Rust Based Virtio Backends for Hypervisor Agnostic Solutions

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Introduction

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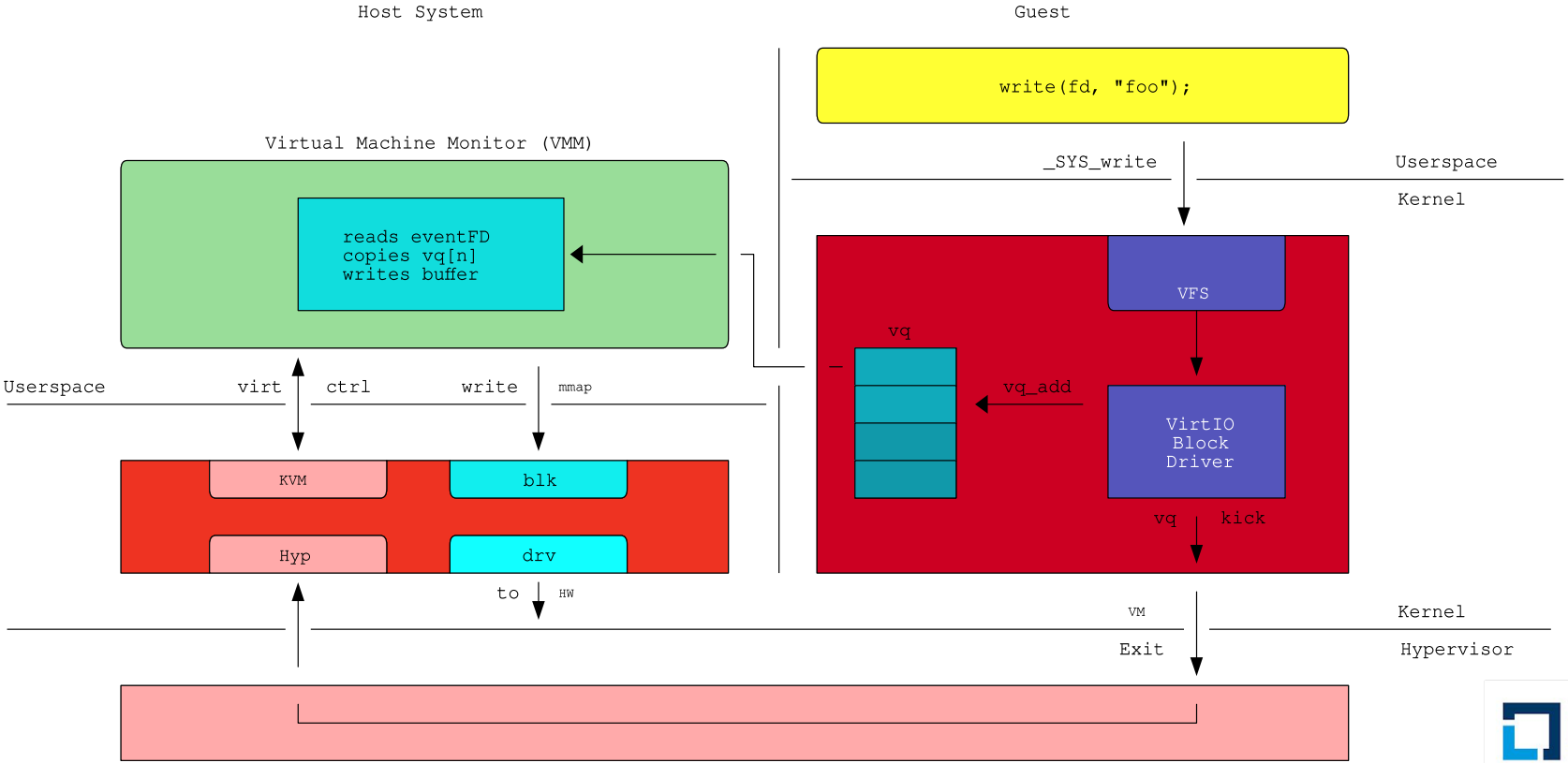
Topics

