Title: “Embedded Linux remote management platform based upon AVR32 architectures”

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Institutions: San Jorge University[[1]](#footnote-0), MACRAUT Ingenieros[[2]](#footnote-1).

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1. Introduction

This project was presented as Final Study Project in order to obtain the Degree in Computer Engineering, from San Jorge University. The project was developed in close cooperation with the Research and Development department from MACRAUT Ingenieros.

MACRAUT Ingenieros is a Spanish company focused on Industrial Processes Remote Supervision and Management. MACRAUT solutions are based upon hardware and software developed by the company, and aimed towards generic and multiple purpose solutions, resulting on products suitable to be applied in a wide variety of scenarios and industrial environments. Some of these scenarios are: meteorological stations, ship alarm control equipment, automation networks for irrigation process, and wind turbine control, among others.

The equipments used by MACRAUT are commercialized under the name PE-COM system (Power Electronics Communication). One key product on the PE-COM system is the *linx* data concentrator, which incorporates a microprocessor Beck IPC12. This microprocessor is no longer available in the market, so a system redesign is required in order to continue manufacturing the *linx* device. The chosen microprocessor for the new *linx* is the AVR32 from the Norwegian manufacturer Atmel, that offers high throughput and low consumption.

In this project I developed a data concentrator conceived as a *linx* replacement, based on the AVR32 and with direct application on distributed automation networks, designed, deployed, and exploited by MACRAUT Ingenieros. As radical changes on the software architecture I have introduced the application of an open source operative system and the software development under the multitasking paradigm. During product development, special consideration was given to the utilisation of the embedded system communication interfaces from the Linux operative system, which was controlling the device. The implementation of the required communication protocols and the concurrency control algorithm on the data access process were of extreme importance as well.

1. Main Objectives

The main objective of the project was the design and development of a data concentrator, a device in charge of the update and maintenance process of a certain set of values relevant and connected with the automation process, known as *memory maps*.

The memory maps are snapshots of stored values at the main memory of the distributed control equipment, deployed at different automation nodes that belong to the same network in which the data concentrator is working.

The data concentrator is responsible for collecting the memory maps through different communication interfaces, in order to make them accessible to the automation process supervisor or the different stakeholders involved on each scenario, using a wide-band TCP/IP based network. The automation administrator will be able of programming actions (managing and modifying the memory map values) and consult the state of the automation process thanks to the real-time monitoring system capabilities.

1. Methodology

In order to get a stable and solid platform, and at the same time an environment that simplifies development and software maintenance, the Linux operative system was chosen as a base for the communication and automation application development. The deployed Linux operative system upon an AVR32 microprocessor has been compiled and optimized to improve its performance and minimize its memory footprint, as well as minimizing error sources. Some other issues were considered while compiling the operative system, such as the required drivers and modules in order to support the hardware.

The concurrency control access to the memory maps snapshots manage by the data concentrator was one of the key points on the system development. Due to the multitasking nature of the Linux operative system, and because the communication routines that update the memory maps have been designed exploiting this approach, the access to a single resource by several processes must be carefully regulated. This has been controlled by a specific library developed for the data concentrator, based upon IPC V semaphores and mandatory for each application working with shared resources.

The data concentrator uses a serial bus to communicate with a UHF radio modem, that allows the establishment of a point-to-point link with several automation nodes. The communication is controlled through the MODBUS protocol, that has been implemented to allow the data concentrator to act as a master node, so the data concentrator is able to control multiple slave stations. In this way the distributed control architecture is taking its greatest advantage.

The device can communicate with Input/Output cards placed on the same frame, using the I2C bus and a custom protocol. To access the I2C bus it has been created specific user-space applications that communicate with the kernel-space modules and interfaces given by Atmel, the AVR32 microprocessor manufacturer.

The automation network supervisor can access the data concentrator from any location with Internet connection, being able to recover all the memory maps of the automation nodes at real-time. This is possible due to the development of a socket server that implements the nexus protocol, a proprietary and adapted MODBUS TCP implementation by MACRAUT, that supports operations not considered by the standard.

All development has been carried out using standard C programming language and generic Linux system calls, reaching a high level of portability on the final product.

1. Results

As a result of this project, a stable and fully functional system has been obtained, able to establish a successful communication with the PE-COM devices and with any automata or electronic device with MODBUS communication capabilities.

Thanks to this development, MACRAUT Ingenieros is going to save software licences cost and to take advantage of the wide range of possibilities offered by a Linux based operative system in a distributed environment.

As secondary results, UML diagrams, documentation and logs of all the stages and process carried out while the development process have been generated.

I am currently improving this system at MACRAUT Ingenieros, expanding the product with new functionalities and features. It is scheduled to release a prototype on December 2009, based upon the software architecture and OS setup developed in this Final Study Project.

1. San Jorge University Official Webpage: www.usj.es [↑](#footnote-ref-0)
2. MACRAUT Ingenieros Official Webpage: www.macraut.com [↑](#footnote-ref-1)