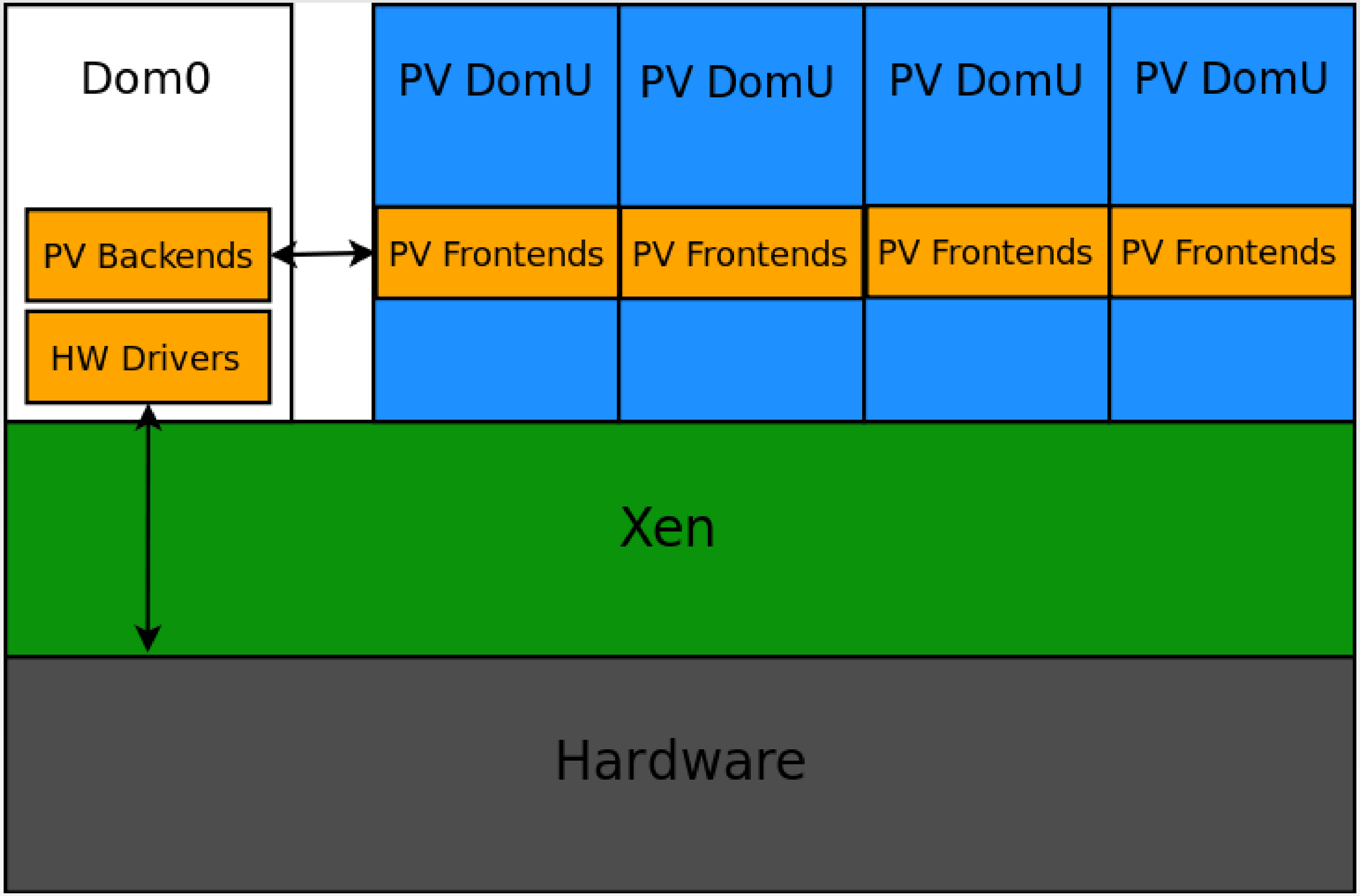
Xen

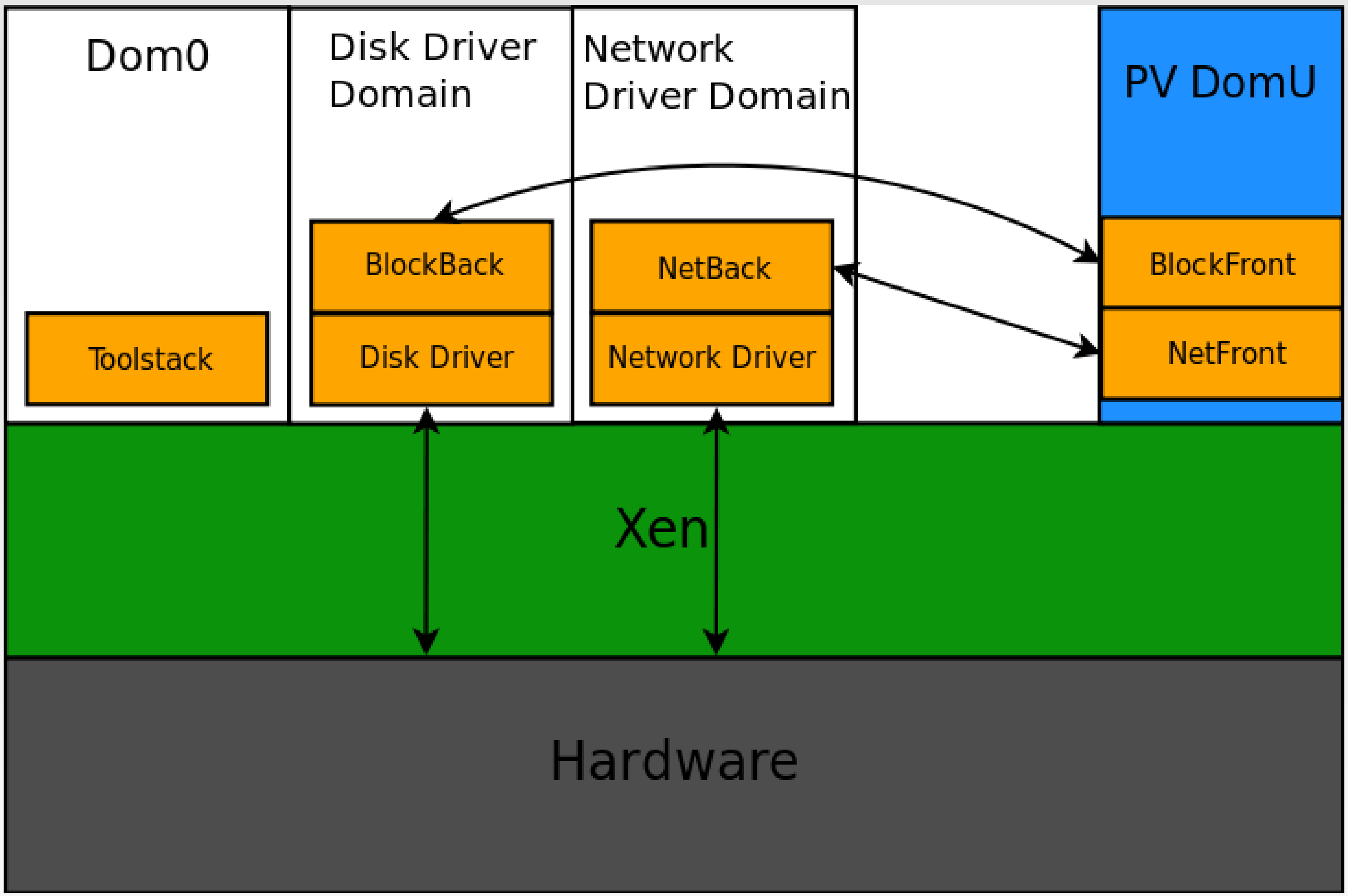
past, present and future

Stefano Stabellini

Xen architecture: PV domains



Xen arch: driver domains



Xen: advantages

- small surface of attack

- isolation

- resilience

- specialized algorithms (scheduler)

