC

I. INTRODUCTION

From the first automated machine based on electromechanical components to the large installations made up of a multitude of machines working in coordination, there has been a common denominator that, to a greater or lesser extent, has always been present, the relationship between the machine and its environment [1].

Today's companies are in need of integrated communications systems to reduce production costs, improve product quality, reduce storage, optimize systems and reduce maintenance costs.

Modern industries have systems or equipment that operate at different levels of automation, but at the same time it is necessary to link them so that they work in an integrated way and thus obtain a satisfactory joint result, which depends on the communication that goes from the

control room to the field instruments, forming the pyramid of CIM automation [2], fig.1.

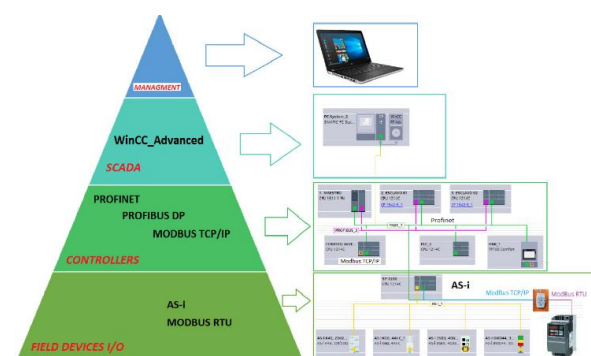


Fig. 1. CIM Automation Pyramid.

Communication protocols have evolved rapidly as electronic technology has advanced, mainly with regard to controllers and have achieved greater measurement accuracy, better availability of information and remote diagnostics

A. Win_CC

SCADA systems provide a new automation feature, such as supervision. This supervised control system allows communication with field devices to control the process automatically from the computer screen, which is user-configured and can be easily modified. In addition, it provides all the information generated in the production process to various users [3].

"SIMATIC WinCC_RT Advanced is the PC-based HMI solution for single-user systems directly on the machine". The connection to the WinCC_RT Advanced is of the non-integrated type, since it has been established using the TIA Portal connection editor in order to run the Runtime [4].

B. Profinet

Profinet, the open and non-proprietary standard based on Industrial Ethernet, allows direct and transparent access from the management level to the field level, where it manages open protocols and industry standard through the use of Profinet and TCP/IP. It is an industry-friendly installation system with real-time capability, integration of decentralized field devices, protection against unauthorized

access, efficient and non-proprietary engineering, and high availability of machines and plants [5].

C. Modbus TCP/IP

The Modbus TCP protocol allows the implementation over Ethernet networks, in order to control and monitor the automation equipment and be able to use the internet as a means of communication for increasing connectivity on any device that supports TCP/IP, directing a device from anywhere in the world, simple to expand and communicating with a Modbus RTU network with a Modbus TCP/IP, is done through Modbus TCP to Modbus RTU converters.

Modbus TCP/IP is an open protocol and has low hardware cost, which is why its implementation is growing every time industrial level [6].

D. Profibus

PROFIBUS DP (Process fieldbus) is a communication bus that implements a master/slave architecture, is used in fast processes, connection of control equipment. The master performs the activities of supervision and control of his slaves, communicating with them periodically in the manner established by the protocol [7].

E. AS-i

The AS-Actuator/Sensor Interface bus used to replace the large number of signals coming from the sensors and directed to the actuators from the controller; known in abbreviated form as AS-i bus, is a link system for the lowest level of processes in automation installations, it uses an AS-I cable as a physical medium and sensors and digital and analogue actuators of the simplest category are coupled to the control units via AS-i modules at field level [8]. Standard AS-i slave modules up to 124 actuators and 124 sensors can be operated on the AS-i cable [9].

