Xen on ARM

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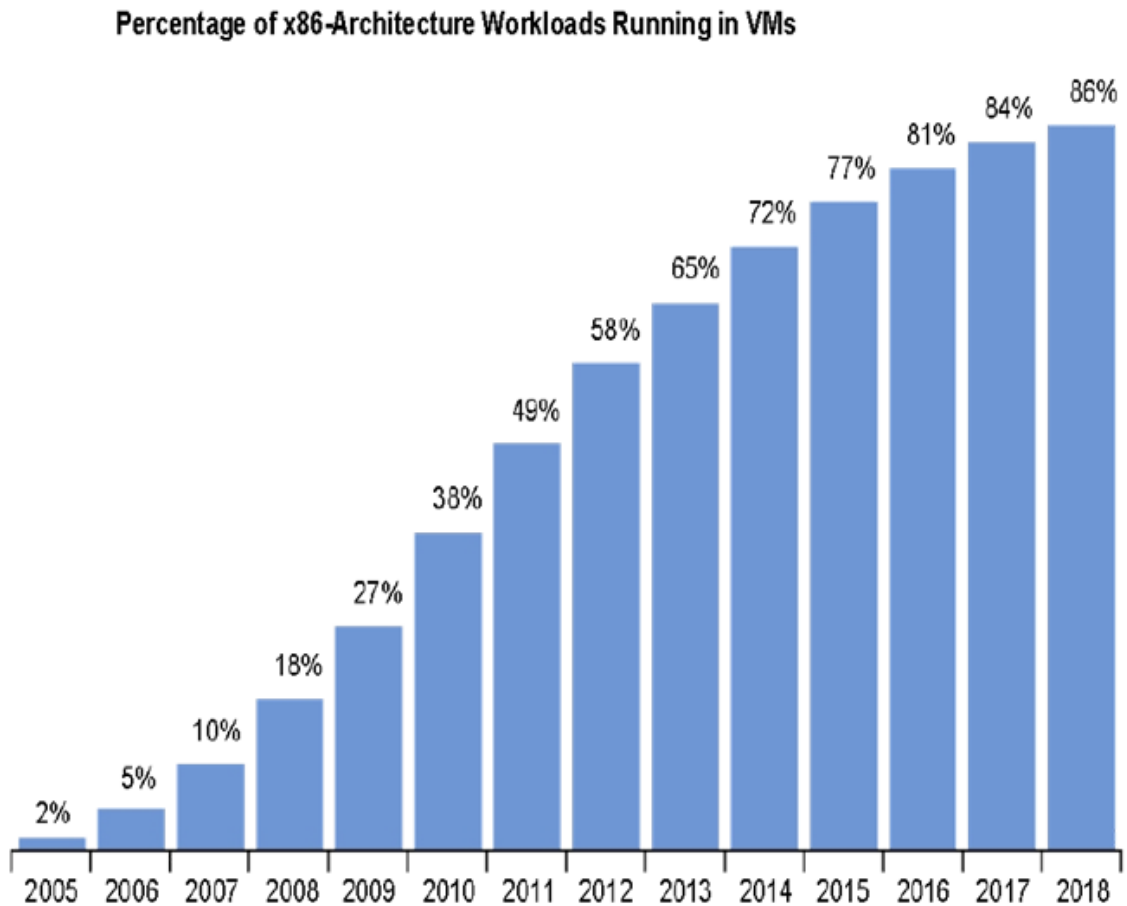
Virtualization: why it matters



Source: Gartner (March 2011)

