INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE CENTRATOM TRIESTE

The United Nations University

SMR/774 - 6

THIRD COLLEGE ON MICROPROCESSOR-BASED REAL-TIME CONTROL - PRINCIPLES AND APPLICATIONS IN PHYSICS
26 September - 21 October 1994

COURSE OVERVIEW

Catharinus VERKERK
Computing and Networks Division
CERN
CH-1211 Geneva
Switzerland

College on "**Microprocessor-based real-time control**" is a follow-up of the basic microprocessor course.

It is aimed at teaching the participants how to design a system to control instruments or an experiment, making use of advanced techniques.

We will therefore teach to build a *real-time control system on top of a suitable, existing operating system* and to use - as far as possible - a *high-level language.*

This means that we will teach *how to integrate specialized peripherals* into a control or data acquisition system.

We will **not** treat hardware interface design as such, or the programming of the hardware functions. We will avoid spending time on "bit flipping" in a controller chip. This is in general the easier part of the job, once the *controller (chip) is well understood.*

We will also show how to build a friendly **graphical user interface (gui).**

To write programs, you will use the programming language C. Teaching C will therefore also be an important ingredient of the course.

In many instances during the course and during the exercises we will take basic things for granted. We will adopt a **high-level view**, in which nitty-gritty **details are hidden**.

We will try to teach how to make your special device look as a normal peripheral, supported by the operating system. The applications programmer then does not need to know about the details and *he can concentrate on the essentials of the application.*

The real-time aspect will receive all necessary attention during the course.

The College will be structured with lectures in the mornings and laboratory work in the afternoons (and evenings if you wish).

We considered to use for the course a commercial real-time operating system.

This would have been very expensive (of the order of 2000 US$ per machine). We felt that we could not recommend the use of expensive solutions, if they can be avoided.

We therefore chose to use **Linux**, for a number of reasons:

- it runs on 386 or 486 based PCs with a reasonable configuration,
- it is a **full-fledged UNIX clone**,
- it is available from many sources for **free**, or at the cost of a CD-ROM disk.
- it aims at **Posix compatibility**, which ensures **portability** of programs.

The present releases of Linux lack a few of the characteristics expected from a true real-time operating system, as needed for **time-critical** applications.

But, with some precautions, it can very well be used for applications which are not really **time-critical** and which do not need very short response times.

Linux, as you will see, will give you a **cheap entry into the world of UNIX**, with all its advantages:

- a widely **adapted standard** operating system,
- a modern **computing environment**, with the **X11 window system** and with **networking**, opening the door to **distributed computing**.

However, for those of you who don't have access to a 386 or 486 based machine, we will show what you can do with MS-DOS.

During the first two weeks we will essentially lay the basis of the knowledge required for the last two weeks.

Thus the following lectures have been scheduled for the first two weeks:

A. Nobile	C programming	8 hrs
C. Verkerk	Practical Linux	4 hrs
P. Bartholdi	Software Design	7 hrs
C. Verkerk	Real-time operating systems	6 hrs
Chu Ang	Cross-development	5 hrs
R. Karnad	ICTP-Colombo board	1 hr

For the last two weeks the following lectures are scheduled:

U. Raich	Linux device drivers	3 hrs
U. Raich	X11 programming	5 hrs
A. Induruwa	Networks	4 hrs
J. Wetherilt	MS-DOS based systems	4 hrs
F. Soso	LabView	3 hrs
D. Bulfone	Control system of Elettra	3 hrs
R. Karnad	case study	1 hr

Practical exercises will start on the second day. In the laboratory you will:

- get accustomed to working with Linux,
- write small programs in C and execute them. This will make you acquainted with the basics of C.
- write programs to make use of a special "peripheral": the ICTP-Colombo board. This will be an occasion to learn more of C and how to interface to the operating system.

Due to some problems, the exercises for the first week will take place in the "*blue room*" in the Main Building, with a limited number of PCs.

We will therefore work in two groups:

- 14-16 h Group A: names beginning with A -
- 16-18 h Group B: names beginning with - Z

In the laboratory you will be assisted by:

I. Ahmed,
Chu Ang,
X. Carelse,
A. Chantchane,
M. Goncalves,
A. Induruwa,
A. Kane,
R. Karnad,
C. Kavka,
M. Trujillo,
J. Wetherilt,
Wu Geng Feng.