Industrial applications, validate the functionality in the implementation of multiple communication protocols in a SCADA of a Network Micro, where the power and startup of a generator is managed, using Modbus TCP and RTU, as well as Industrial Ethernet [10]. SCADA automation systems automation system laboratory elements and applications implements an integrated automation system, for digital control of electrical drives with distributed peripherals, is used to control an induction motor in manual/automatic interconnected mode, the system employs industrial buses such as Profibus and Ethernet, an HMI and SCADA with trends, alarms, motor frequency and automatic motor speed profile sequence.[11]

II. RESEARCH METHODOLOGY

The method used in the research is based on the hypothetical deductive, because it establishes a topic of interest, which collectively encompasses the most used industrial communication networks and interfaces and provides its functionality to perform real-time control of proportional hydraulic systems, PID composite controls of physical variables, energy quantifiers and reliability in the operation of sensors and actuators are controlled locally from HMI's and remotely from a control room; the database generated in the Scada or if necessary it is visualized in a mobile device, monitoring and storing states of variables, historical and alarms in a database; for analysis and decision making in maintenance, operation and production.

III. PROCESS

The distributed system control algorithm is designed for the compound control of the level, velocity, position and energy quantification process, fig. 2.

The distributed control flow diagram details the operation of the Multivariable plant composite control, the proportional hydraulic position and pressure control, as well as the quantification of energy and databases of a level process

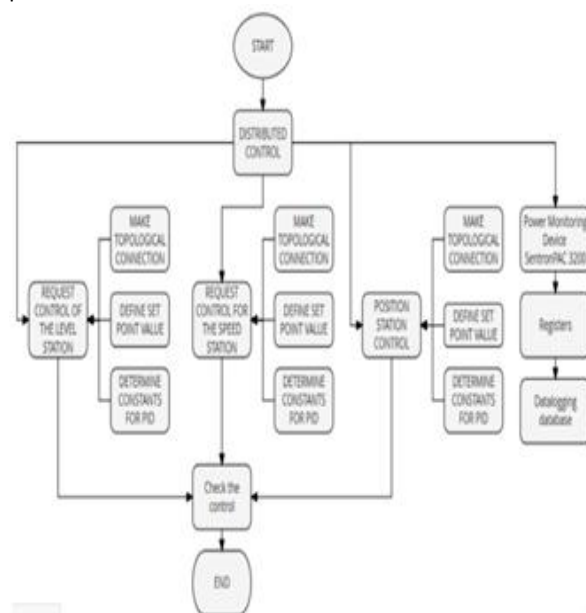


Fig. 2. Explanatory diagram of system controls.

The wiring diagram of the system distributed in the different stages of the automation pyramid, fig. 3.

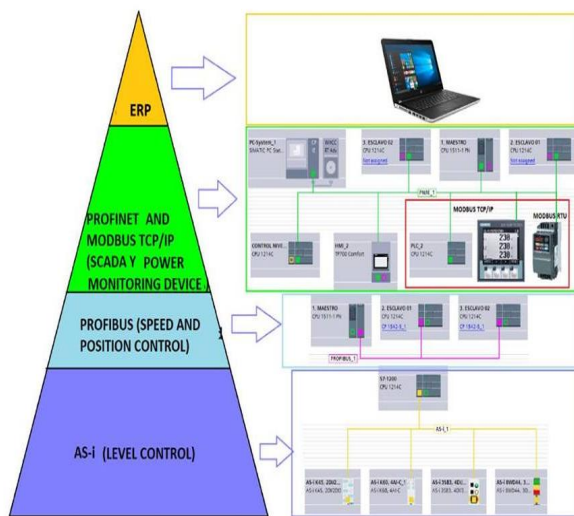


Fig. 3. Diagram of the system distributed.

The Modbus network flow diagram, TCP/IP, allows connectivity and configuration of the energy quantifier, fig. 4.

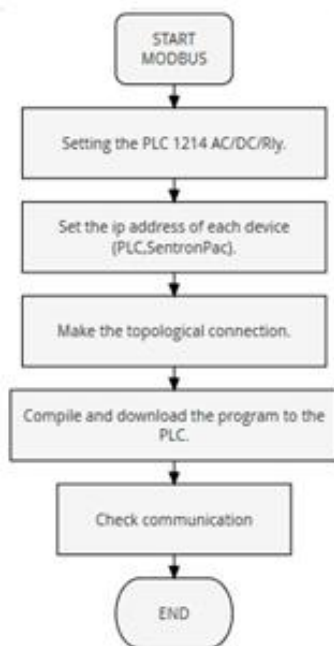


Fig. 4. Modbus network flow diagram.