Xen: the gears of the cloud

- large user base
  more than 10 million individuals users

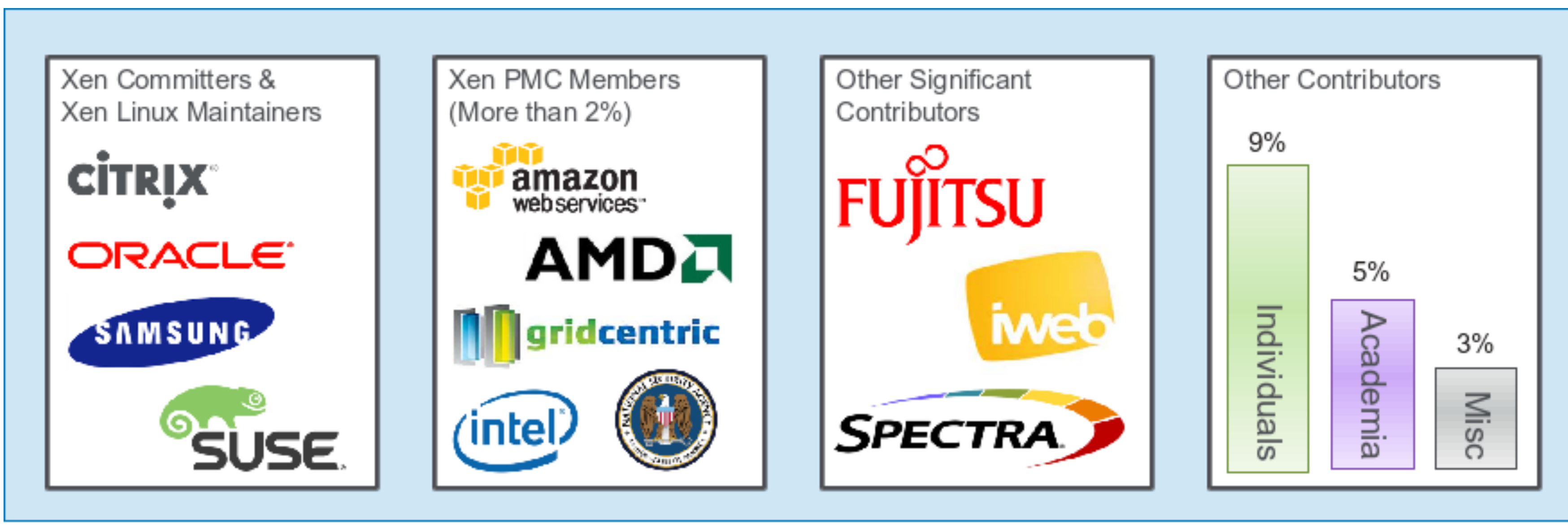
- power the largest clouds in production

- not just for servers

Xen: Open Source

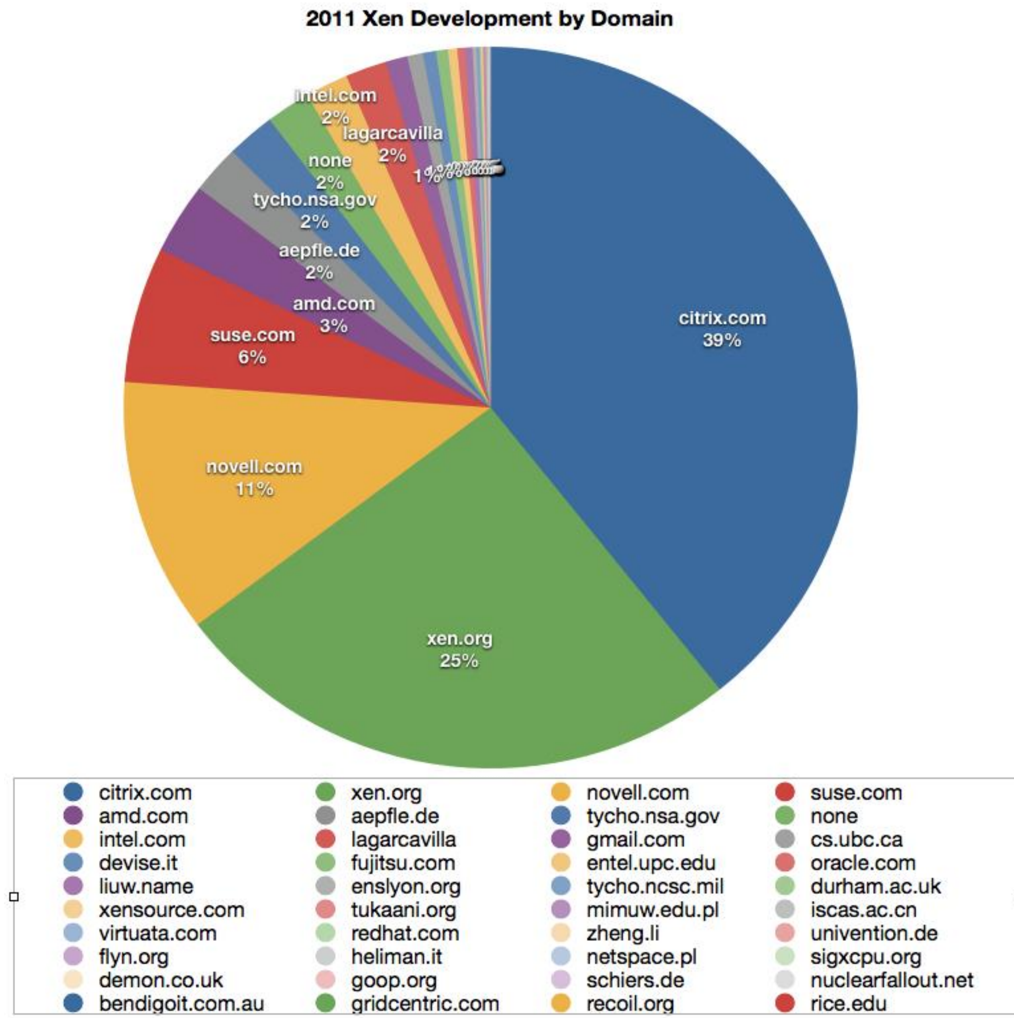
GPLv2 with DCO (like Linux)

