CRISP 2nd annual meeting

The use of hardware virtualization in RASHPA

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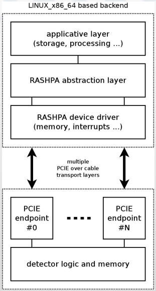
Context - RASHPA reminder



RASHPA basic goal is to transfer **detector** memory contents into a **backend** for further processing, visualisation or storage. To do so, RASHPA relies on low level hardware and software components

- a data transport layer, currently PCI Express over cable
- a data transmission engine implemented on XILINX FPGA
- LINUX kernel device driver and userland software

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Context - RASHPA project issues

Still being prototyped

- how to simplify hardware software codesign ?

Aims at using multiple PCIE links. Yet, the first prototype is single link

- how to scale the prototype platform ?

Well positionned to interface with PCIE based accelerating technologies

- how to test unavailable (too recent or expensive) hardware ?

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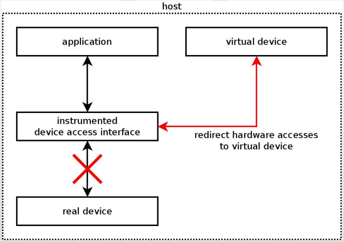
Context - solution

Solution: **device virtualization**

Device virtualization - main idea



Applications on a **host** machine access hardware via interfaces. By **instrumenting** these interfaces, one can **redirect** the accesses to a software implementing the device. The device is said to be **virtualized**.

Device virtualization - hardware access redirection (0)

Virtualization assumes device accesses are made using a known interface

- software library API (system calls)
- memory mapped registers
- CPU specific instructions (in, out)

Device virtualization - hardware access redirection (1)

The interface is then instrumented to redirect access to the virtual device

- software hooking (code instrumentation, library replacing)
- instruction emulation (QEMU)
- hardware traps (page protection)
- architecture support (INTEL VT)
- paravirtualization (XEN)

Device virtualization - applications

Device virtualization example applications

- support: application running on unmaintained platform
- security: sandboxing, reverse engineering
- quality: debugging, fault injection
- testing: milkymist, zinq, android

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VPCIE - goals

VPCIE, a Virtual PCIE framework made for RASHPA

- virtualize PCIE endpoints
- generic enough to fit other projects
- the backend software must run **without any modification**
- should be possible to use VHDL for device simulation

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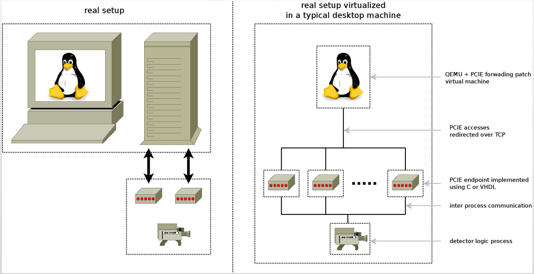
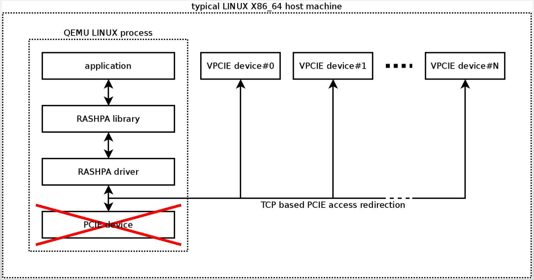
VPCIE - RASHPA possible setup (0)



VPCIE - RASHPA possible setup (1)



VPCIE - opensource building blocks

QEMU

- http://wiki.qemu.org/Main_Page
- architecture emulator (X86_64, ARM ...)
- used to trap PCIE hardware accesses

GHDL

- http://ghdl.free.fr
- VHDL frontend for GCC
- used to implement device in VHDL

VPCIE - RASHPA backend

RASHPA backend is a full featured LINUX system

- runs in a QEMU virtual machine
- PCIE accesses are trapped and sent over TCP to the devices
- PCIE forwarder is available as a QEMU patch

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VPCIE - RASHPA devices

RASHPA devices

- run as a LINUX processes
- can be implemented in C or VHDL
- can be duplicated at will

VPCIE - benefits

Hardware software codesign

- reduce development time
- no **modification** on the backend software (esp. driver)
- act as a stimuli generator for VHDL simulations

Platform scaling

- one PCIE endpoint per LINUX process

Investigate unavailable technologies

- NVM Express support for QEMU is available

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VPCIE - more benefits

Virtual machine

- resources easily changed (RAM amount ...)
- test with different CPU architectures (x86, x86_64, ARM ...)
- small LINUX disk images reduce reboot times (few seconds)

Fault injection

- LINUX and software response to PCIE device disconnection

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VPCIE - availability

https://github.com/texane/vpcie

VPCIE - demo

demo