- Intro to VirtIO / Vhost / Vhost-user
- Linaro’s Project Stratos
- Future work

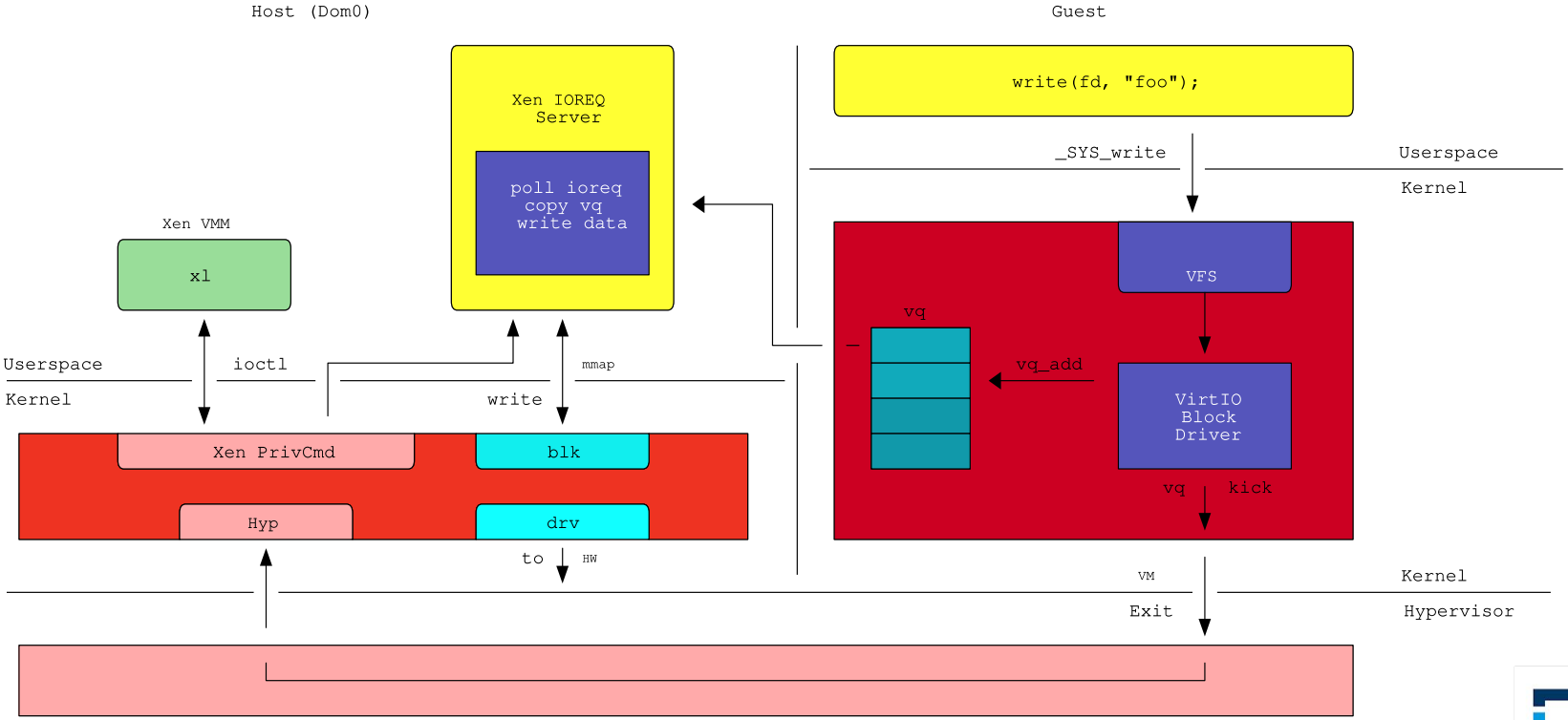
VirtIO

- Standardized open interface for VMs
- Maintained by OASIS
- Host - VirtIO Device
- Guest - VirtIO Driver
- Transport - PCI, MMIO, Channel I/O (s390x)

