EICASLAB™

Automatic Control Design of the Amazing Ball with the EICASLAB suite

Webinar n.3

Rapid Control Prototyping - Fundamentals -

Welcome to Innovation

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Rapid Control Prototyping

- State of art
- EICASLAB innovative approach
- Rapid Control Prototyping (RCP) in EICASLAB
  - Scheduling, cores & threads
  - RCP on field
  - Slow Motion
  - SIM RCP
  - EICASLAB tools to support RCP

EICAS Automazione S.p.A.
excellence and passion in automatic control design
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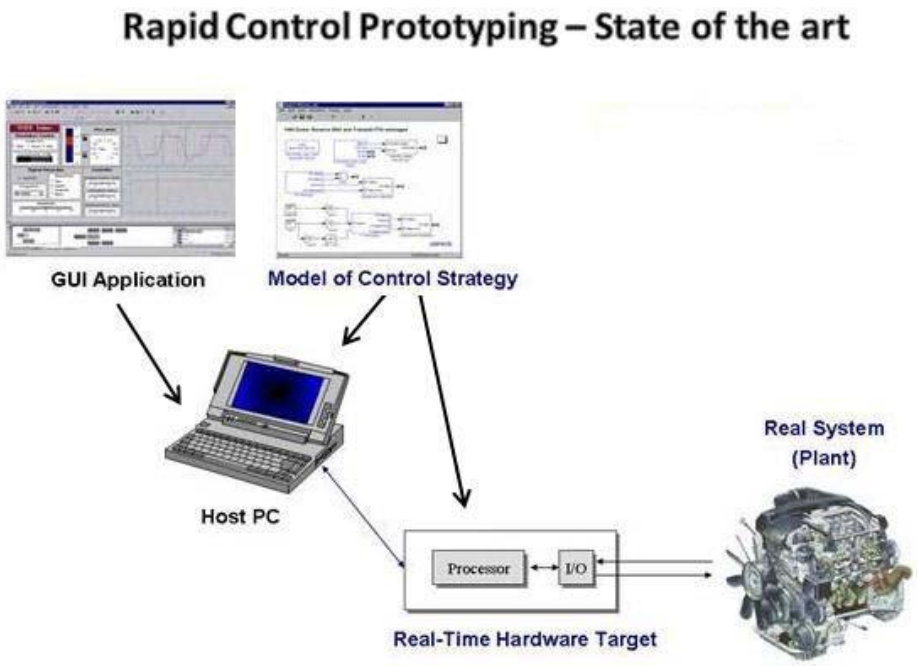
Rapid Control Prototyping: state of art

The **Rapid Control Prototyping (RCP)** is a process which lets the engineer quickly test and iterate its control strategies on a **real-time** computer with real **input/output devices**:

- the **plant** under control is **real**,
- the **control** strategy is downloaded and then executed in real-time in a specific and separated *Real-Time Hardware Box* that can be commanded through a non real-time host computer and that has limited capabilities to record data for tuning and debugging purposes.



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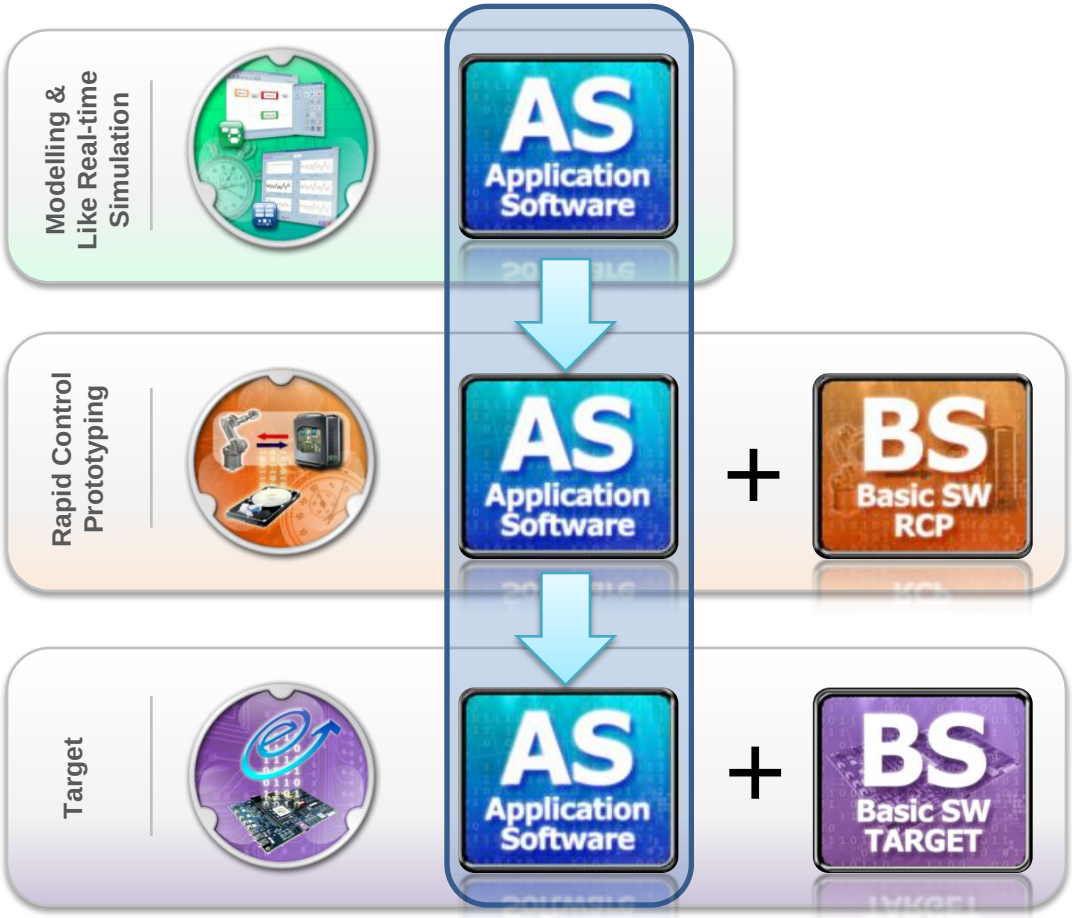
EICASLAB innovative approach