El diagrama de flujo conexión Profinet-Profibus DP permite la conectividad y configuración del SCADA, con el HMI así como el control de posición y velocidad de sistemas hidráulicos, fig. 5.

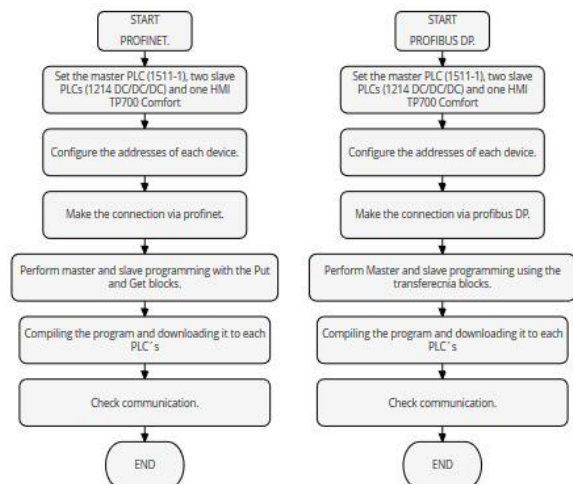


Fig. 5. Profibus DP and Profinet network flow diagram.

The AS-i network flow diagram fig. 6 enables connectivity and configuration of the liquid level process PID control.

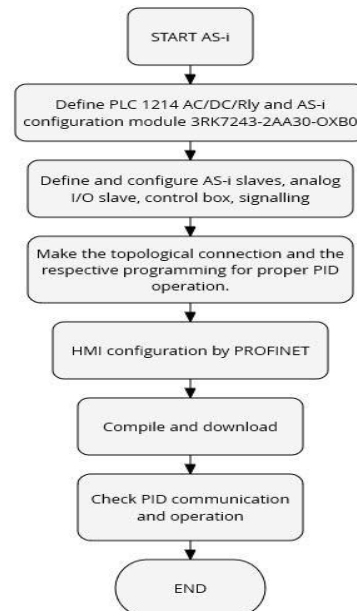


Fig. 6. ASi network flow diagram.

IV. TEST AND ANALYSIS

PROFINET: Interconnects the WinCC_Advanced SCADA system, the HM TP700 display, the Profibus network master, the level control process controller (AS-i, for I/O) and the controller in Modbus TCP/IP that links the SENTRON PAC 3200 energy meter, using the Put - Get communication functions.

Data logging bases, PID tuning and electrical variables of the energy meter are displayed and monitored on the Scada as well as on the HMI display.

MODBUS TCP/IP: used in the level control process, with an energy meter and a PLC, the communication function

used is MB Server and MB Client for the Sentron PAC, and for reading and writing in MODBUS RTU for the Holding Register of the Delta variable speed drive.

PROFIBUS DP: allows the communication of distributed hydraulic proportional control systems, both position and velocity, using three controllers a master and slaves; for serial communication between the control devices transfer areas were used.

The design of the screens of the Scada system were generated according to the corresponding communication protocols, fig. 7.



Fig. 7. SCADA Main Screen.

The PID control tuning of the level process was generated in the Profinet network (Asi- for I/O), fig. 8a and the composite control database, fig. 8b.