Xen and the Linux kernel

Xen was initially a university research project

invasive changes to the kernel to run Linux as a PV guest

even more changes to run Linux as dom0

Xen and the Linux kernel

Xen support in the Linux kernel not upstream

↓

Great maintance effort on distributions

↓

Risk of distributions dropping Xen support

Xen and the Linux kernel

- PV support went in Linux 2.6.26

- basic Dom0 support went in Linux 2.6.37

- Netback went in Linux 2.6.39

- Blkback went in Linux 3.0.0

A single 3.0.0 Linux kernel image boots on native, on Xen as domU, as dom0 and PV on HVM guest

Xen and Linux distributions

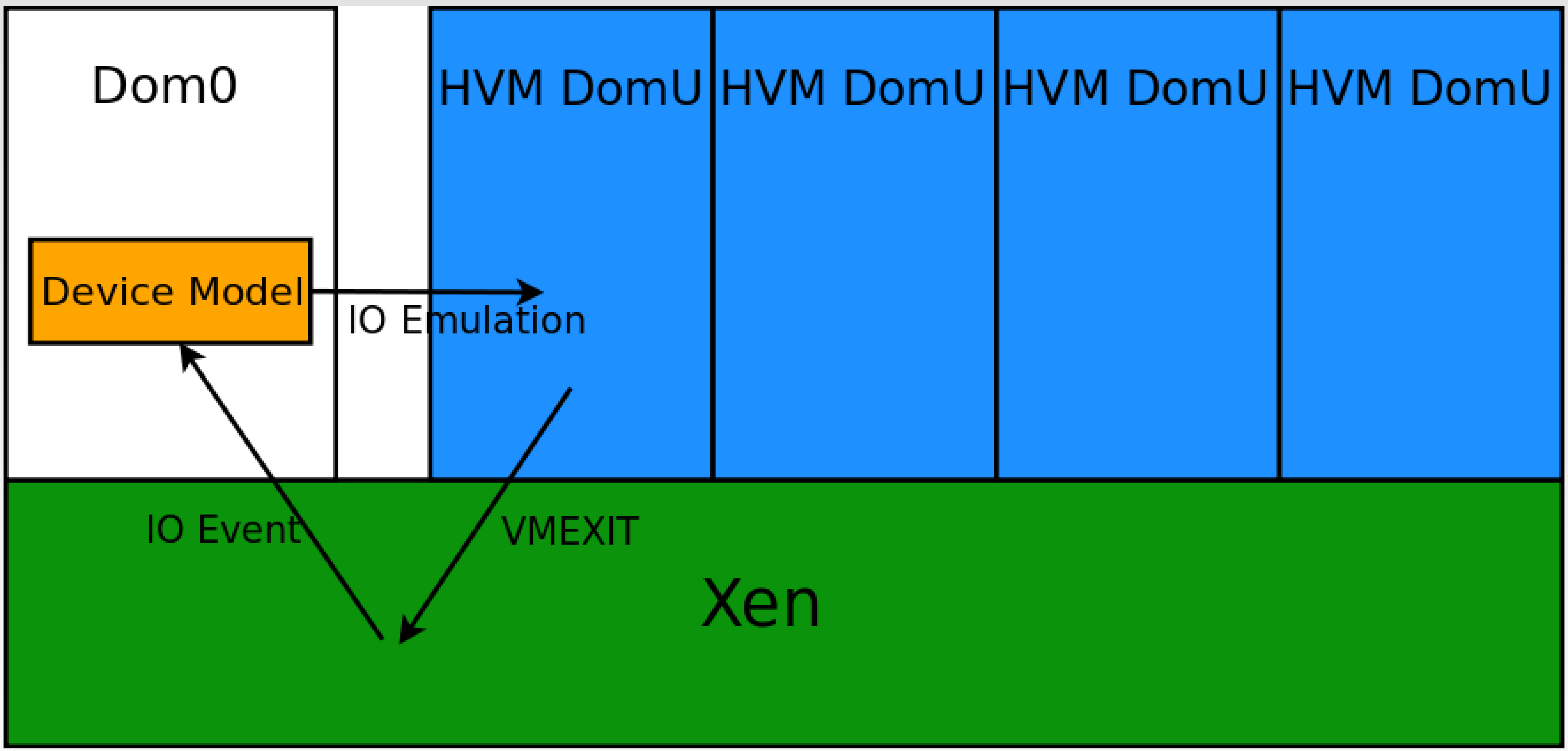
2010

- Fedora and Ubuntu dropped Xen support from their Linux kernels
- Debian, Suse, Gentoo still provide Xen kernels
- XenServer went Open Source with XCP