Diverse contributor community

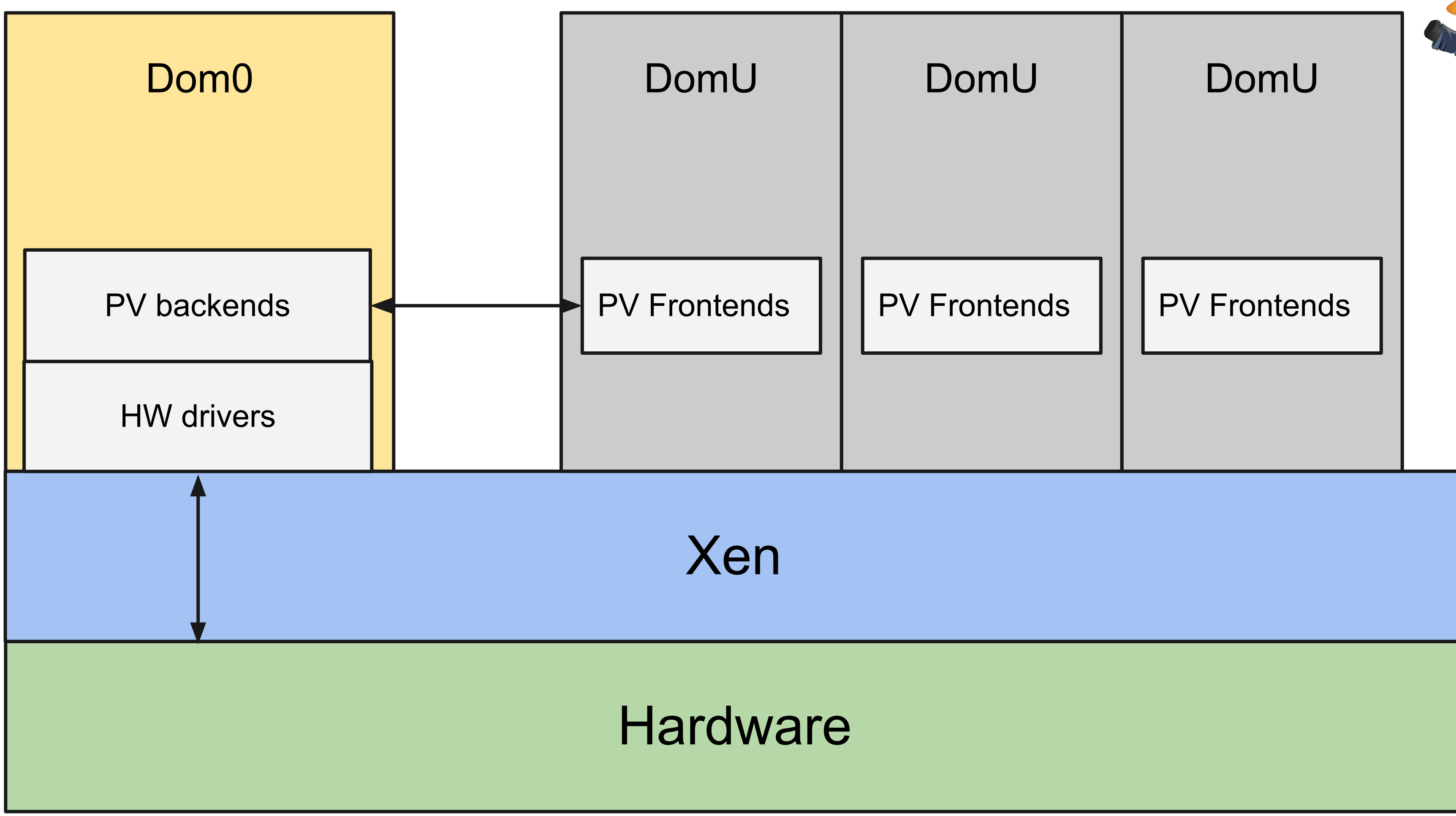


Xen: Open Source