KVM VirtIO path



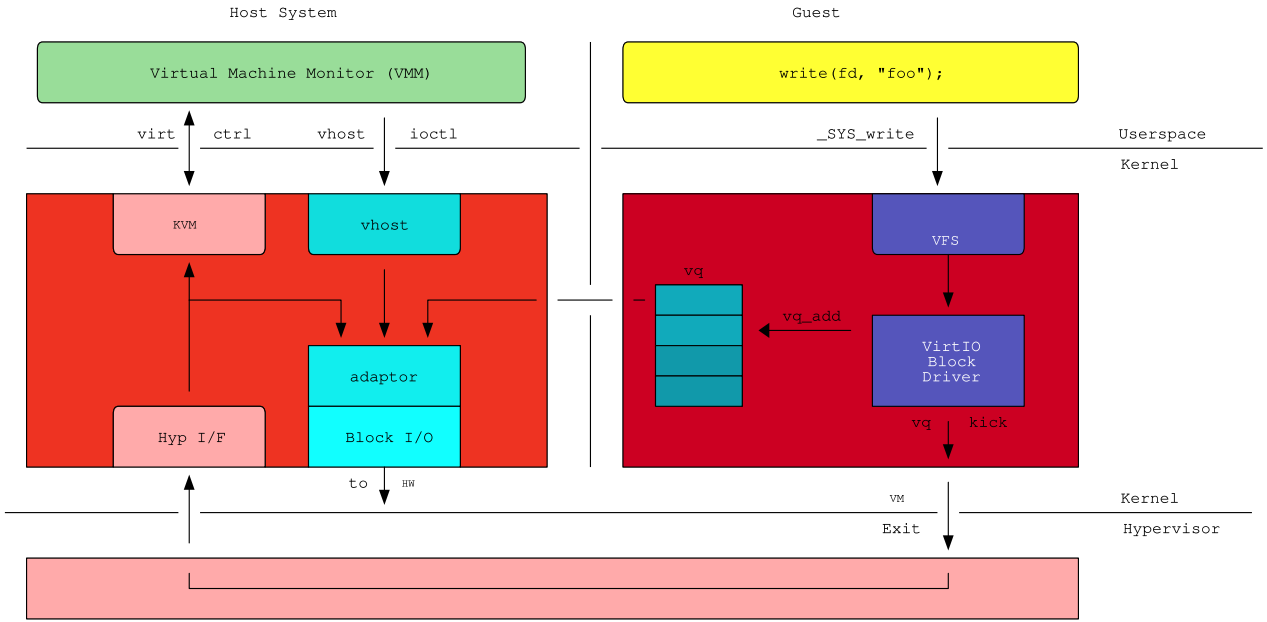
Xen VirtIO Path



Vhost

- Protocol to offload datapath processing.
- Processing happens in the host kernel.
- Implements control path via ioctls to host.