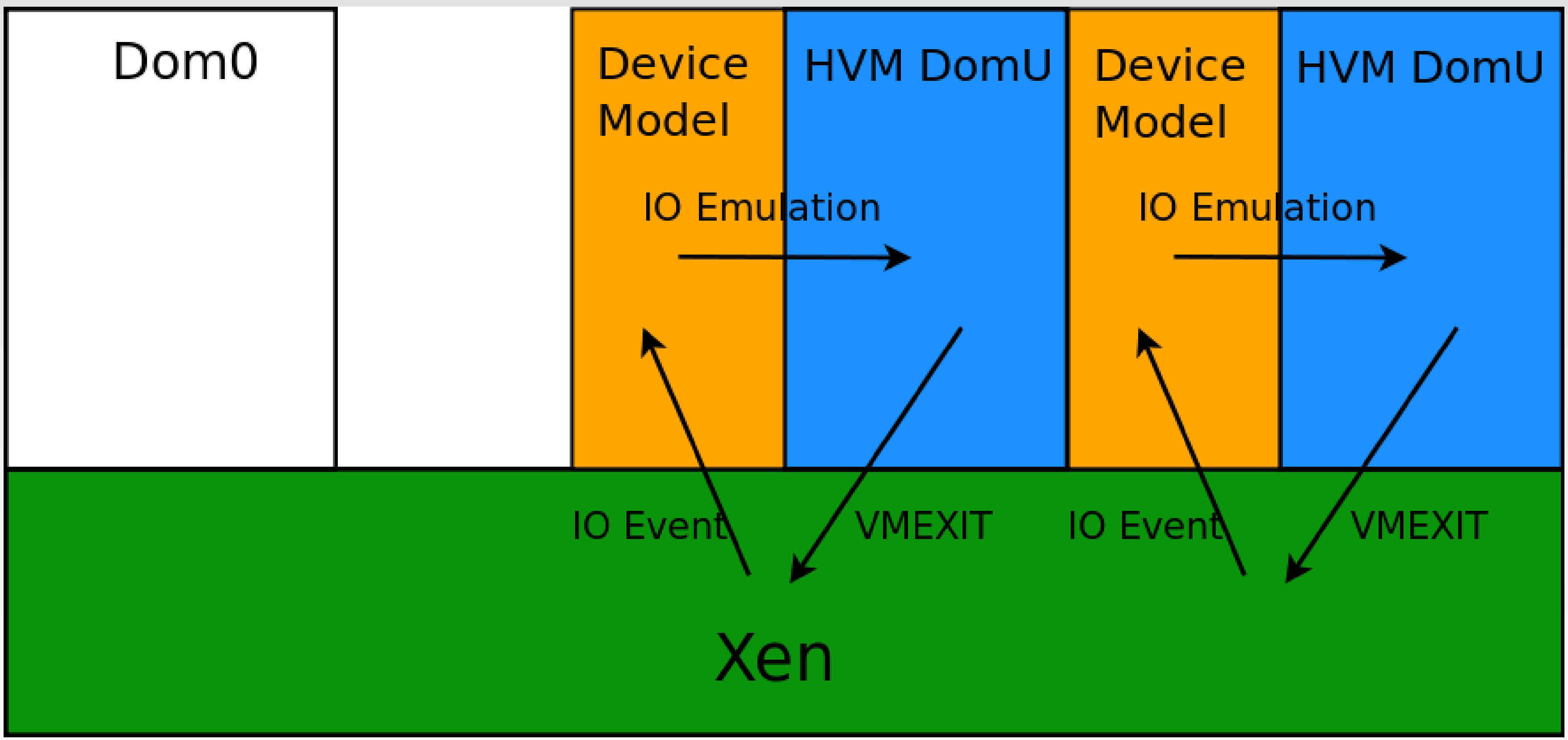
Present

- Fedora and Ubuntu are adding Xen support back in kernel in the next releases

Xen architecture: HVM domains



Xen architecture: stubdoms



Xen and Qemu

- initially forked in 2005

- updated once every few releases

- Xen support went in upstream Qemu at the beginning of 2011

- Upstream Qemu is going to be used as device model with Xen 4.2

New developments: Libxenlight

Multiple toolstacks:

- Xend, Xapi, XenVM, LibVirt, …
- code duplications, inefficiencies, bugs, wasted efforts

Xend:

- difficult to understand, modify and extend
- significant memory footprint

Libxenlight

What is Libxenlight:

- a small lower level library in C
- simple to understand
- easy to modify and extend

Goals:

- provide a simple and robust API for toolstacks
- create a common codebase to do Xen operations

XL

- the unit testing tool for libxenlight
- feature complete
- a minimal toolstack
- compatible with xm

Do more with less!

XL: design principles

- smallest possible toolstack on top of libxenlight

- stateless

CLI → XL → libxenlight → EXIT

XL vs. Xend

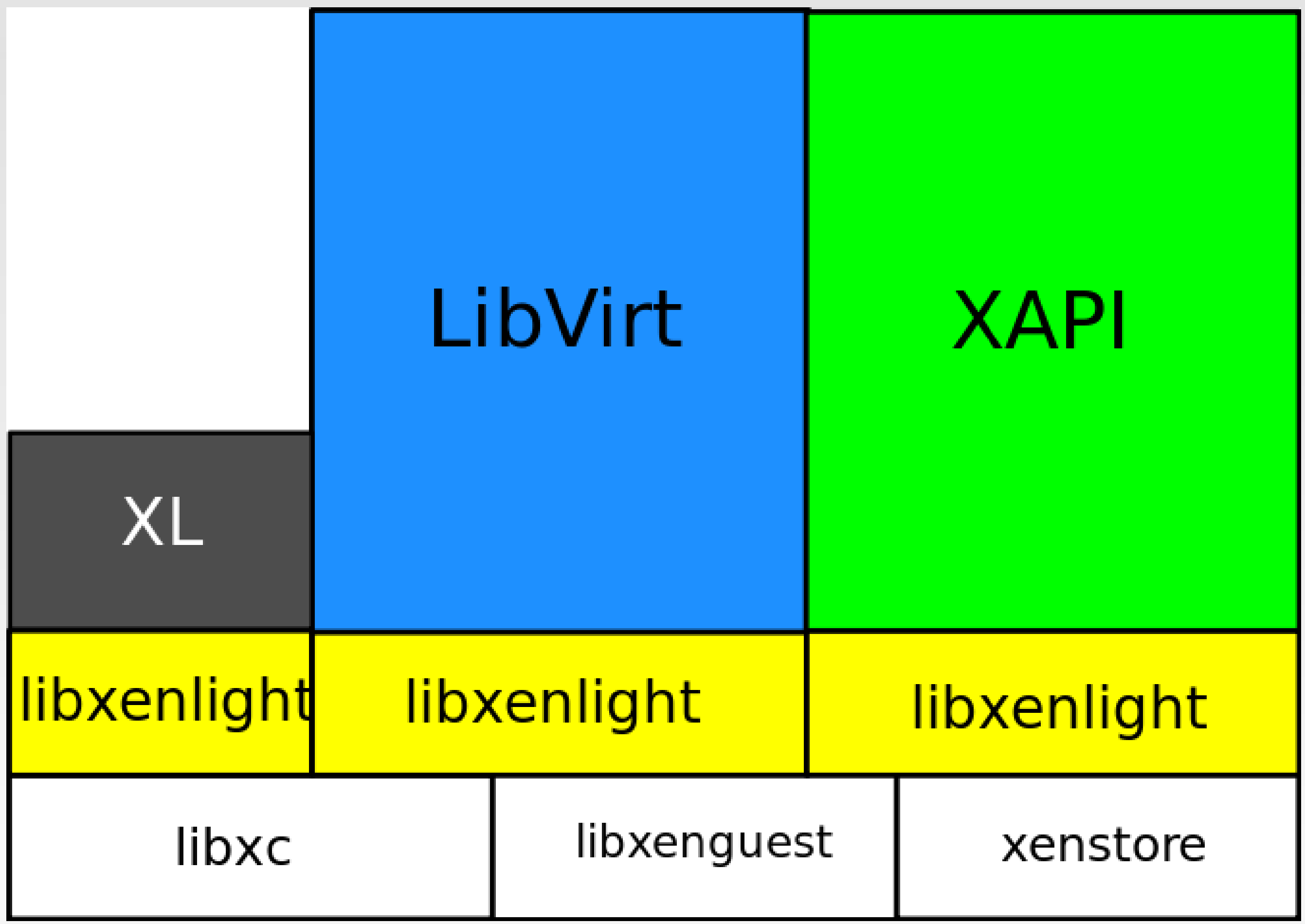
XL: pros

- very small and easy to read
- well tested
- compatible with xm

Xend: pros

- provide XML RPC interface
- provide ”managed domains”

Libxenlight: the new world



Linux PV on HVM

paravirtualized interfaces in HVM guests

Linux as a guests: problems

Linux PV guests have limitations:

- ~~difficult~~ “different” to install

- limited set of virtual hardware

Linux HVM guests:

- install the same way as native

- very slow

Linux PV on HVM: the solution

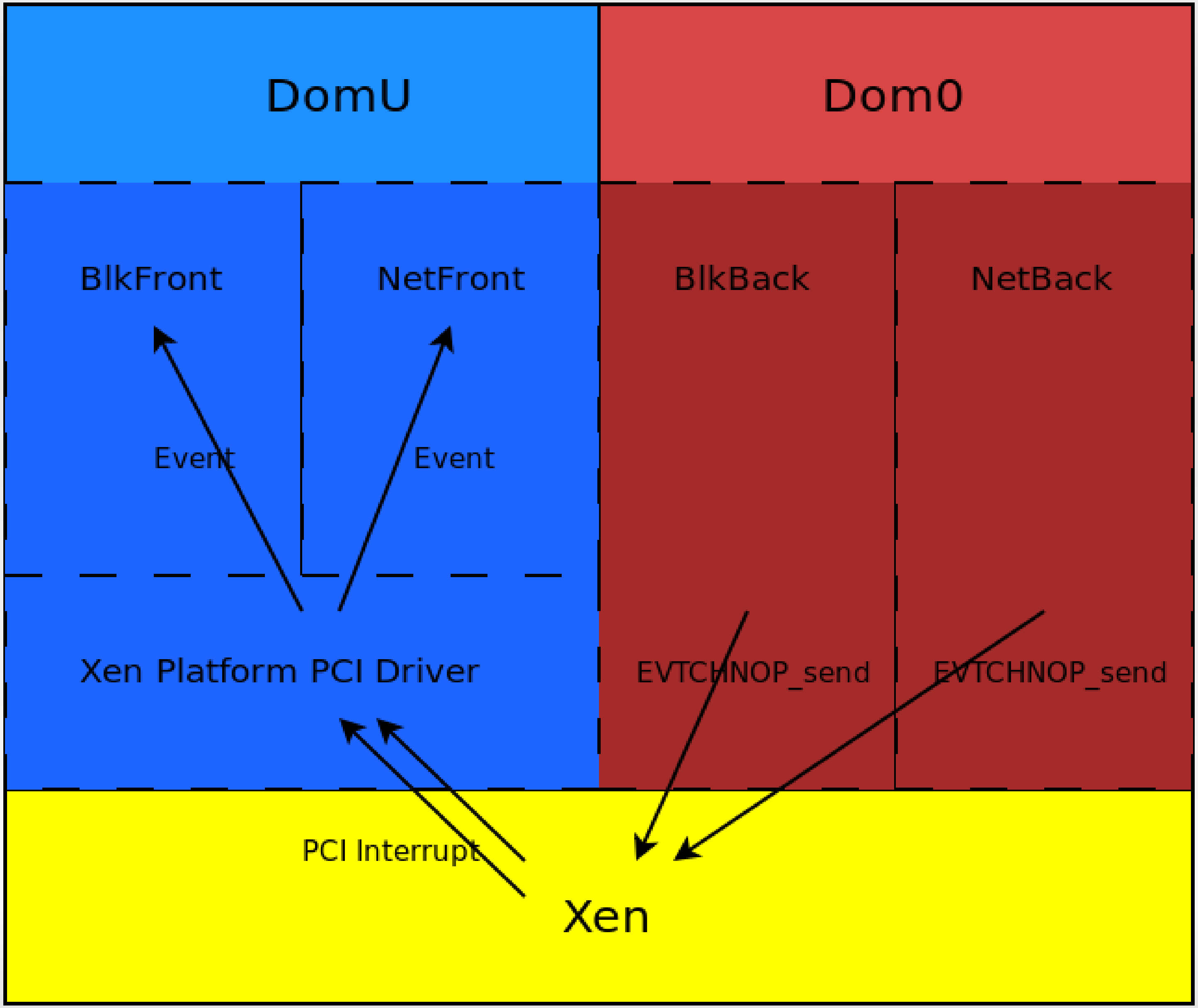
- install the same way as native
- PC-like hardware
- access to fast paravirtualized devices
- exploit nested paging

Linux PV on HVM: initial feats

Initial version in Linux 2.6.36:

- introduce the xen platform device driver
- add support for HVM hypercalls, xenbus and grant table
- enables **blkfront**, **netfront** and **PV timers**
- add support to PV suspend/resume
- the **vector callback** mechanism