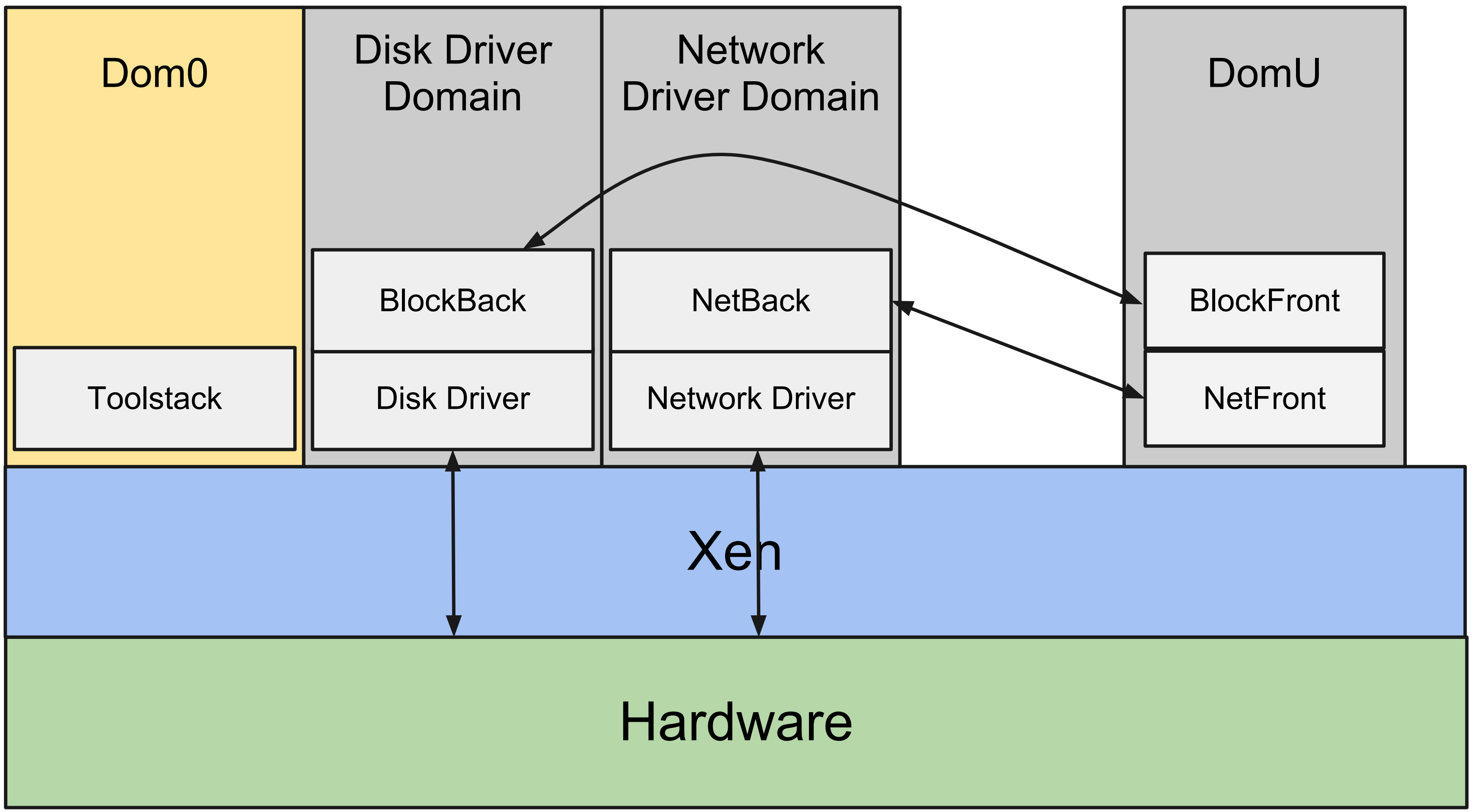
source:
Mike Day
http://code.ncultra.org