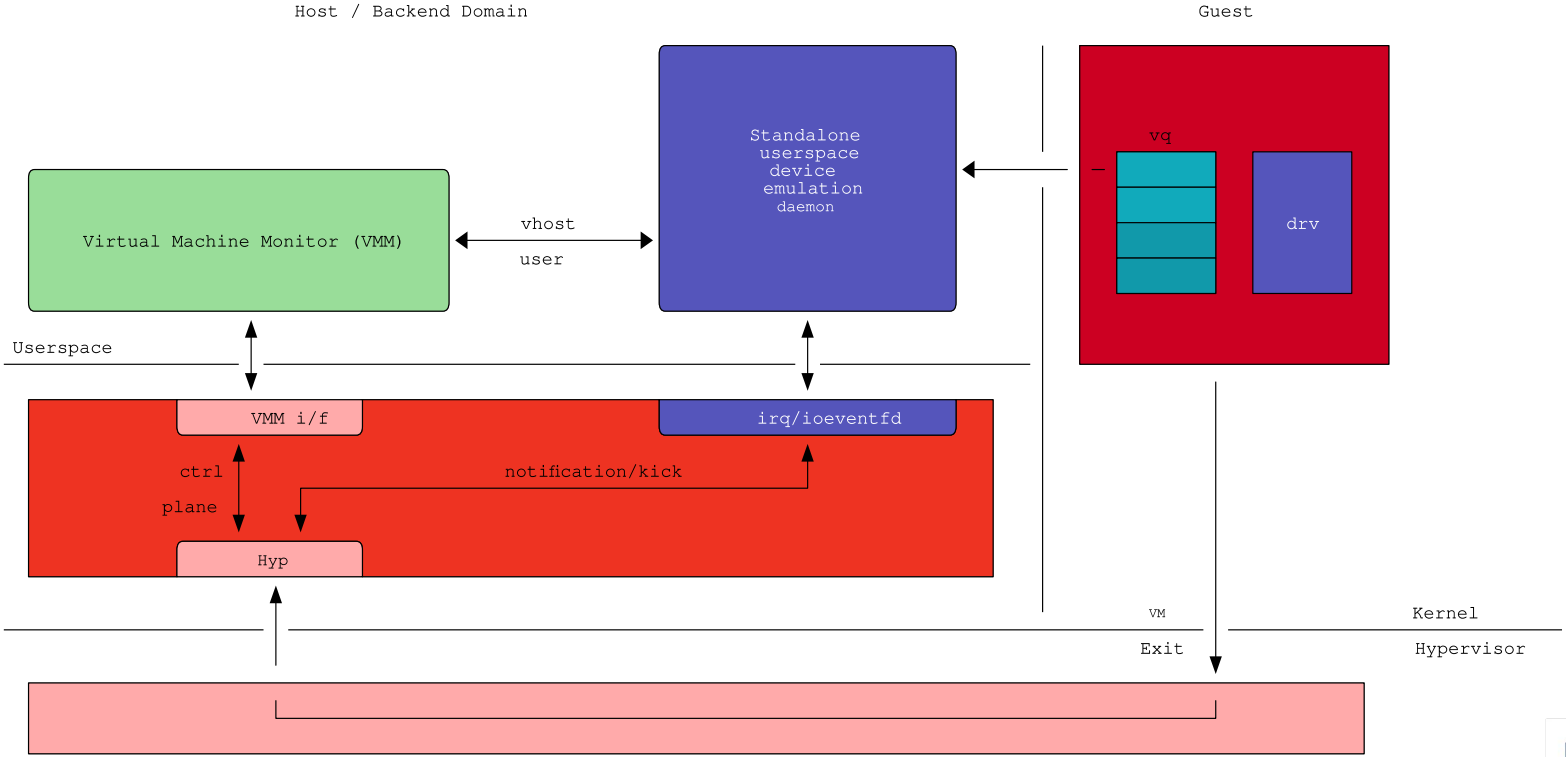
Vhost VirtIO path



Vhost-user

- Processing happens in host userspace.
- Control path via Unix domain socket.
- Defines front-end and back-end.
- Front-end shares its virtqueues (VMM).
- Back-end consumes the virtqueues.

Vhost-user VirtIO path



Linaro's Project Stratos

- Hypervisor Agnostic VirtIO
  - Decouple backends from Hypervisor
- Standardization and Upstreaming
  - Upstreaming VirtIO specification
  - Reviewed and implemented kernel drivers
  - Linux userspace vhost-user daemons
  - Rust bindings for libgpiod
  - Qemu / Xen support

Rust based vhost-user daemons

- Rust
  - Performance, safety and concurrency.
  - Safely handling untrusted guest data
  - Rust is cool

- Rust-vmm
  - Rust framework for building VMMs
  - Common components to share
    - CrosVM, Firecracker, Cloud Hypervisor

