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Haute Ecole Spécialisée
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PENAR
Porting XEN on ARM

Project Summary

The PENAR project aimed at porting an hypervisor and guest operating systems tailored to ARM-based embedded systems with the support of hard realtime applications. The general approach consisted to provide high-level applications with two strong isolated execution environments, namely two different running operating systems, on a single microcontroller.

Based on existing experiences in this area and partial available source code, XEN hypervisor, para-virtualized Linux (2.6.18) and para-virtualized Xenomai realtime OS have been ported on ARM architecture ending up with a single multi-kernel binary file which is automatically parsed, relocated in memory and set up at boot time.

The migration strategy has led to integrate all the source code within a native Linux (2.6.18) source code tree in order to reuse the well-known and proof Makefile, KBuild and KConfig mechanisms available in Linux, and to try unifying kernel structures as much as possible. Each critical files used commonly by the hypervisor and guest OSes have been examined in details and adapted by means of conditional compilation according to the ongoing target kernel (three separate build modes have been defined, one for the hypervisor, another for the Linux guest OS, a third for Xenomai). An adequate virtual and physical memory layout has also been elaborated based upon the original layout adopted by XEN.

Performance assessment has been achieved and led to interesting results showing the different IRQ latencies and propagation delay up to the guest OS, with different load scenarios. IRQ latencies vary from 3 to 5 microsecs from a conventional Linux, and propagation to guest OS may require up to 300 microsecs. It has to be noted that the native EDF-based scheduler from XEN hypervisor has not been adapted in this project; however, such adaptations will be performed in the context of new upcoming projects.

Valorisation

Thanks to PENAR, a complete virtualized environment on embedded systems – called EmbeddedXEN – is now available at a prototype stage, including a complete Linux acting as a non-realtime guest operating system which can host any applications (GUI, Web-based applications, communication modules, etc.), and a second hard realtime operating system based upon the original Xenomai Linux extension providing a secured execution environment for critical applications, such as motion control dedicated applications, realtime communication systems, general purpose realtime monitoring, etc. This project has allowed us to start two CTI projects focusing on embedded virtualization, one in the field of multimedia applications, one in the field of motion control. Furthermore, we published our work on Sourceforge (http://sourceforge.net/projects/embeddedxen).

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