Xen Architecture



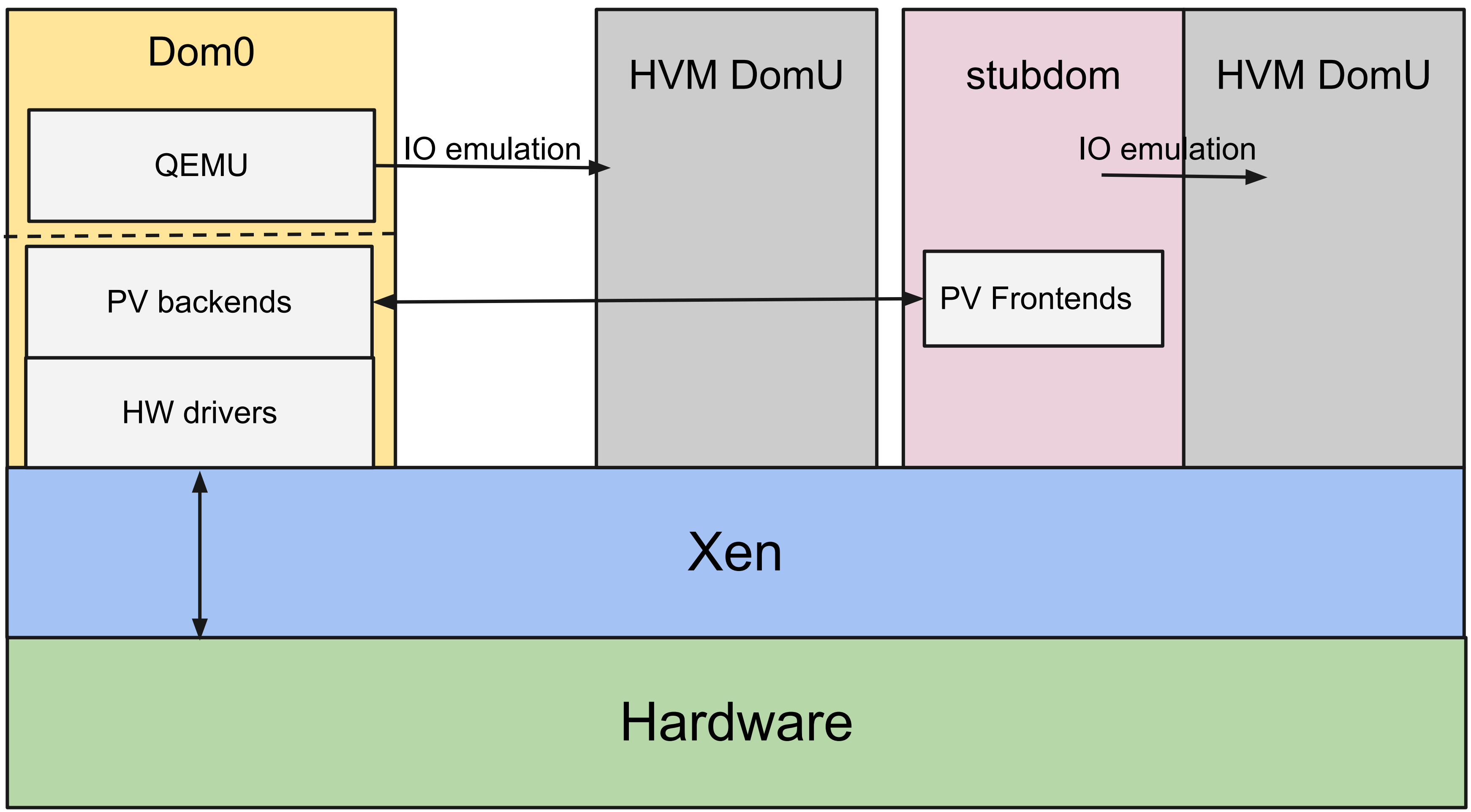
Xen Architecture: driver domains



Xen: advantages

- small surface of attack
- isolation
- resilience
- specialized algorithms (scheduler)

Xen Architecture: HVM guests



Xen upstream status

- Xen (Dom0 and DomU support, PV frontends and backends) fully upstream in Linux since v3.0