Old style event injection



Receiving an interrupt

do_IRQ

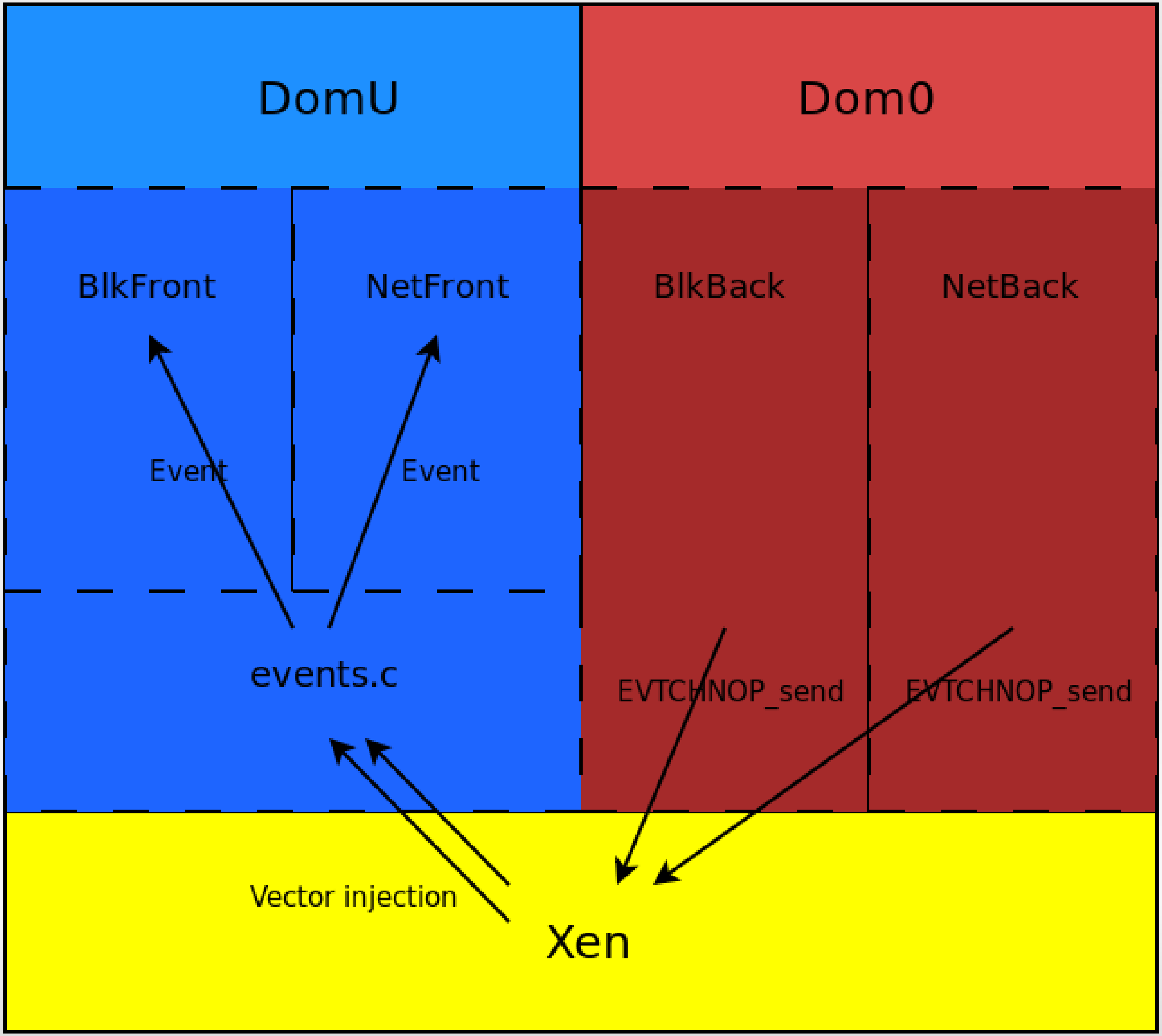
handle_fasteoi_irq

handle_irq_event

xen_evtchn_do_upcall

ack_apic_level ← **>=3 VMEXIT**

The new vector callback



Receiving a vector callback

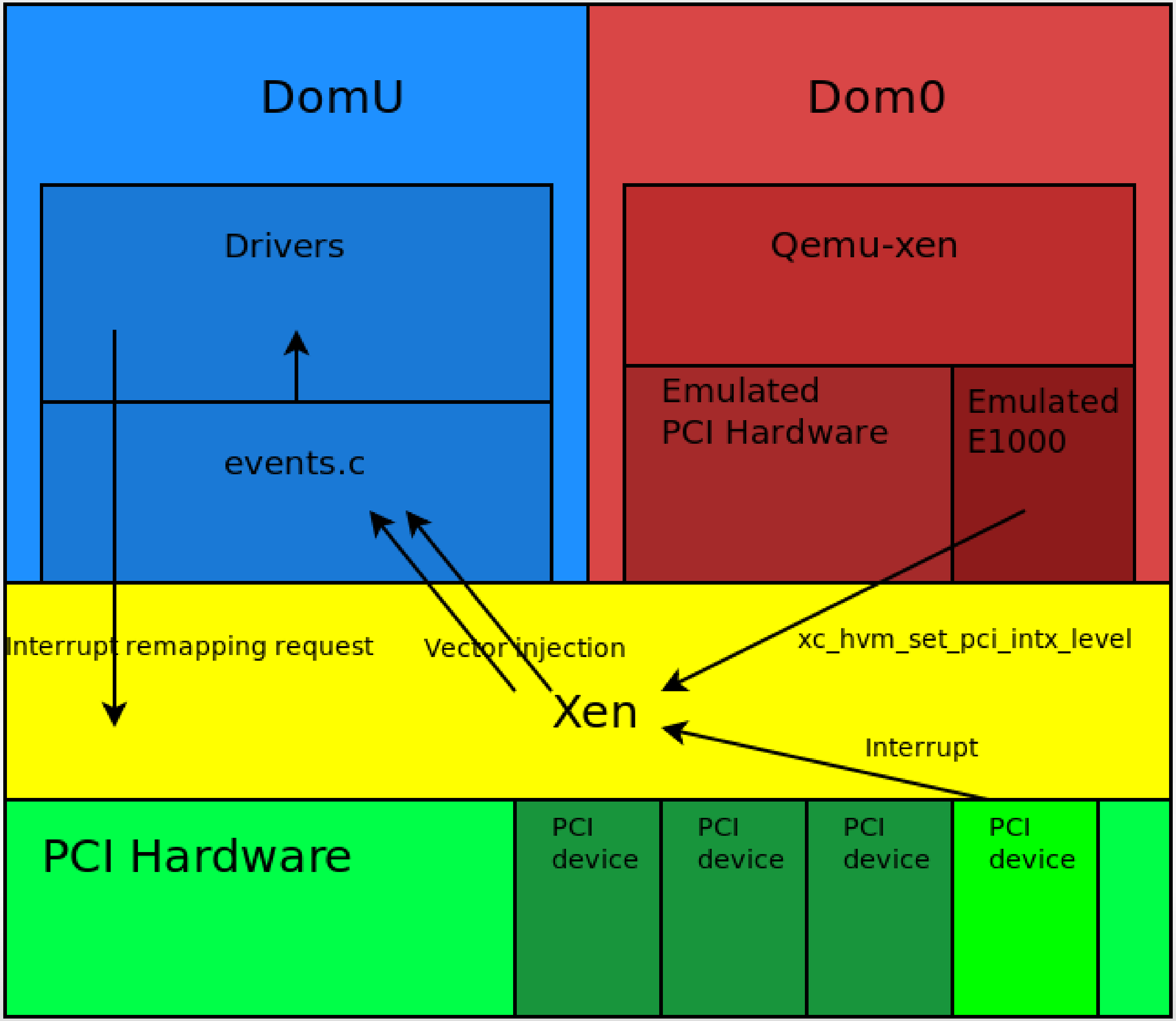
xen_evtchn_do_upcall

Linux PV on HVM: newer feats

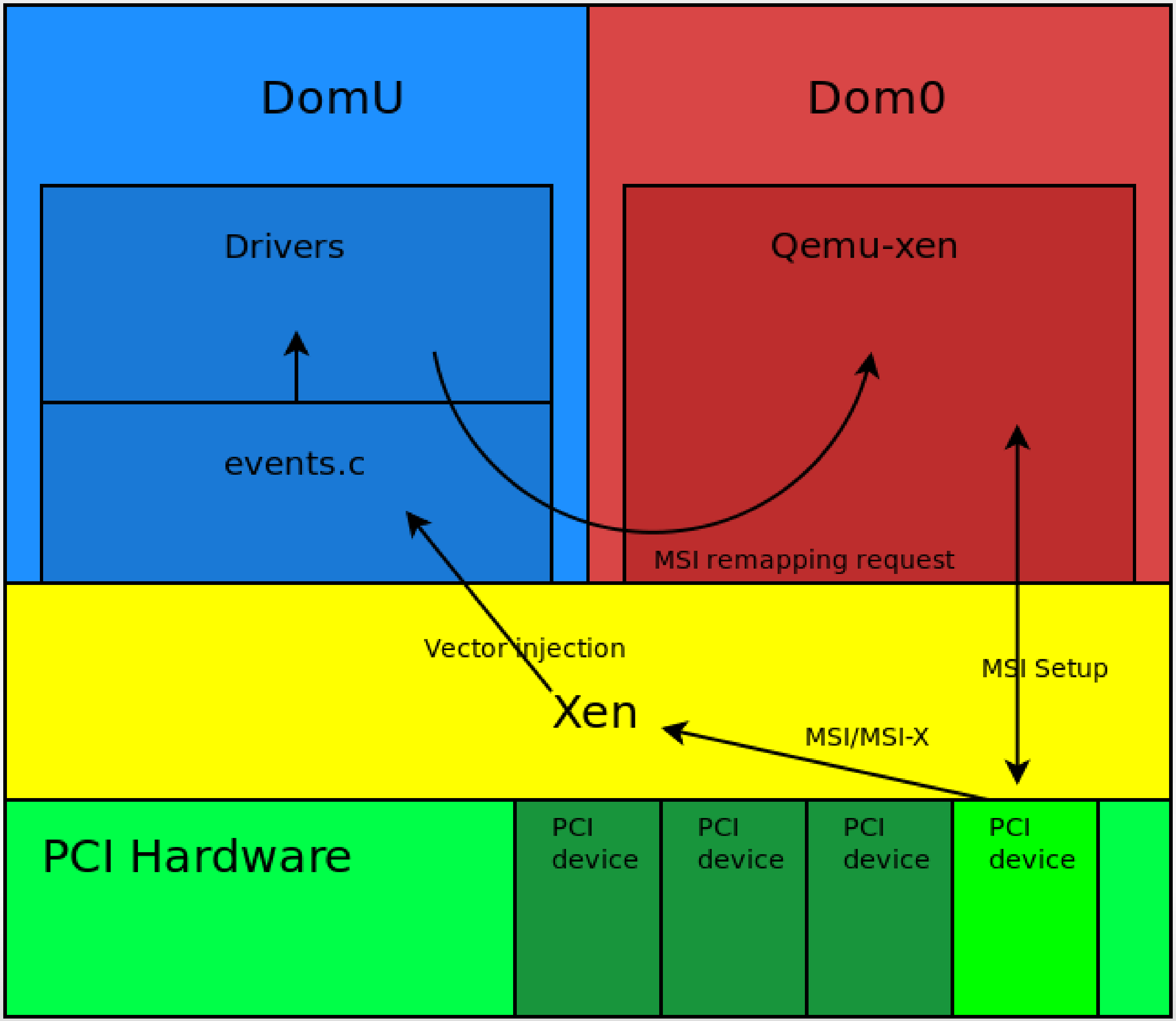
Later enhancements (2.6.37+):