The approach is based on the idea that **by using**

- **a single IDE (the EICASLAB suite)** and
- **a standard PC (the EICASLAB RCP Platform)**

it is possible to gather all the control design activities (from system concept to final code generation of code for the final target and the validation test campaign).



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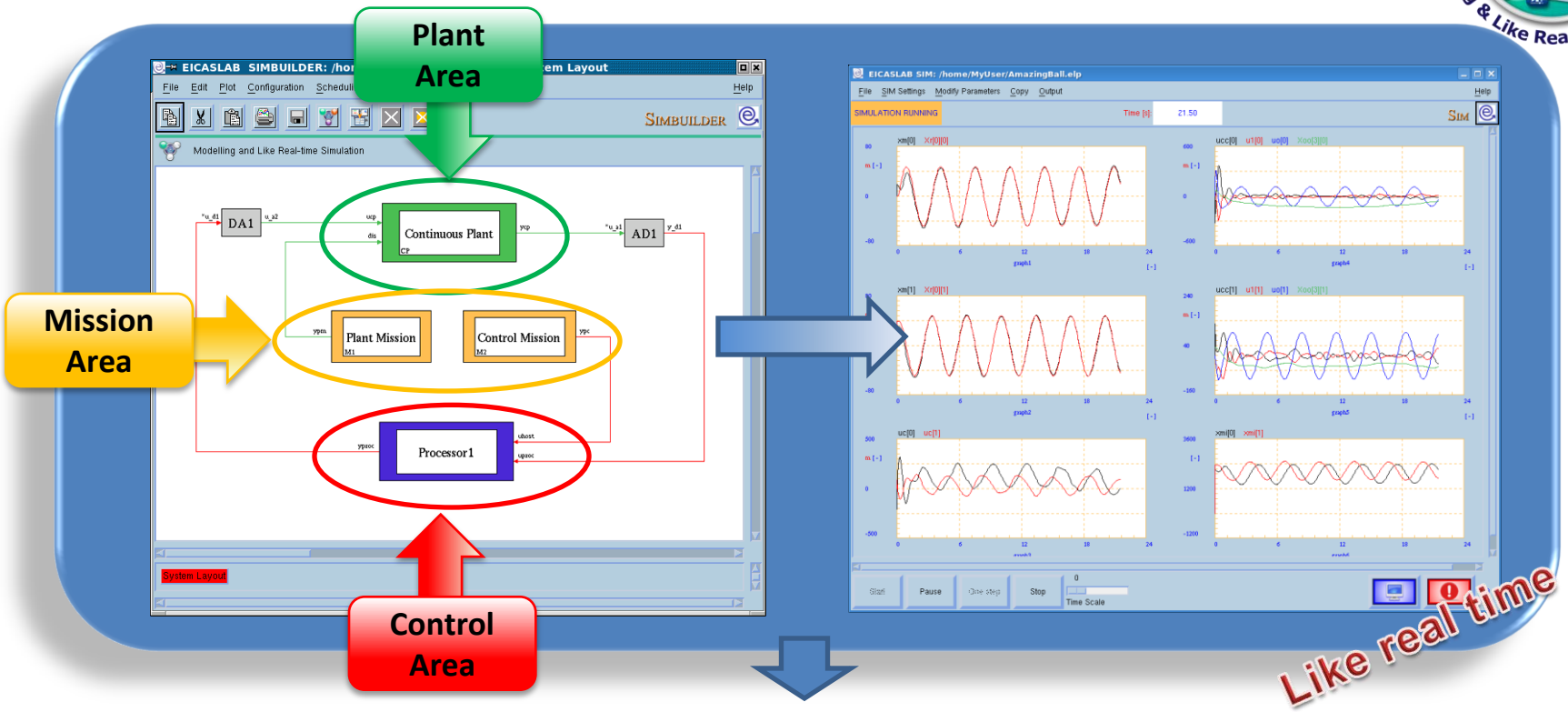
Modelling and Like Real-time Simulation