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

- Xen upstream in QEMU since v1.3

- Xen supported by SuSE, Debian, Ubuntu, Fedora, CentOS, NetBSD and more

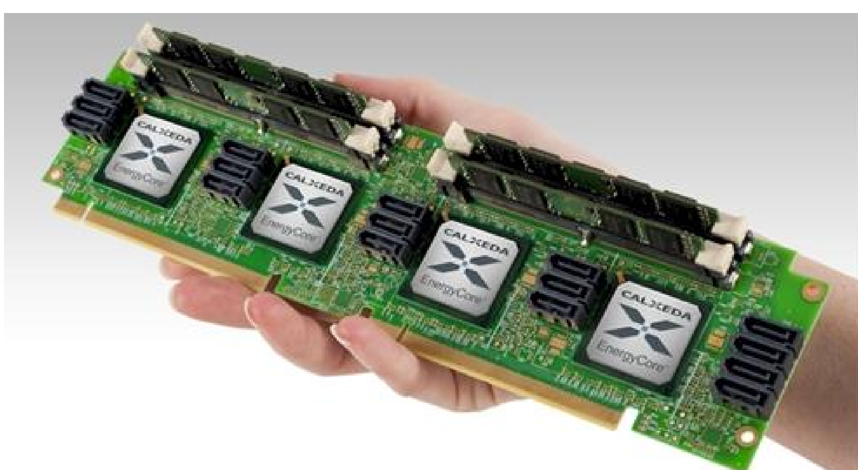
ARM Servers coming to market

4GB RAM, 4 cores per node

3 x 6 x 4 x 4 = 288 cores

single node virtualization -

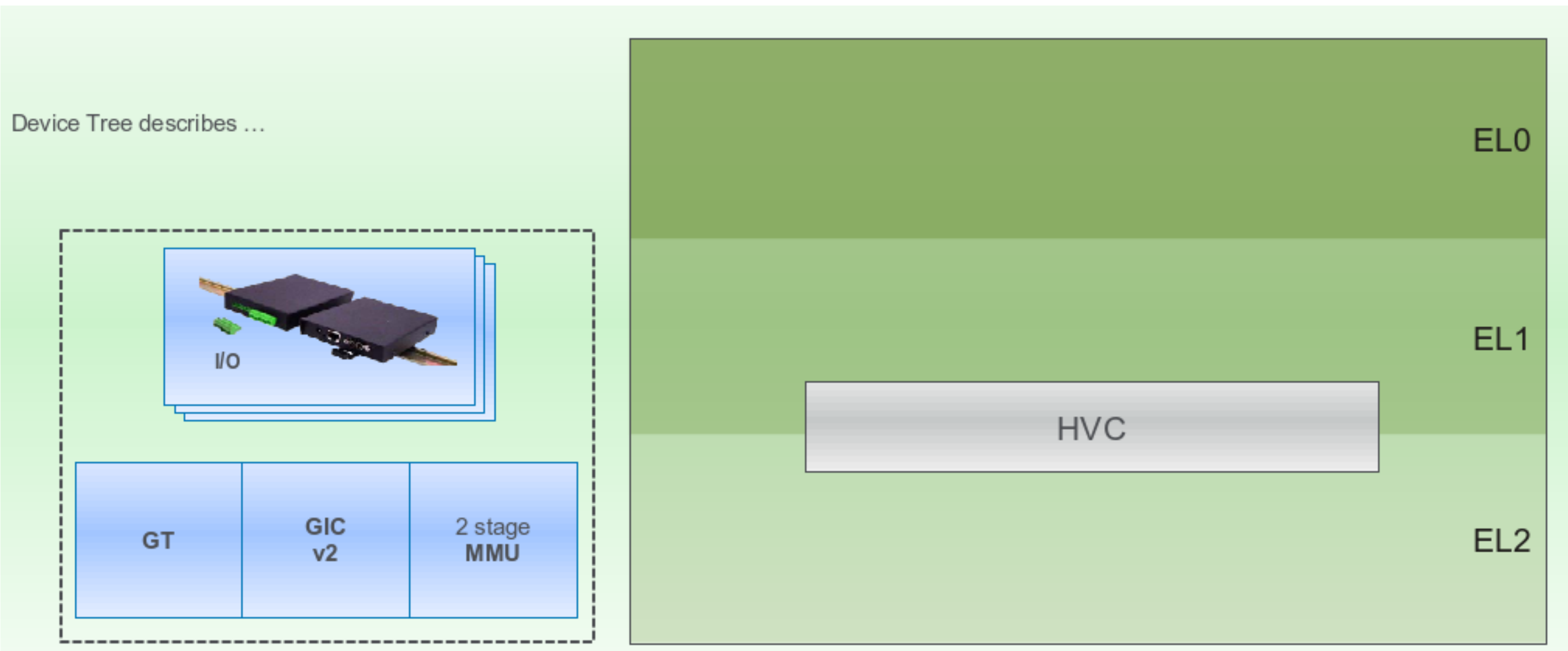
manageability -



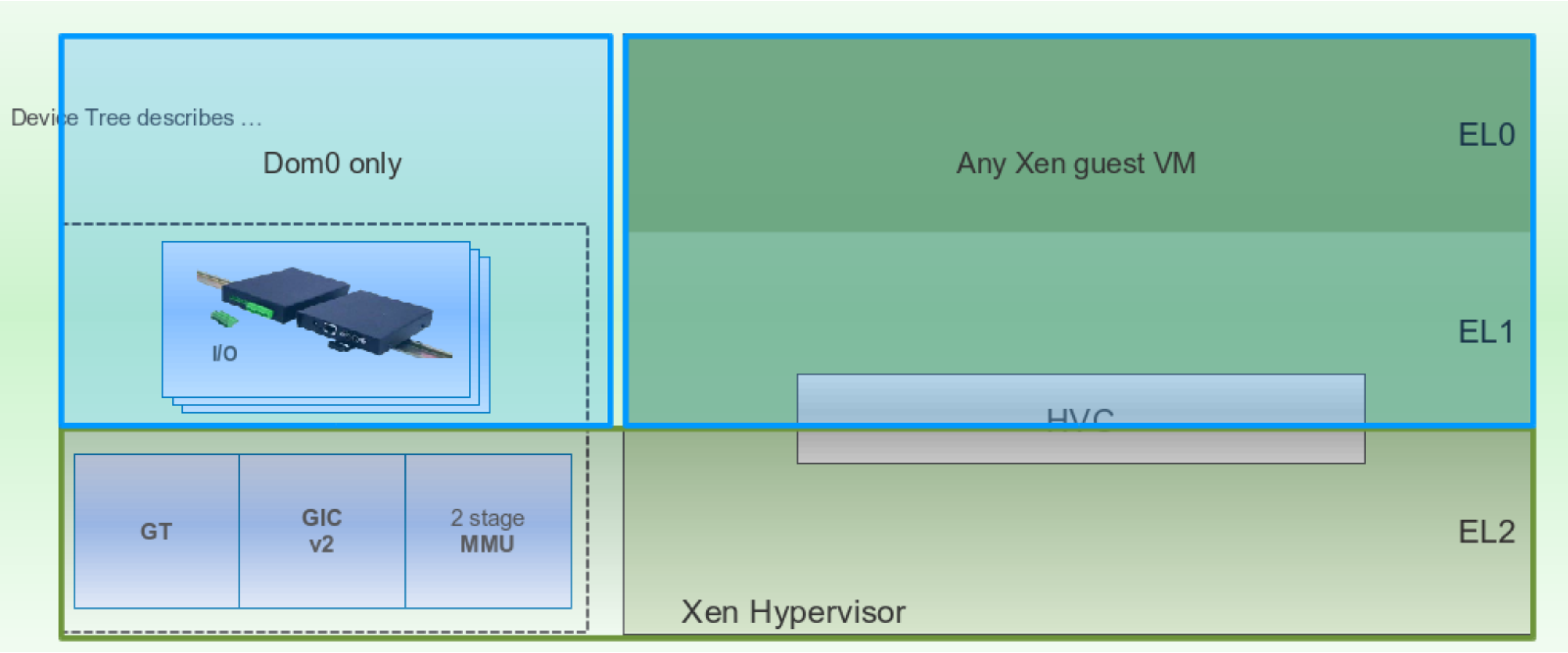
Design goals

- exploit the hardware as much as possible
- one type of guest
- Rearchitected for the modern age:
    - no QEMU
    - no compat code
    - no shadow pagetables
    - no PV MMU hypercalls

Xen on ARM architecture



Xen on ARM architecture



Exploit the hardware

Exploit the hardware virtualization extensions support as much as possible:

- hypervisor mode
- MMU: second stage translation
  - no PV MMU calls
  - no shadow pagetables: -10721 lines of code!!
- hypercall: HVC
- generic timers

General Interrupt Controller

an interrupt controller with virtualization support

- use the GIC to inject hardware interrupts into dom0
- use the GIC to inject event notifications into any guest domains with Xen support
    - use PPI 31
    - advertise the IRQ via Device Tree

One type of guest to rule them all

One type of guest

Like PV guests do it:

- support booting from a supplied kernel