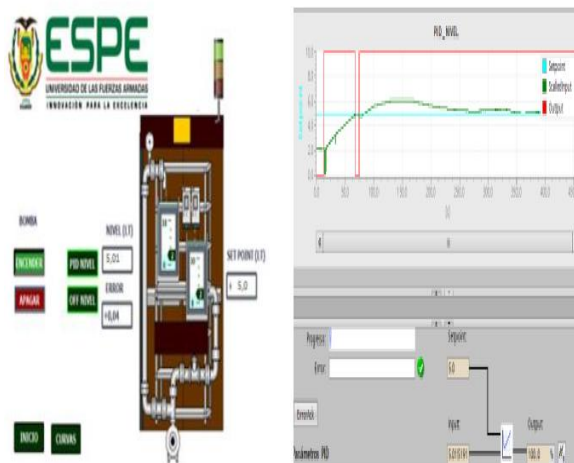


Fig. 8a. PID level control tuning

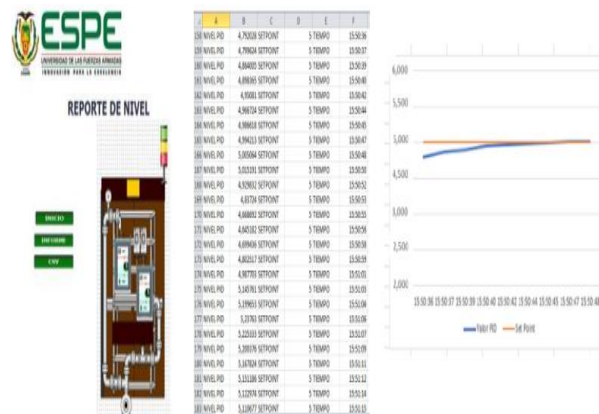


Fig. 8b. PID control data logging level.

El HMI para el control hidráulico proporcional de posición fig. 9a y de presión fig. 9b, se interconecta con los registros de memoria de la red Profibus DP.



Fig. 9a. Position control.

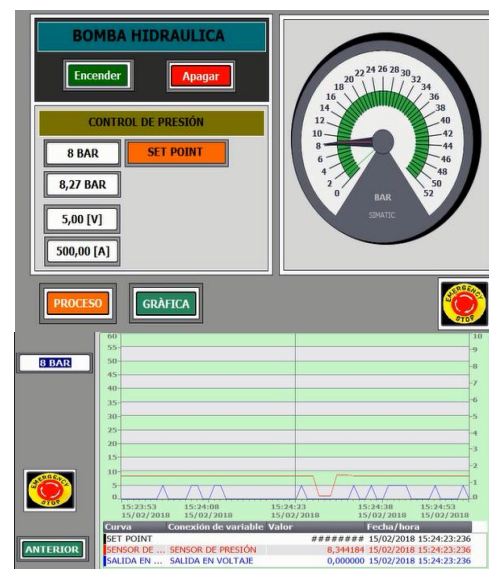


Fig. 9b. Pressure control

Data reading from the Sentron PAC 3200 Power Meter is displayed on both the meter and the SCADA system, fig. 10.



Fig. 10. Energy monitoring.

V. RESULTS AND DISCUSSIONS

The SCADA system provides information on the monitoring and control of each process implemented in each segment or level of the automation pyramid in real time, as well as reports and databases generated from physical variables based on time, better availability of information, diagnosis and remote decision making.

The centralized control of the distributed processes in the WinCC RT and in the HMI screen, allows the management, operation and maintenance personnel to have a permanent control of the SCADA system. The different industrial communication networks implemented, the controllers and I/O field devices, and thus coordinate the activities of production, maintenance, for programmers acquisition of equipment and spare parts to ensure optimal functionality of the company.

Centralizing the industrial processes distributed in the different areas of an industry, by means of a Scada system, guarantees the permanent and real-time monitoring of all physical variables, as well as validating that at field level, in the data networks involved in I/O (RTU - ASi) data volumes are small and the speed of instantaneous response; At cell level the PLC's - HMI (Profibus - Profinet - Modbus TCP/IP) the volume of data is medium and its response speed is high; whereas at plant level (Scada) the volumes of data are large and the response speed decreases; establishing that an industrial data communication system is more demanding the closer we are to the process.

VI. CONCLUSIONS

A SCADA of distributed systems was implemented using Modbus, TCP/IP - RTU, Profinet, Profibus DP, AS-i communication protocols, allowing monitoring, control and generation of reports, reports and databases.

By integrating protocols, it is possible to reduce costs, optimize work times and increase productivity rates.

Satisfactory interaction of the different levels of the automation pyramid: field level, control level and supervision; in modern industries depend on communication ranging from control rooms to field instruments.

With the communication protocol PROFINET and MODBUS TCP it allows the integration between the Scada system, HMI and controllers configured in ETHERNET INDUSTRIAL in a very satisfactory way.

The control of the distributed processes of proportional hydraulics were configured in a serial way using profibus DP, passivate disturbances of the environment, due to the noise of the pumps and temperature variations of the system.

For the configuration of I/O field devices, it will read and output from the Holding Register, using Modbus RTU and ASi, ensuring the movement of information from the field to the SCADA system in a reliable and secure manner.

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