EICASLAB RCP Platform

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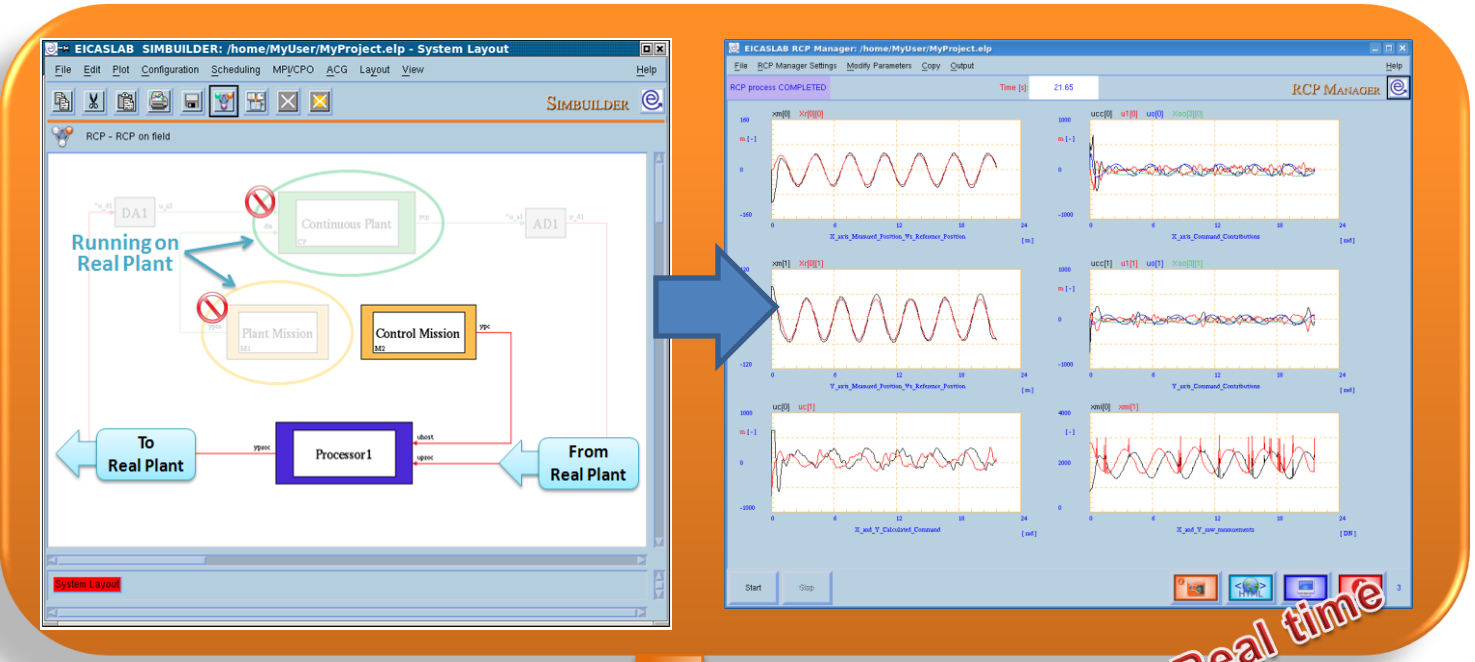
Rapid Control Prototyping