- no emulated devices
- use PV interfaces for IO

↓

no need for QEMU

One type of guest

Like HVM guests do it:

- exploit HW nested paging
- same entry point on native and on Xen
- use Device Tree to discover Xen presence
- no unnecessary devices in the Device Tree
- simple device emulation can be done in Xen

↓

no need for QEMU

The hypercall calling convention

the hypercall interface:

- **hvc** instruction
- hypervisor specific imm **0xEA1**
- hypercall arguments passed in registers

Device Tree

Use Device Tree to describe the virtual platform

```
hypervisor {
        compatible = "xen,xen", "xen,xen-4.2";
        reg = <0xb0000000 0x20000>;
        interrupts = <1 15 0xf08>;
};
```

Device Tree

Use Device Tree to describe the virtual platform

version of the Xen ABI

```
hypervisor {
        compatible = "xen,xen", "xen,xen-4.2";
        reg = <0xb0000000 0x20000>;
        interrupts = <1 15 0xf08>;
};
```

Grant table memory area

event notifications IRQ

a 64 bit "ready" ABI

a single hypercall ABI for 32 bit guests and 64 bit guests

↓

no compat code in Xen

- 2600 lines of code lighter

ARMv8

- Builds on foundations laid by ARMv7
  - xen/arch/arm mostly common code

- Initially 32 bit dom0+domU on 64
  - Kernels already ready
  - 64-bit guest support in progress