- ballooning
- PV spinlocks
- PV IPIs
- Interrupt remapping onto event channels
- MSI remapping onto event channels

Interrupt remapping



MSI remapping



PV spectrum

	HVM guests	Classic PV on HVM	Enhanced PV on HVM	Hybrid PV on HVM	PV guests
Boot sequence	emulated	emulated	emulated		paravirtualized
Memory	hardware	hardware	hardware		paravirtualized
Interrupts	emulated	emulated	paravirtualized		paravirtualized
Timers	emulated	emulated	paravirtualized		paravirtualized
Spinlocks	emulated	emulated	paravirtualized		paravirtualized
Disk	emulated	paravirtualized	paravirtualized		paravirtualized
Network	emulated	paravirtualized	paravirtualized		paravirtualized
Privileged operations	hardware	hardware	hardware		paravirtualized

Benchmarks: the setup

Hardware setup:

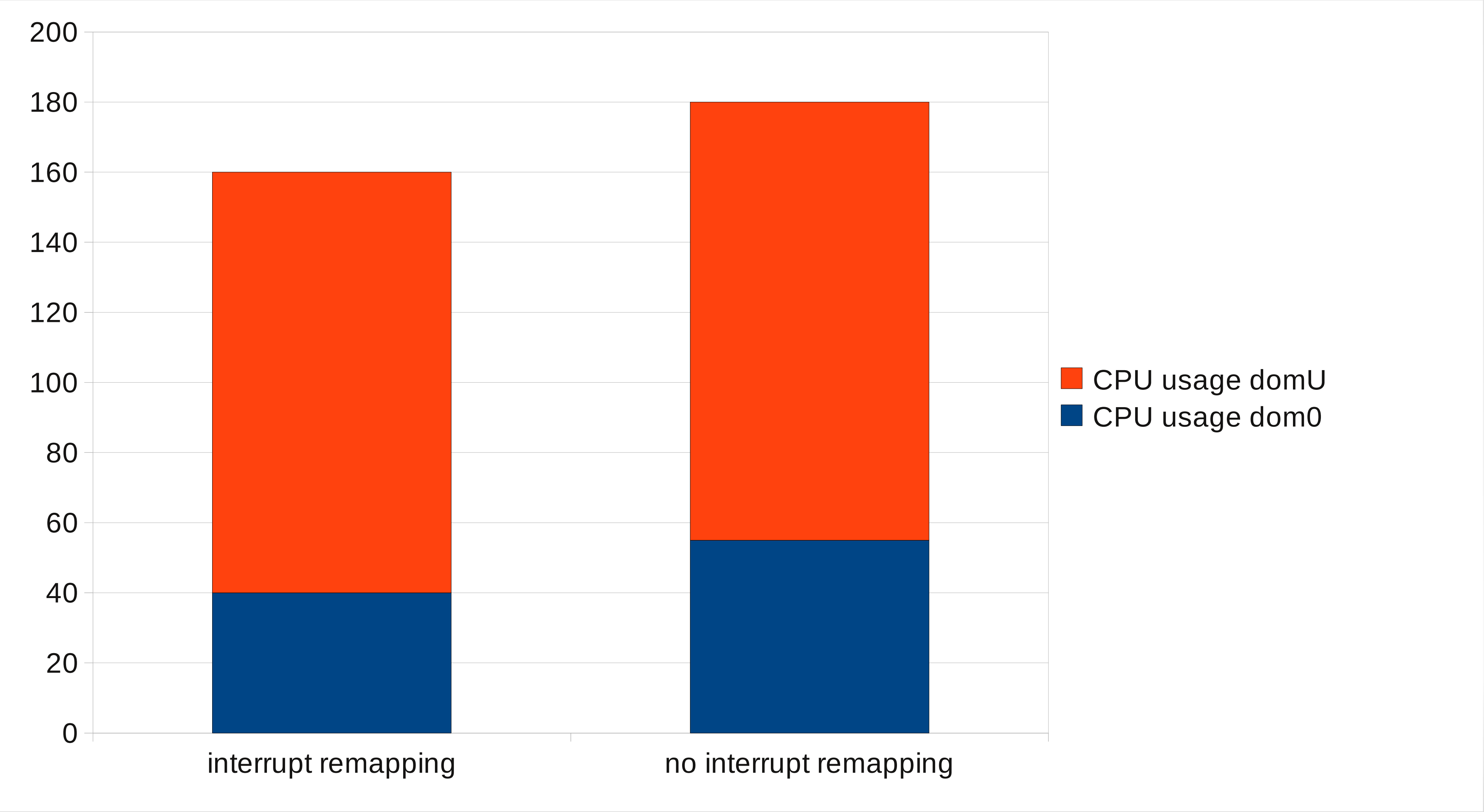
Dell PowerEdge R710
CPU: dual Intel Xeon E5520 quad core CPUs @ 2.27GHz
RAM: 22GB

Software setup:

Xen 4.1, 64 bit
Dom0 Linux 2.6.32, 64 bit
DomU Linux 3.0 rc4, 8GB of memory, 8 vcpus