Real time

EICASLAB RCP Platform

RTAI

I/O Interfaces

Linux RT

Real Plant

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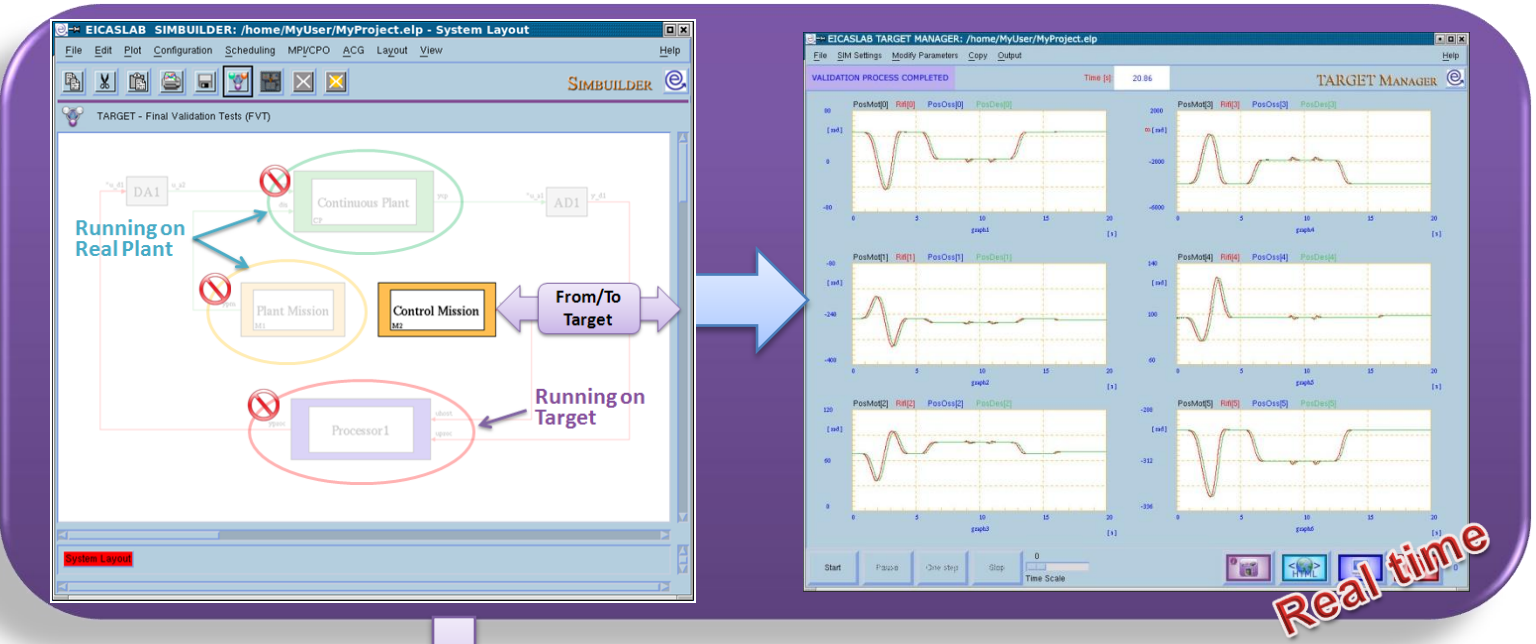
Target – On field validation tests



EICASLAB RCP Platform

RTAI

I/O Interfaces

Linux RT

Host & Supervisor, Data monitoring & recording

Target

Real plant

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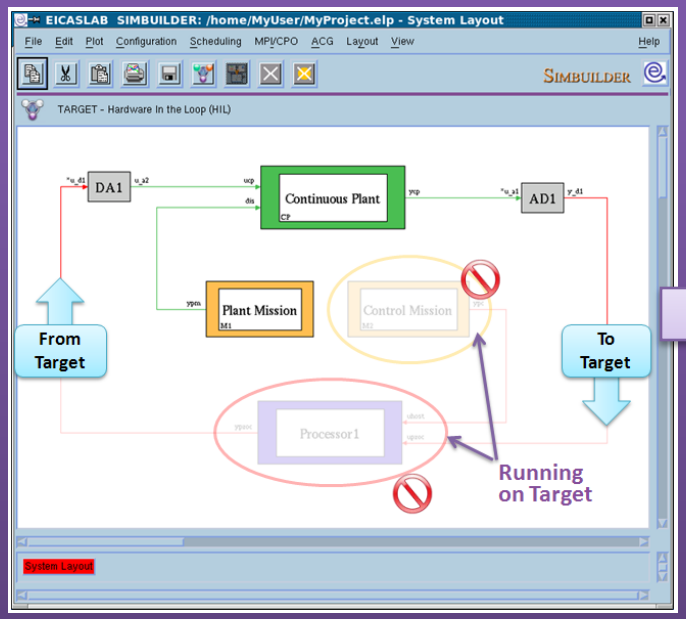
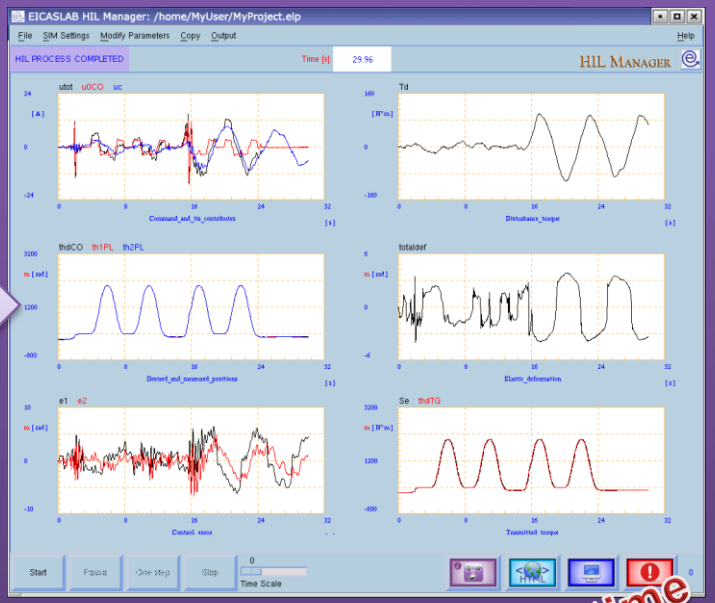
Target – Hardware in the Loop





