Analyzing the usage of Power Management Techniques and Extra-Functional Properties by using Virtual Prototyping

Virtual Prototype Makani

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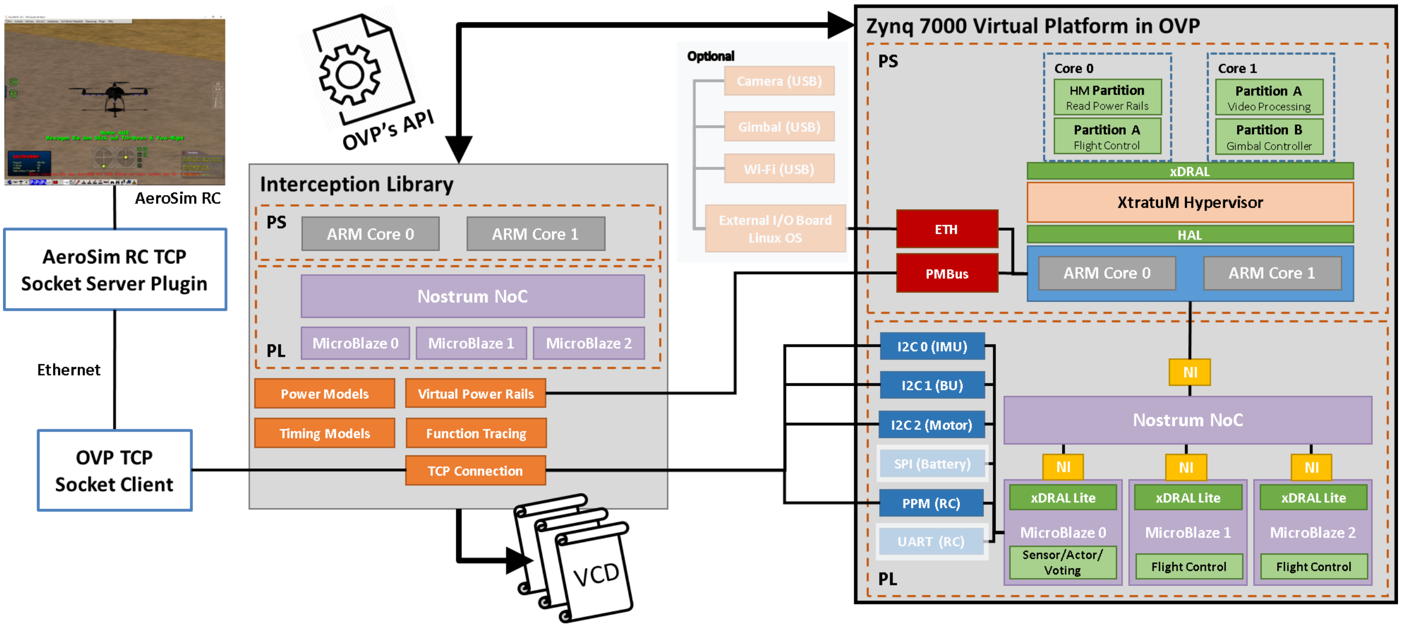

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I. Introduction

This work consists of analyzing the correct usage of power management techniques, as well as the analysis of extra-functional properties, including power and timing properties, in multiprocessor system-on-chips (MPSoC). Especially in safety-critical environments, the power management gets safety-critical too, since it is able to influence the overall system behavior. To demonstrate my developed methodologies I use a mixed-criticality multi-rotor system and its corresponding fully functional virtual prototype.

II. The Demonstrator

A Xilinx Zynq 7000 MPSoC serves the multi-rotor system's avionics. The hardware architecture includes ARM and MicroBlaze cores, a network-on-chip (NoC) to realize the communication between the processing tiles and peripherals to connect to further systems, e.g. motor drivers, inertial measurement and barometric unit. The MPSoC processes two bare-metal applications of different criticality levels:

Safety-critical flight application: This application is distributed and processed on four processing tiles (PT). It is implemented with a triple modular redundancy technique. Three PTs compute all sensor processing and PID controller tasks. The last PT executes the voting as well as sensor data acquisition and control the motor drivers.

Mission-critical (quality of service) video processing application: The second application uses video data of an object detection algorithm. This is done to trigger a camera gimbal to focus the object.

The virtual prototype consists of the corresponding virtual platform (VP) of the physical system paired with an environmental model, which is given by a flight simulator (FS). The ability to run a co-simulation is realized by a TCP socket connection between the VP and the FS.

III. Interception Library

The virtual platform is equipped with an own developed interception library. It implements several features, like the TCP socket client to communicate with the flight simulator or function tracing to characterize the behavior and trace executed functions on the PTs. To acquire and provide data for timing and power models, the processor models of the virtual platform are observed and their states analyzed in specialized modules of the interception library. The timing models are quasi cycle accurate (trade-off: slow-down of simulation / accuracy), the power models are state based and supported by power values of real measurements. All acquired data is committed to a data stream framework. This framework processes the data and writes them to value change dump (VCD) files for further analyzations.

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