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Computing Systems

# Demo

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## **Multicore emulation-in-the-loop in the Khronosim project**

**Luis Miguel Pinho**

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## Abstract

# Multicore emulation-in-the-loop in the **Khronosim** project

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# Outline

- Context
- The **KhronoSim** project
- Distributed testing framework
- Supporting emulation-in-the-loop
- Conclusions

# Context

- Complex systems and systems of systems are an integrated set of components and sub-systems
  - Tightly interacting together to achieve a specific goal
- Guaranteeing that individual sub-systems behave according to their specifications is a (relatively) “simple” task
  - The magnitude of the validation is much higher when it comes to provide guarantees on the correct integrated behavior
- All the possible interactions between the sub-systems must be properly tested in order to capture all the system properties.

# Context

- Testing systems in actual environment is overly expensive and/or too slow
  - In particular when considering Cyber Physical Systems
  - Even simple algorithms and software may become extremely complex to test due to the interaction with the environment
- The use of model and platform simulators is growing in importance to address testing of complex systems
  - Nevertheless there is a challenge on how to integrate the different testing components

# Context

- Simulators allow for an increase in the productivity of software development, enabling:
  - Simultaneous development of software and hardware
  - Testing software before actual hardware exists
  - Providing a friendlier environment for software testing, without requiring actual hardware-in-the-loop
- Supporting hardware emulation is key for software testing
  - But requires emulator in the loop of the testing framework
  - Introduces further challenge on how to provide real-time behavior of the integrated system



# KhronoSim

## › KhronoSim

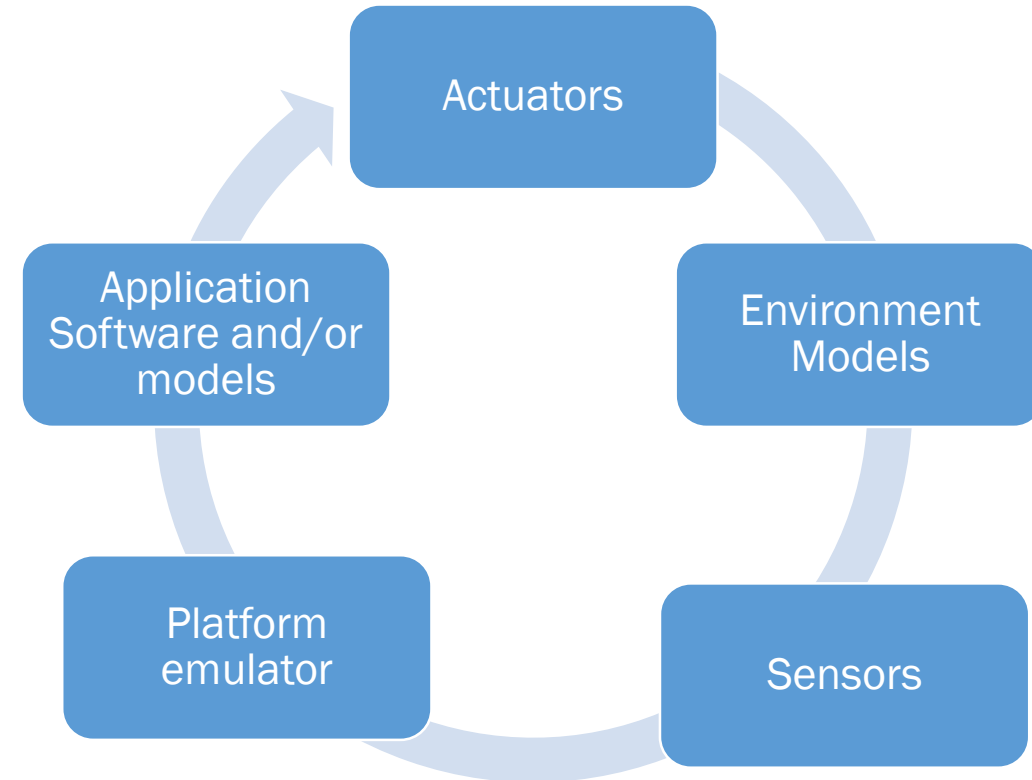
- › A distributed, modular and extensible system for simulation and test of complex systems
- › Enables integration of simulation models, platform emulators and physical systems in a closed-loop test environment
- › Ongoing industrial project, led by Critical Software, including CISTER and UCoimbra





# KhronoSim

- KhronoSim allows to
  - Simulate complex systems in real-time by including either the whole or part of the system under test
    - Including the simulation of the environment and other interacting systems
  - Emulate the hardware platform upon which the system will execute
    - A special concern is in particular multicore embedded platforms