Real time

EICASLAB RCP Platform

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Target

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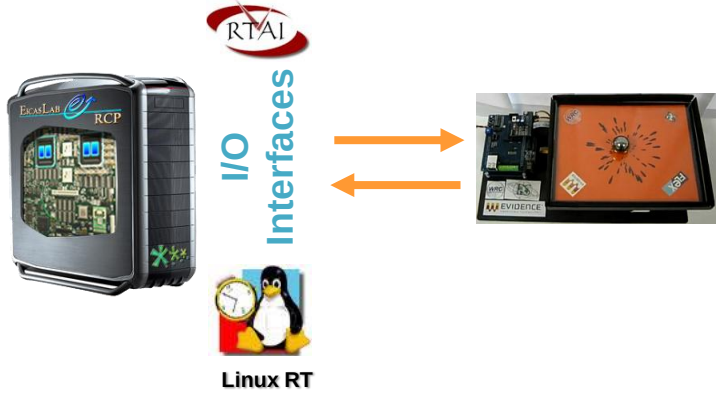
EICASLAB innovative approach on RCP

The **innovative concept proposed by EICASLAB** is to carry on the *Rapid Control Prototyping* using the **EICASLAB RCP Platform** composed by:

- a **standard low-cost PC** (that can be the **same** used in the *Modelling and Like Real-time Simulation* phase), equipped with:
  - A Real-Time Operating System (**RTOS**),
  - The **EICASLAB software suite**,
  - **real input/output devices** that allow to connect the PC to real Plant.



The software code is executed **in real-time** in the EICASLAB RCP Platform, composed by:

- the **same AS**, generated and preliminary tested in “like real-time” in the *Modelling and Like Real-time simulation* operative mode,
- the **BS**, automatically generated by EICASLAB, able to schedule the activities and to manage the HW I/O interfaces respecting the constraints easily fixed by the user in EICASLAB.

Main Advantages of EICASLAB RCP

Working with a **standard PC** implies:

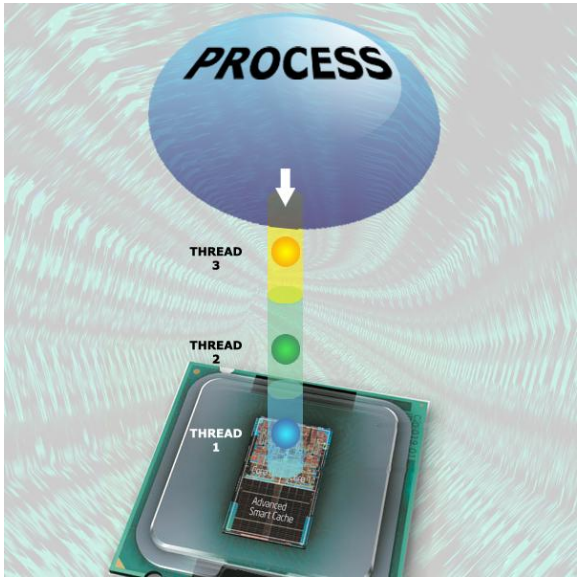
- **low cost equipment**,
- **Multi-core** and **multi-thread** capabilities, giving the possibility to emulate, in a standard PC, a network of Processors,
- easy switching from Modelling and Like Real-time Simulation Operative Mode to RCP and vice versa,
- **reading and recording on the PC hard disk** all the data of interest, during the experimental trial execution, for advanced tuning and debugging purposes. Two types of data recording are available:
  - variable recording for offline analysis through the **POST** tool,
  - advanced **Slow Motion** recording function that allows, by means of the **Slow Motion** tool, the offline repetition of experimental trials executed on field.

Having exactly the **same AS** running in all the Operative Modes makes debugging and tuning easier and safer.

The platform can be used also in target mode.

Multi-core & multi-thread applications

A **multi-core processor** is a processing system composed by two or more independent cores.
In a multi-core processor each core can run a portion of code so that a real concurrent execution is achieved.