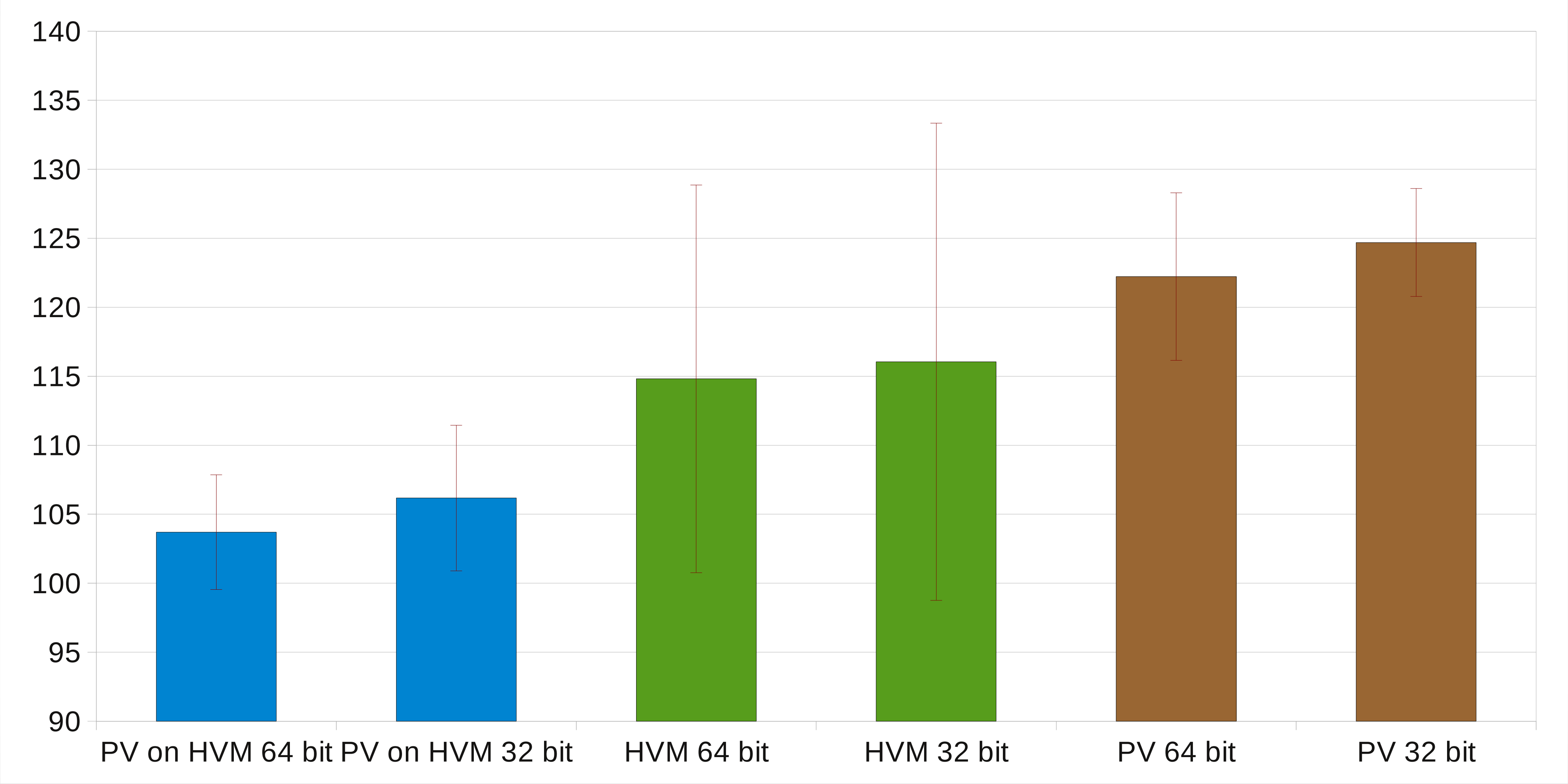
PCI passthrough: benchmark

PCI passthrough of an Intel Gigabit NIC
CPU usage: the lower the better:



