IMPLEMENTATION OF AN INTELLIGENT DISTRIBUTED SYSTEM FOR INDUSTRIAL CONTROL

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Extended Abstract

In recent years in the field of industrial automation process has been revolutionised in the aspects of system architecture. Traditional methods propose solutions based on parallel signal channels (buses) which in most of the cases create significant limitations. For example, the extensive installations with point-to-point cabling between clusters of sensors/actuators have been replaced by a multi-point industrial network, resulting in reduced development costs and delays.

The increasing level of automation in process technology has made mandatory the transfer of computing power from the process control computer to the field or to the sensor-actuator-devices by providing more and more intelligence to the local devices. This philosophy leads to compact or integrated powerful microcontrollers that handle one or a few sensor/actuator devices. These controller are capable to perform complex local functions and support, at the same time, the network requirements.

These considerations show the growing need of using in the lowest CIM level of automation a field bus and intelligent controllers interconnected via a physically distributed domain. There are several requirements that ought to be taken into account in the design of an industrial controller and its related network. These are:

- high reliability
- low cabling and interconnection costs
- processing functions of field devices
- high flow of information
- real-time responses
- data coherence and consistency

According to these requirements a new design philosophy for industrial controllers is being promoted that provides both computing and communication power in the form of a single device solution.

This paper describes the design and implementation of an industrial controller and an industrial network. The specific application comprises both of these basic elements and was developed in compliance with the requirements proposed above. Special care has been taken in order to accomplish the sufficient and reliable exchange of data, in concatenation with the power of a microprocessor executing local preprocessings consisting of individual function blocks (tasks).

For this reason, the CPU which has been chosen to implement the basic part of the industrial controller is the powerful 8344 Intel Microcontroller. Its unique feature of being capable to carry out the user's tasks simultaneously with the data exchange by means of a network interconnection, renders this chip a quite adequate choice.

The basic features of a 8344 CPU are the coexistence on a single chip of the well-known 8051 microcontroller with a serial interface unit (SIU) providing network facilities according to IBM SDLC standard. Having implemented OSI-RM's first two layer (physical and data link) in silicon (8344), the application programmer is relieved from almost all the communication requirements, thus making it possible to perform more complex tasks related with the network management and industrial process.

For the optimal usage of the computing capabilities of the chip, a real time operating environment has been adopted. The iDCX operating environment, with a number of modifications, provides special features which make the industrial controller to look more like a powerful micro system than a single microcontroller. The iDCX provides all of the supervisory services needed for real-time control systems, that involve multiple control functions. These services facilitate the implementation of real-time local applications.

Furthermore, using the services of the Serial Interface Unit, we can have the networking facilities of the BITBUS interconnection. The BITBUS interconnect has been designed for all cases where a high speed transfer of short control messages in a hierarchically industrial system is required. It provides an easy to use, high performance serial interconnect that is transparent to the application programmer. It supports a group of commands, in the form of short messages, that can manage remotely the whole network in a sufficient way. Services like up/down load code are included, providing dynamic modifications to the applications running locally in the controllers. New tasks can easily be created as well as be deleted and blocks of memory can be transferred very rapidly.

In addition, a flexible software has been developed to support locally in an optimal way the controlling process. Analog and digital function blocks have been designed covering a great variety of signal preprocessing cases. All of these function blocks work in a programmable way, with the user passing actual parameters individually each time an application is created. They also enable the controller to carry out self tests and diagnostic functions and schedule the sampling process.

Finally, to meet the need of monitoring and controlling all of the available signals, special printed circuit boards were developed to interface the CPU with the industrial plant devices. These cards include simple industrial standard, 8 digital/8 analog I/O , LCD drivers, special purpose fiber optic serial interfaces and wireless IR interconnections.

The presented system has been implemented and it is currently being installed in several collaborating Greek industries for long period testing.