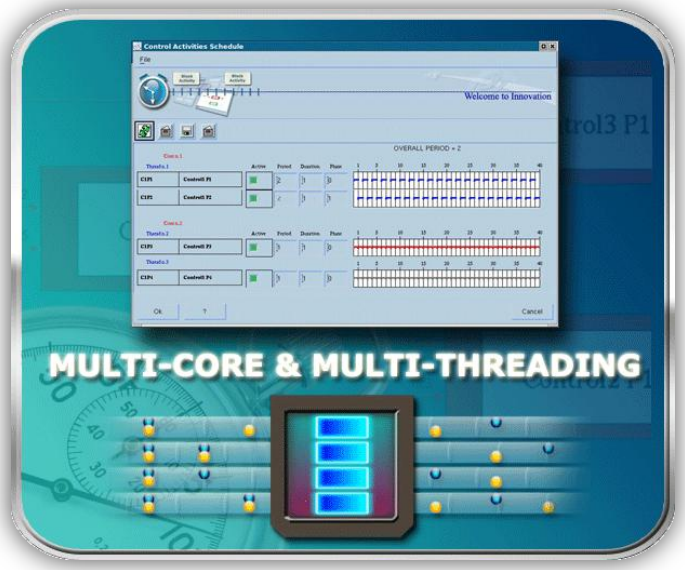
A **thread** is a unit of executable code. In a thread-based multitasking environment all processes have at least one thread of execution, which is called the main thread. Each multithreaded process starts with the main thread that creates one or more additional child threads.

Multithreading changes the fundamental architecture of a program. Unlike a single-threaded program that executes in a strictly linear way, a multithreaded program executes portions of itself concurrently. Then a single program can perform two or more tasks concurrently. The true concurrent execution is possible only in a multiple-CPU or multi-core CPU systems.

Scheduling, cores & threads

The Control system works directly with the real Plant, then just the Control Area must be scheduled.

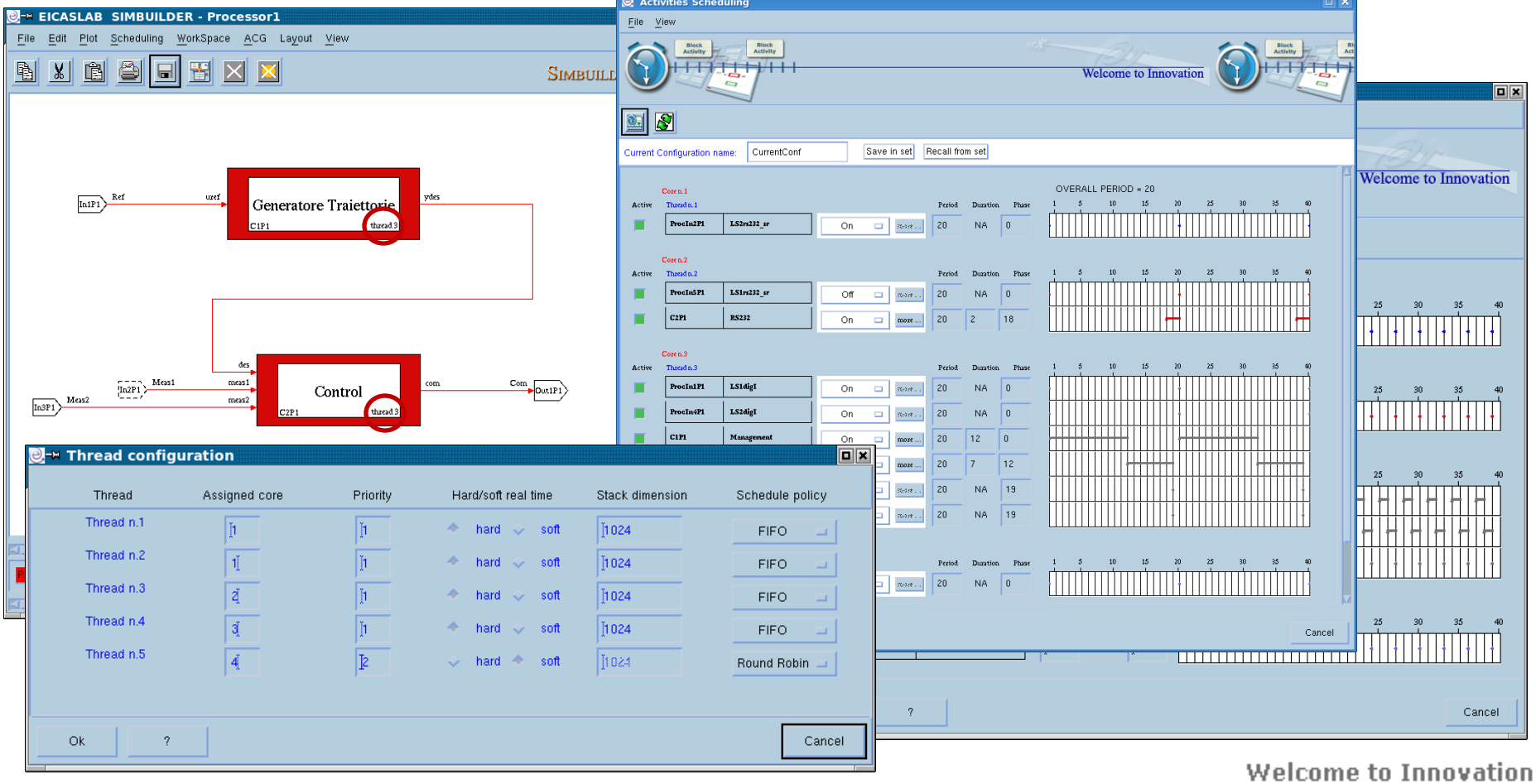
The scheduling requires to organize the control functions in **threads**, that will be distributed on the **cores** of the multi-core CPU available in the PC platform, thanks to the application in EICASLAB of multi-threading and multi-core programming techniques.