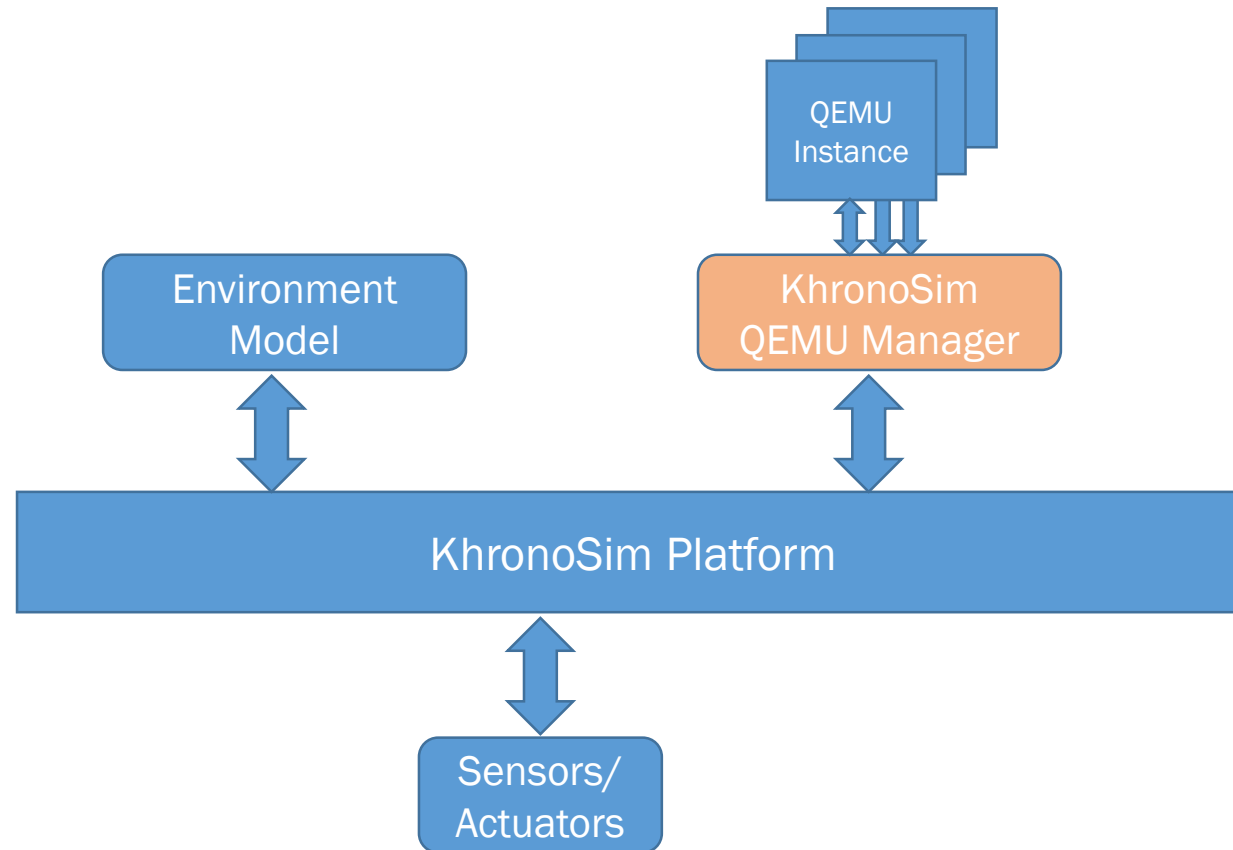


# Multicore emulation-in-the-loop

- Multicore emulation is of paramount importance
  - Testing several configurations of the system and thus providing a better understanding of the design choices
  - Accelerate the certification and the development of components, e.g., real-time operating systems (RTOS), mixed-criticality systems (MCS), etc
  - Provide a further insight into the latest developed methods and techniques to solve multicore challenges

# Emulation-in-the-loop

- Addressed with the integration of QEMU within the KhronoSim platform



# Emulation-in-the-loop

## ➤ QemuManager

- The QEMU Machine Protocol allows interaction with QEMU instances using predefined commands
- KhronoSim provides a QemuManager that natively implements this system and uses TCP sockets to communicate
  - A TCP server exists in each QEMU instance and then sending QMP commands to interact, using JSON format.
- This approach allows for a simpler and suitable way to interact with the QEMU
  - It is also scalable as it is possible to add new commands to the QEMU system

# Emulation-in-the-loop

- QemuManager allows services to
  - Load specific configurations of a platform and/or application
  - Start/stop emulation
  - Suspend/resume the execution of the emulated application
  - Execute and trap commands
  - Control the speed of emulation

# Emulation-in-the-loop

## › Emulation speed control

- › Important feature is the ability to control and align the time base of the emulator with the overall timebase of the other modules
  - › E.g. Matlab model execution
- › The QEMU throttle control is exposed to the QemuManager
  - › A throttle command is then made available to the distributed simulation control

# Conclusions

- KhronoSim tackles the challenge of testing and validating complex Cyber-Physical Systems
  - Using hardware emulation in the testing loop, integrated with models and environment
- The KhronoSim QEMU Manager was developed to enable the integration of hardware emulation in a closed loop in the KhronoSim platform
  - Goal is to test and analyze different configurations of a multicore platform



# Thank You.

## Questions?

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