vIrtical

SW/HW extensions for virtualized heterogeneous multicore systems

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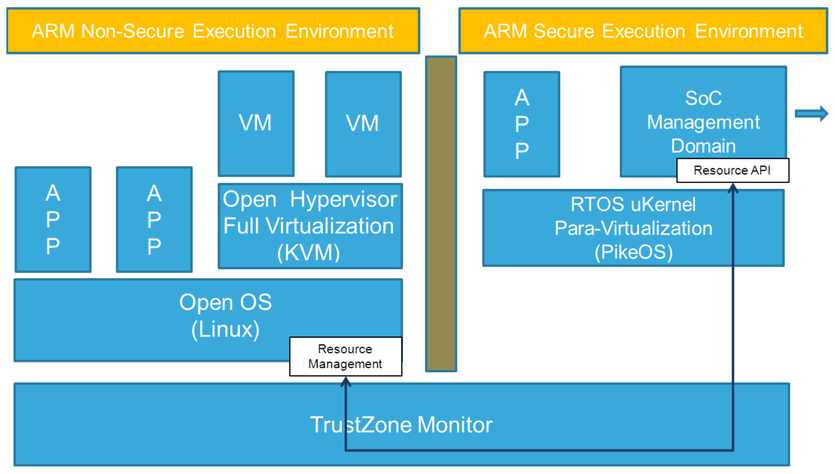
Key Innovation

Embedded devices are pervasive in our everyday live in e.g. cellular phones, set-top boxes and TV sets. Their hardware complexity is increasing exponentially and their flexibility is required to adapt them to a wide variety of applications. Virtualization, widely used in the general-purpose computing domain, allows an effective and clean way to isolate applications from hardware. However, virtualization on embedded systems is still in its infancy.
The vIrtical project will develop the virtualization concept in the embedded domain to manage and take advantage of the wide variety of hardware elements available in SoC multicore platforms, tackling different system layers (hardware, hypervisor, applications).

The vIritcal project will provide a set of hardware and software extensions that will allow improving SoC performance, programmability, QoS, reliability, security, power consumption, etc.

Features

- Heterogeneous virtualization multi-core platform.
- Integration of virtualizable ARM cores A-15 and A-7.
- IOMMU and GPPA powered NoC.
- Openness (total decoupling from hardware to application software), security, programmability and performance of heterogeneous multicore embedded systems.
- Virtualization with KVM & PikeOS hypervisors.



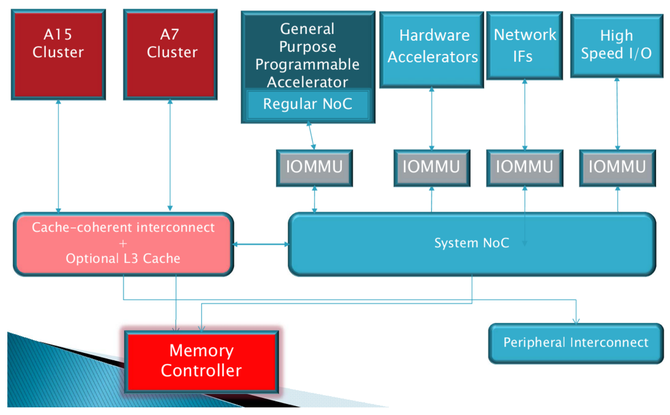
Hypervisor extensions supporting virtualization facilities

vIrtical plans an hypervisor development and extension effort that aims at managing virtualization along with the special requirements of complex embedded systems, e.g., real-time responsiveness, deterministic and diverse hardware and software support.

The Adaptive Hypervisor will support concurrent existence of multiple isolated software operating environments (software domains) in an adaptive manner across both an open platform system and a more fixed-function embedded system. The isolation of these various software domains, when combined with proper real-time and security support, has the potential to dramatically reduce software design complexity and thus associated cost.

