Demo

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

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CISTER-TR-180112
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Abstract
Multicore emulation-in-the-loop in the **Khronosim** project

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Mixed Criticality Systems Workshop, HiPEAC 2018

23 January 2018
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
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 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

- Environment Model
- QEMU Instance
- KhronoSim QEMU Manager
- KhronoSim Platform
- Sensors/Actuators
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?

This work was funded by the Portuguese National Innovation Agency (ANI) under the ERDF (European Regional Development Fund) through “Portugal 2020” program, within project KHRONOSIM, nº 017611, POCI-01-0247-FEDER-017611