Virtual Platforms for Complex Software Stacks

Lukas Jünger and Rainer Leupers, ICE, RWTH Aachen University

Over the past decades hardware/software systems have become more and more complex. Nowadays, it is common for systems to consist of many cores and peripherals. Even small embedded systems run complex software stacks often consisting of millions of lines of code. At a realistic average error rate of one to two errors per hundred lines of code, this adds up to thousands of bugs that can cause critical failures in production systems.

System simulations, usually referred to as Virtual Platforms (VPs), have been paramount in handling this complexity, because they enable deep introspection into the systems behavior even before physical prototypes are available.

The demonstrated VP is depicted in Figure 1. It consists of two ARM Cortex-A72 CPU cores that are connected to the system memory and several peripherals via an ARM AMBA AXI bus model. Both cores are connected to an ARM GIC-400 interrupt controller model. Outside networks can be reached via an Ethernet controller model. The UART model allows for interaction with a text console or other data transfer. In addition, the VP contains a DMA-capable SDHCI for attaching SD memory card models for data storage. The Random Number Generator (RNG) model can be used to accelerate cryptographic operations.

The software stack executed on the VP is depicted in Figure 2. It consists of the Xen hypervisor, which manages the simulated hardware resources, and two Virtual Machines (VMs), both of which run a Linux operating system. The main VM (dom0) has full access to the physical hardware, while the second VM (dom1) uses paravirtualized devices and is more restricted. As a benchmark, a lighttpd web server and a Node.js-based server application are executed on dom1. An AngularJS-based web application is served to a client running on the simulation host, which then interacts with the Node.js application via a REST API. For this communication the Ethernet controller model and Xen’s paravirtualized network devices are used.