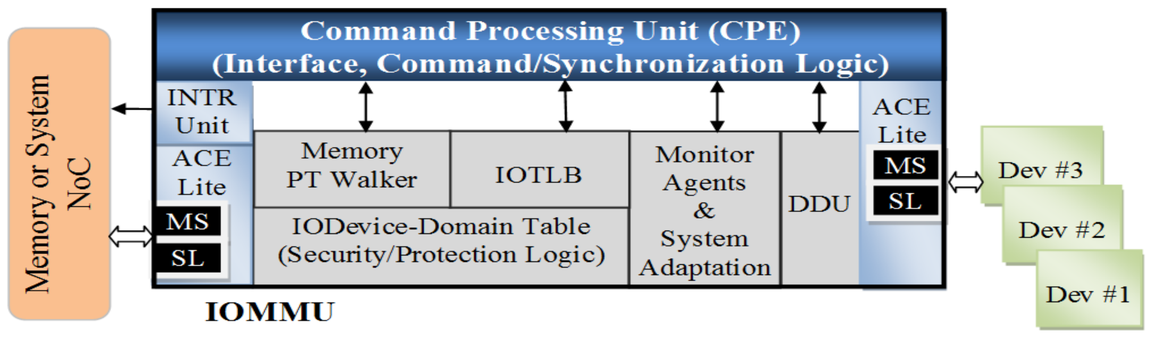
On one hand, PikeOS, adapts the concept of virtualization to the needs of safety-critical systems. On the other hand, the open source linux Kernel-based Virtual Machine (KVM) will be extended to support the ARM architecture to pave the way for its move from enterprise to embedded virtualization.

Virtical Architecture



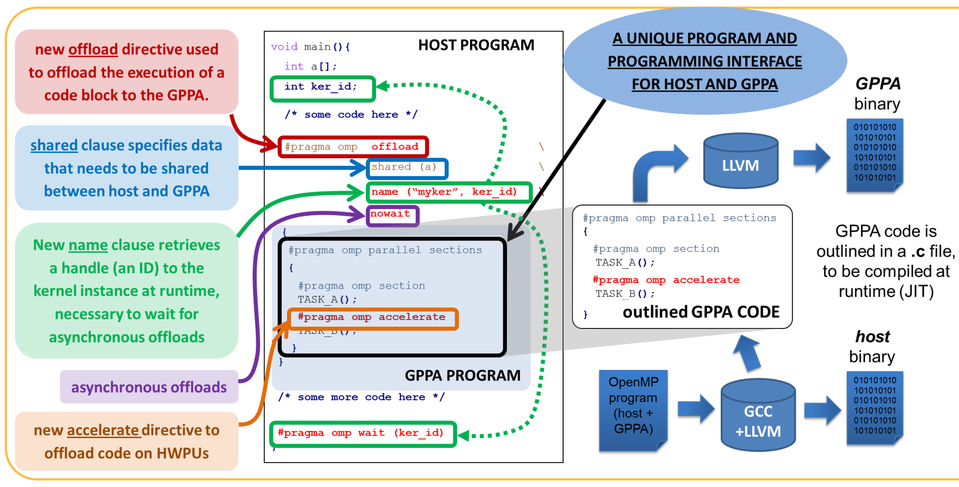
Technical approach

The Project will focus on heterogeneous multi-core processors and specific hardware accelerators since they allow the required computing power while exhibiting a good performance/watt ratio. The aim of the vIrtical project is to develop a platform efficient and flexible enough to be used in a wide variety of embedded applications taking advantage of the hardware components. These efficiency and flexibility could only be achieved using the virtualization concept. However, virtualization on embedded systems requires particular approaches. The vIrtical project aims virtualization addressing the specific requirements for effective embedded virtualization.



An IOMMU for Hardware-assisted Full Virtualization of Heterogeneous Multicore SoCs

Hardware virtualization is a major challenge in embedded virtualization. The key to improving resource utilization in a virtualized system is to allow maximum possible resource access operations to perform natively with minimal intervention by the virtual machine monitor, while at the same time ensuring protected operation among different virtual machines' address space. A novel I/O Memory Management Unit component (IOMMU) is architected to enable mapping of virtual addresses from multiple devices to the correct VM's physical memory locations, offering enhanced protection, scatter-gather functions on distributed memory organizations, high performance supported by a configurable TLB and an integrated lightweight hardware monitoring unit to facilitate dynamic system optimizations.



Programming model: OpenMP extensions for heterogeneity

Heterogeneity in the vIrtical platform comes in multiple flavors. First, to the ARM host system is coupled a many-core, programmable accelerator, the GPPA. Second, within the GPPA several homogeneous cores can be coupled to HW accelerators (HW Processing Units, HWPU) of various kind.

Our programming model extends the familiar OpenMP interface with custom directives to offload computation to the GPPA and to the HWPUs from within a unique program.

Dynamic Reconfiguration to enable Partitioning Support inside the GPPA

To support truly virtualization of GPPA resources, a method for partitioning and reconfiguration of the GPPA NoC is under development. The method will provide hypervisor-level support to configure multiple partition configurations and to assign them to different running applications. The NoC resources will be configured to completely isolate NoC traffic between applications.

QoS and compression techniques will be developed on top of this infrastructure.

Scientific, Economic and societal Impact

The presence of major European industrial players in the consortium will enable rapid commercialization of the project outputs, enhancing European competitiveness.

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