You define for each control function the scheduling constraints (period and phase).

Such a scheduling allows testing the control system on the real plant and emulating the hardware architecture of the final target, by using only one multi-core PC platform.

Scheduling assignment



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RCP sub-modes in EICASLAB

According to the EICASLAB innovative approach the RCP activity is carried out through three steps:

- **RCP on field** that manages the overall experimental trial executions;

- **Slow Motion** that allows, by means of the Slow Motion tool, the offline repetition of experimental trials executed on field for advanced debugging and tuning purposes;

- **SIM RCP** that allows a very easy switching from real-time to the simulation environment in order to perform further analysis with the same control algorithms and configuration experimented on field.

RCP on field

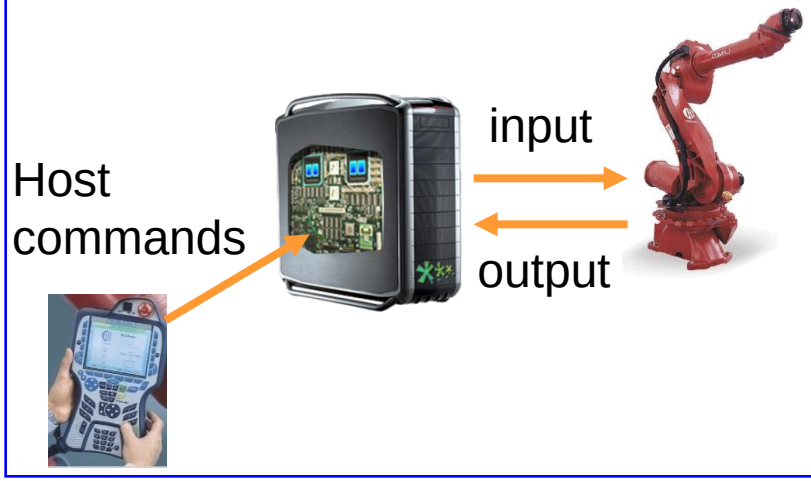
Starting from the control system architecture designed in EICASLAB and through a Real-time Scheduler and multi-threading and multi-core programming techniques, EICASLAB generates the real-time software code, running on the PC Platform, able to:

- configure and manage the PC platform interfaces,
- configure the control activities real-time scheduling,
- execute in real-time the RCP trial by piloting the plant through a specific professional tool – the **RCP Manager** – including an easy and friendly GUI and offering capabilities for:
  - controlling and managing the RCP process in real-time,
  - enabling diagnostic reports,
  - variable real-time monitoring,
  - variable recording on the PC disk,
  - commanding and modifying parameters during the real-time execution.