Code size
sometimes smaller is better

	Common	ARMv7	ARMv8	Total
xen/arch/arm	5,122	1,969	821	7,912
C	5,023	406	344	5,773
ASM	99	1,563	477	2,139
xen/include/asm-arm	2,315	563	666	3,544
TOTAL	**7,437**	**2,532**	**1,487**	**11,456**

- Entire hypervisor ~200,000LOC
  - X86 (64-bit only) ~100,000LOC (~4,000 ASM)
    - ~22,000: HVM. ~14,000 MMU

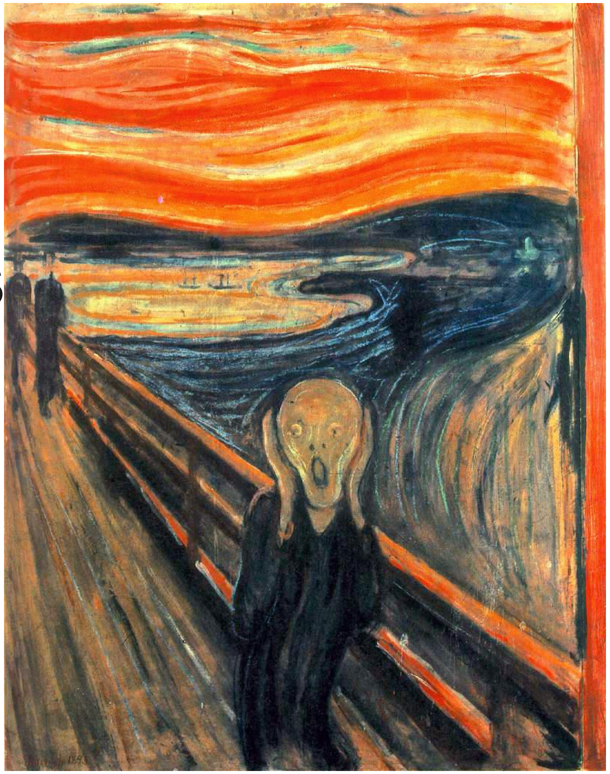
Challenges

From the emulator to real hardware:

~~War Stories~~ Challenges

From the emulator to real hardware:

- barriers and flushes
- cache coherency
- GIC and race conditions
- virt_timer documentation bugs



Porting Xen to a new board

- Xen only relies on GIC and GT
- platform specific code in Xen is reduced to:
  - secondary cpus bring up
  - UART drivers
  - any platform specific bootup quirks (ideally none)

Status of the Project: ARMv7

- Xen and Dom0 booting on Versatile Express Cortex A15 and Arndale
- XL (Xen toolstack) ported to ARM
- PV console, disk and network working
- basic VM lifecycle operations functional
- Xen and Linux ARM patches fully upstream

Status of the Project: ARMv8

- Xen booting 64 bit
- Dom0 32 bit boots on Xen 64 bit
- 32 bit guest creation and destruction
- Shared code means most features developed on ARMv7 Just Work

Roadmap

Xen 4.3

- ARMv7 (VExpress and Arndale) fully supported
- ARMv8 64-bit port of the hypervisor

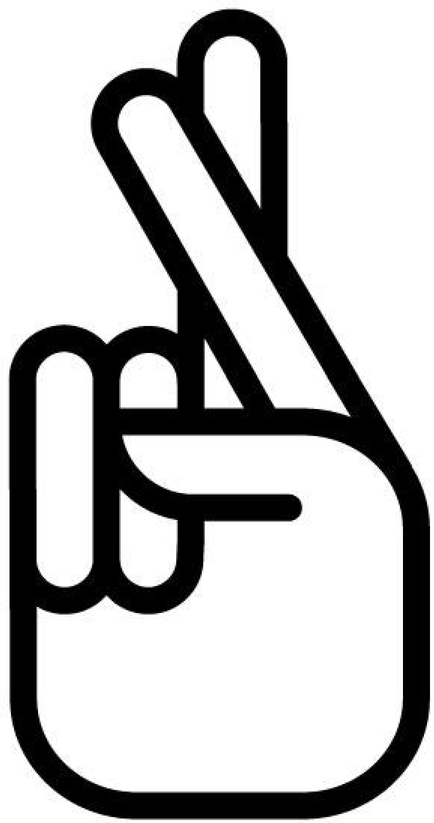
Xen 4.4

- increase HCL
- automated testing
- ARMv8 64-bit virtual machines and tools
- PCI passthrough, live migration

Linux 3.11/3.12

- full ARMv8 64-bit Xen guest support

Demo



More Information

- http://www.xen.org
- Xen on ARM @wiki.xen.org: goo.gl/FKNXe
- http://lists.xen.org/mailman/listinfo/xen-devel