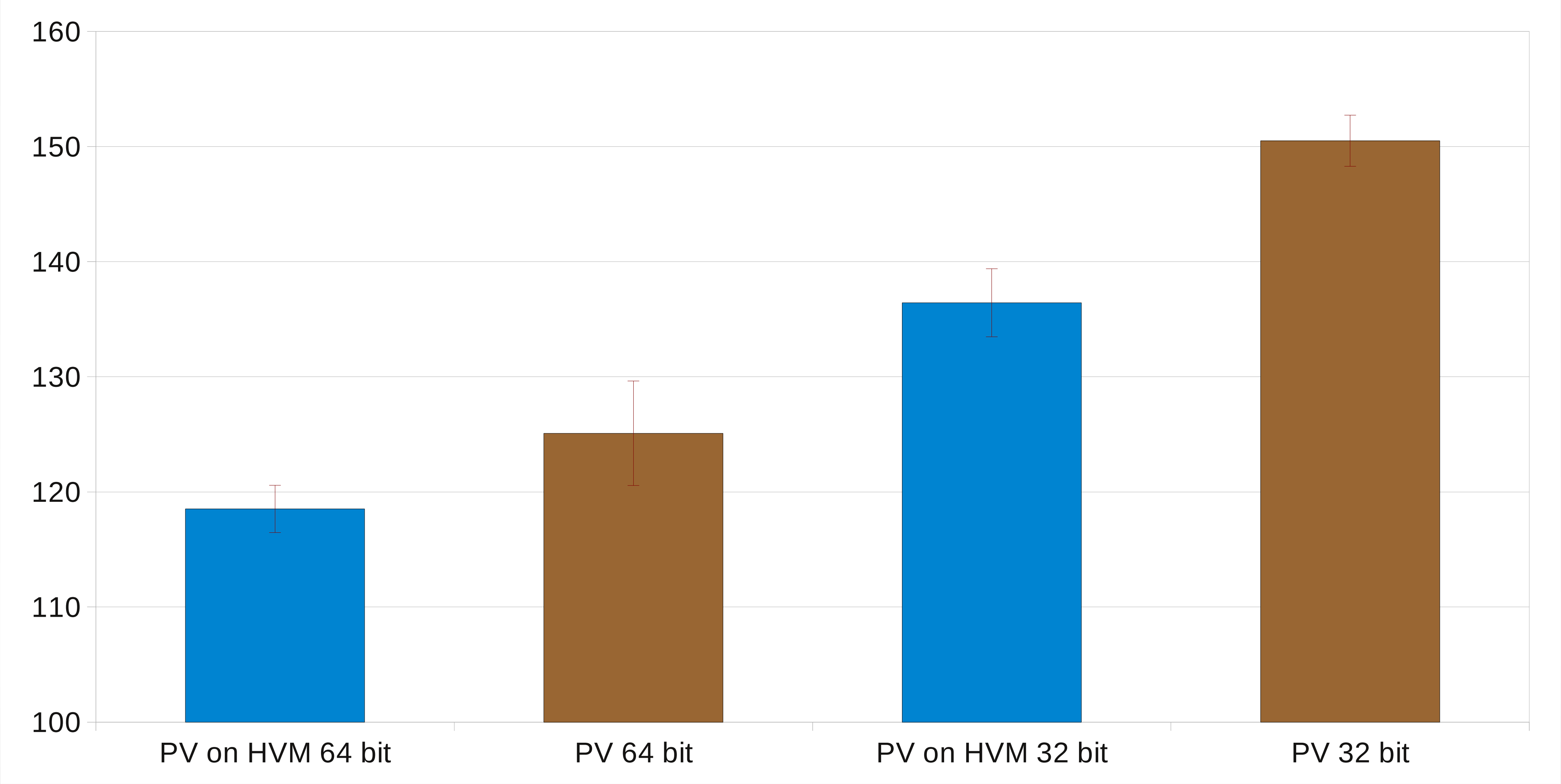
Kernbench

Results: percentage of native, the lower the better



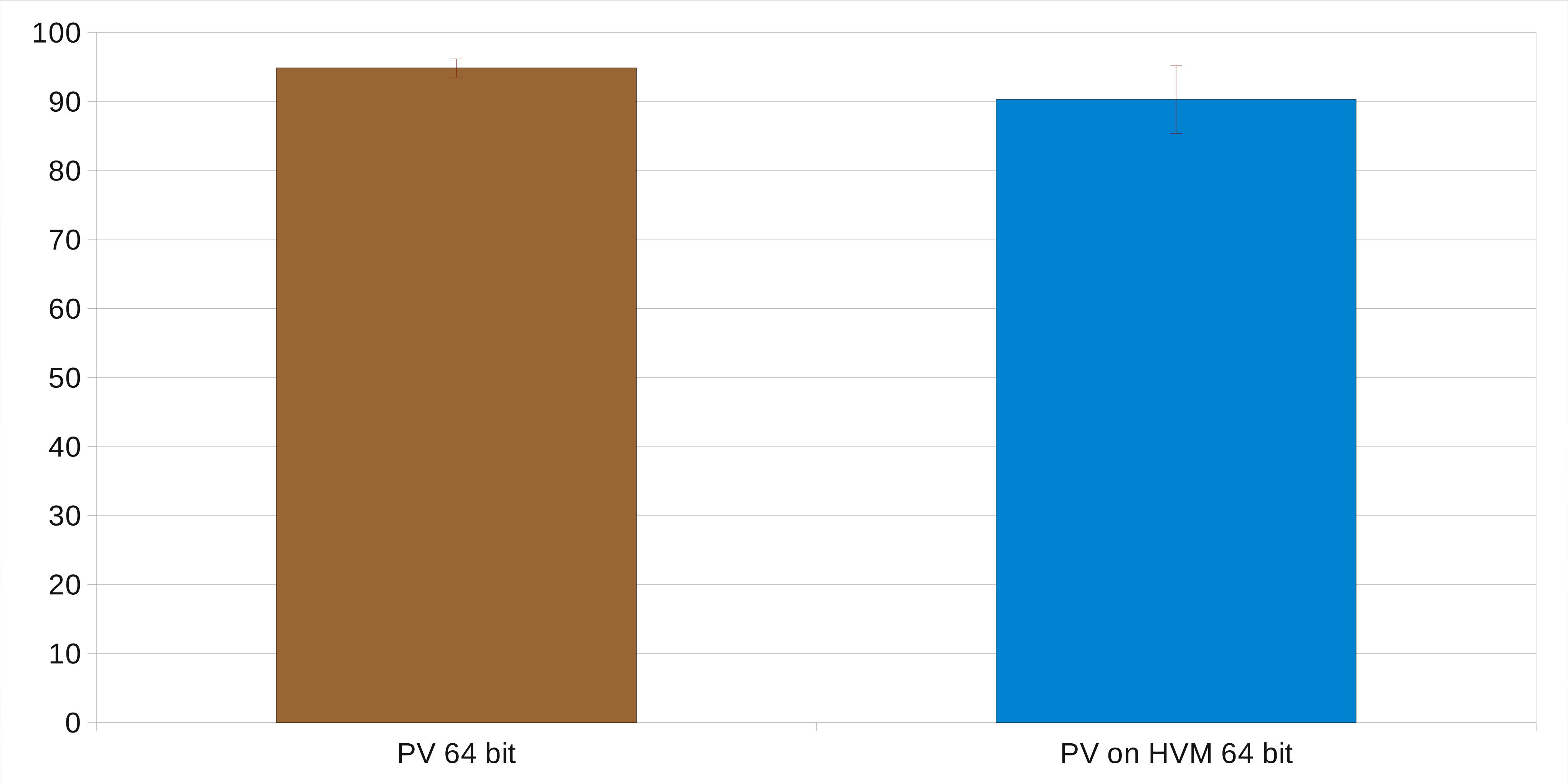
PBZIP2

Results: percentage of native, the lower the better



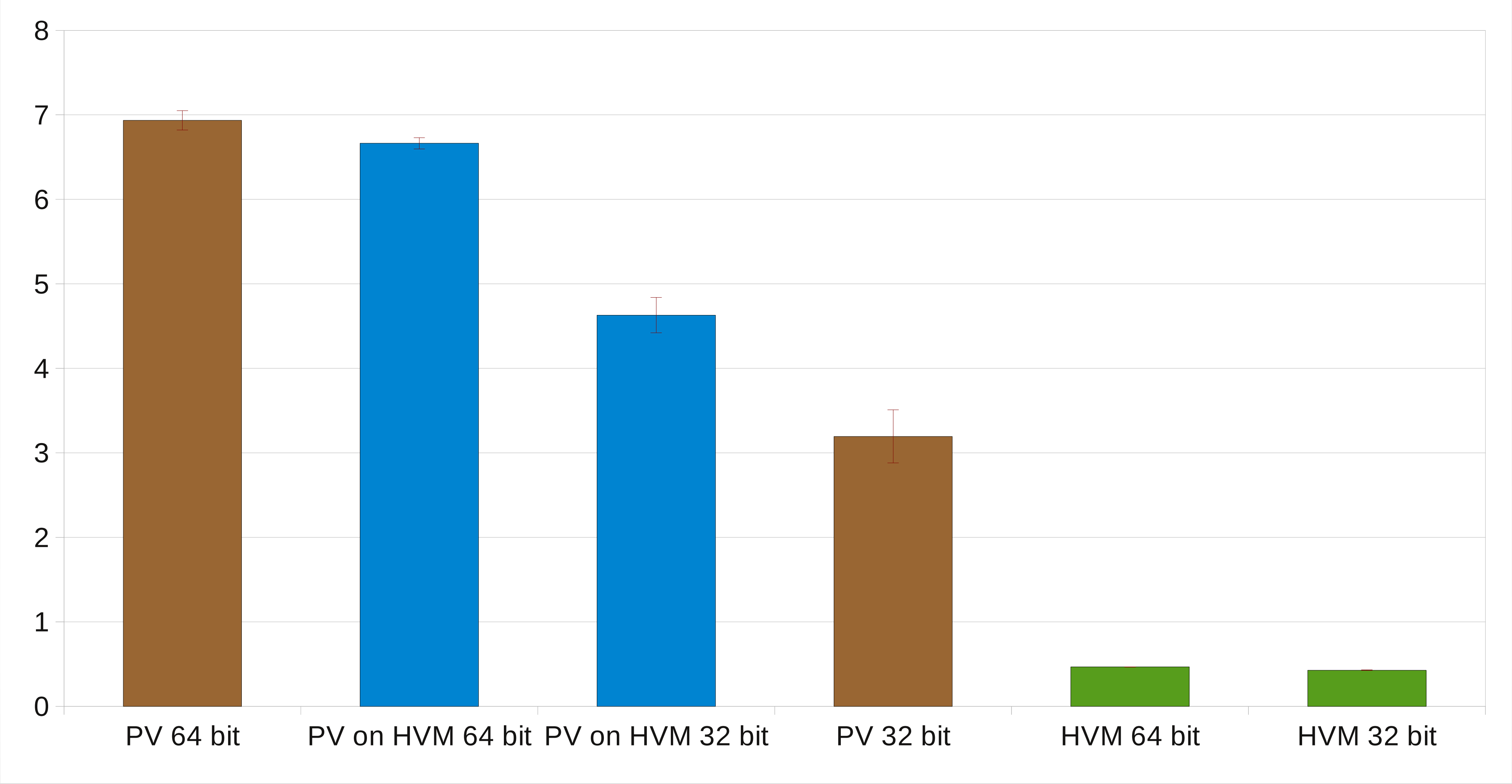
SPECjbb2005

Results: percentage of native, the higher the better



Iperf tcp

Results: gbit/sec, the higher the better



Conclusions

PV on HVM guests are very close to PV guests in benchmarks that favor PV MMUs

PV on HVM guests are far ahead of PV guests in benchmarks that favor nested paging

Questions?