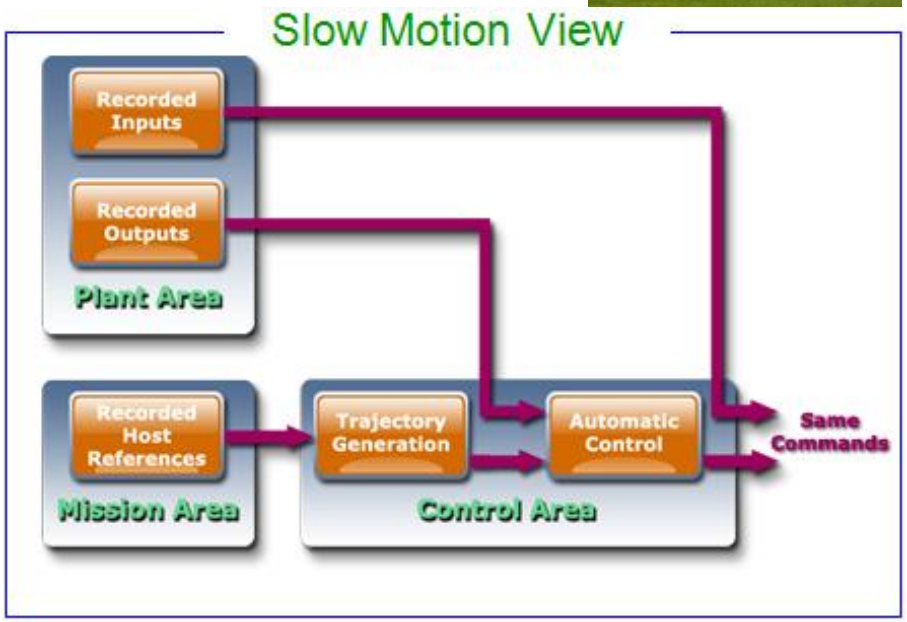
Slow Motion

During the RCP trial executions you can record all the Plant I/O

RCP on field



Slow Motion allows, by means of the **Slow Motion tool**, the offline repetition of experimental trials executed on field for advanced debugging and tuning purposes.

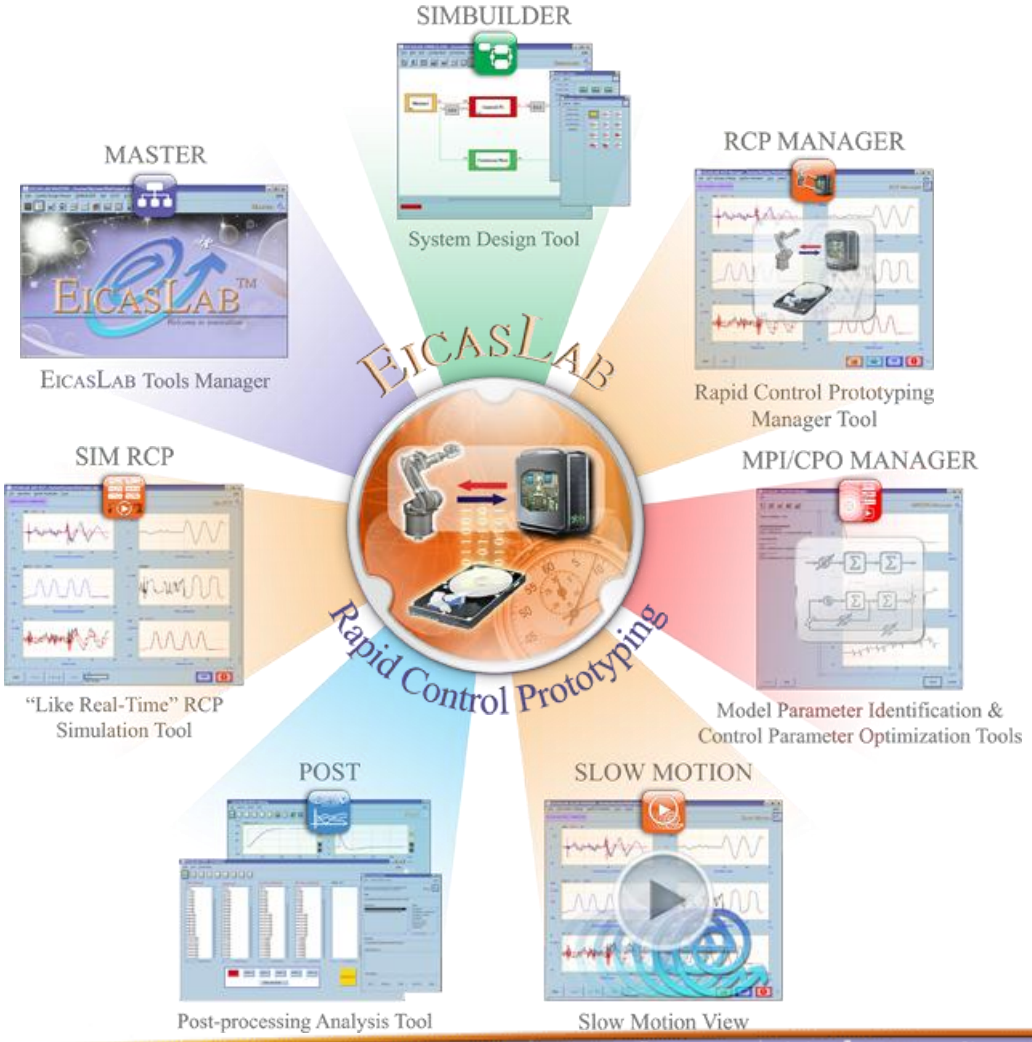


SIM RCP

The **SIM RCP** sub-mode allows to easily switch from RCP on field to the simulation environment in order to perform further analysis with exactly the same control algorithms and the same control configuration experimented on field.

The user can then easily switch from the SIM RCP to the RCP on field in order to carry out the RCP trial on the improved control algorithms.

EICASLAB tools to support the operative mode



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