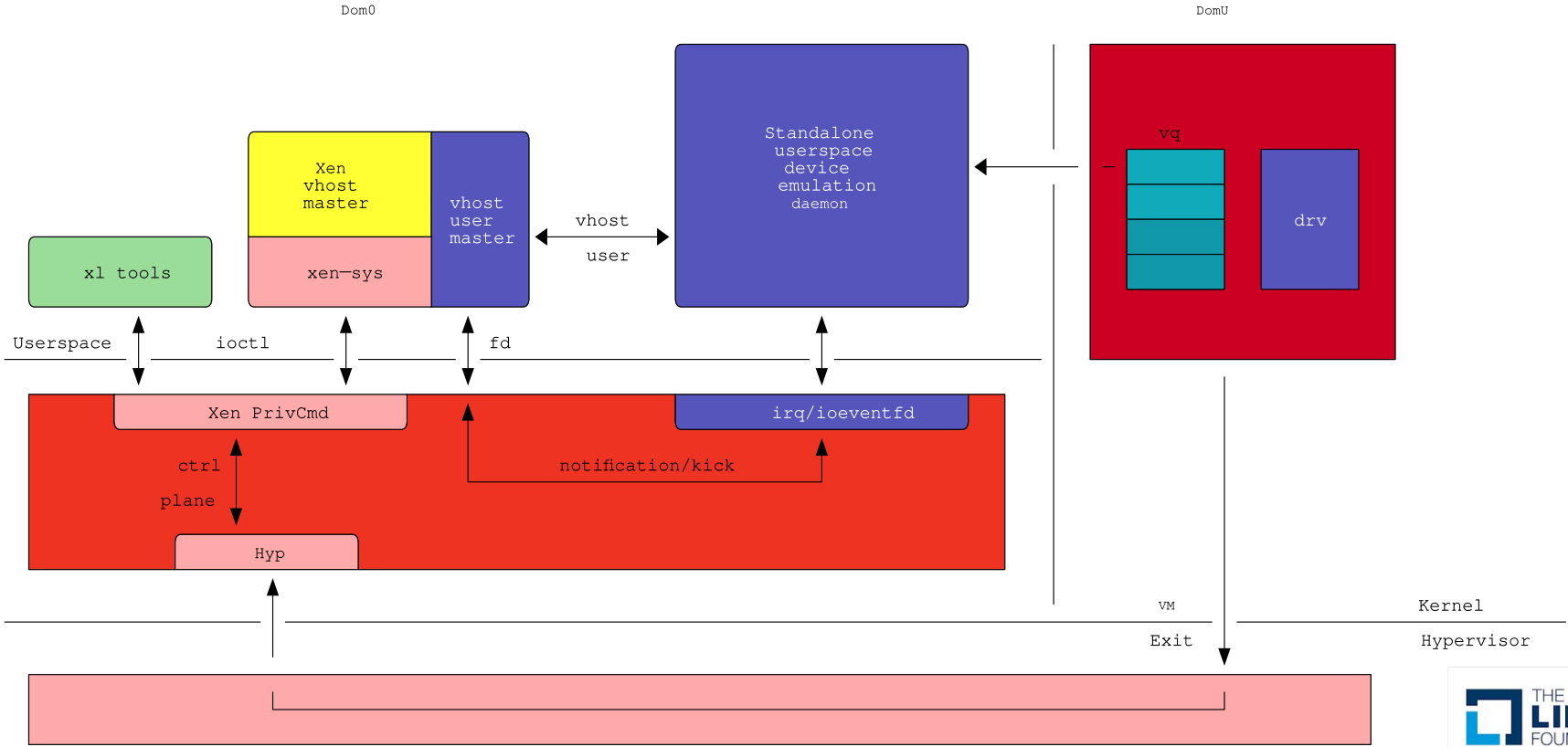
Vhost-device Implementations

- Upstreamed (rust-vmm / vhost-device)
  - gpio
  - i2c
  - rng
- WIP
  - rpmb
  - scmi
  - video
  - vsock
  - scsi

Xen vhost-master Implementation

- Backends developed with QEMU initially.
- Unmodified backends tested with Xen.
- Working implementation available now.
- Backends are truly Hypervisor agnostic.
- WIP to upstream to rust-vmm.

Xen vhost-master (Cont.)



Xen vhost-master (Cont.)

- Components
  - Xen-sys
    - Xen Hypercalls
    - Ioctls via kernel
    - Direct bare metal
  - Vhost user-master
    - Master side of vhost-user protocol
    - Reused from cloud-hypervisor
  - Xen vhost-master
    - Xen specific vhost-master implementation
    - Based on EPAM's virtio-disk implementation

Xen’s User vs Kernel Pages

- Xen doesn’t use /dev/shm
- /dev/xen/privcmd, uses kernel memory.
  - Kernel sets user PTE to invalid for short time
  - Xen gets EFAULT on access

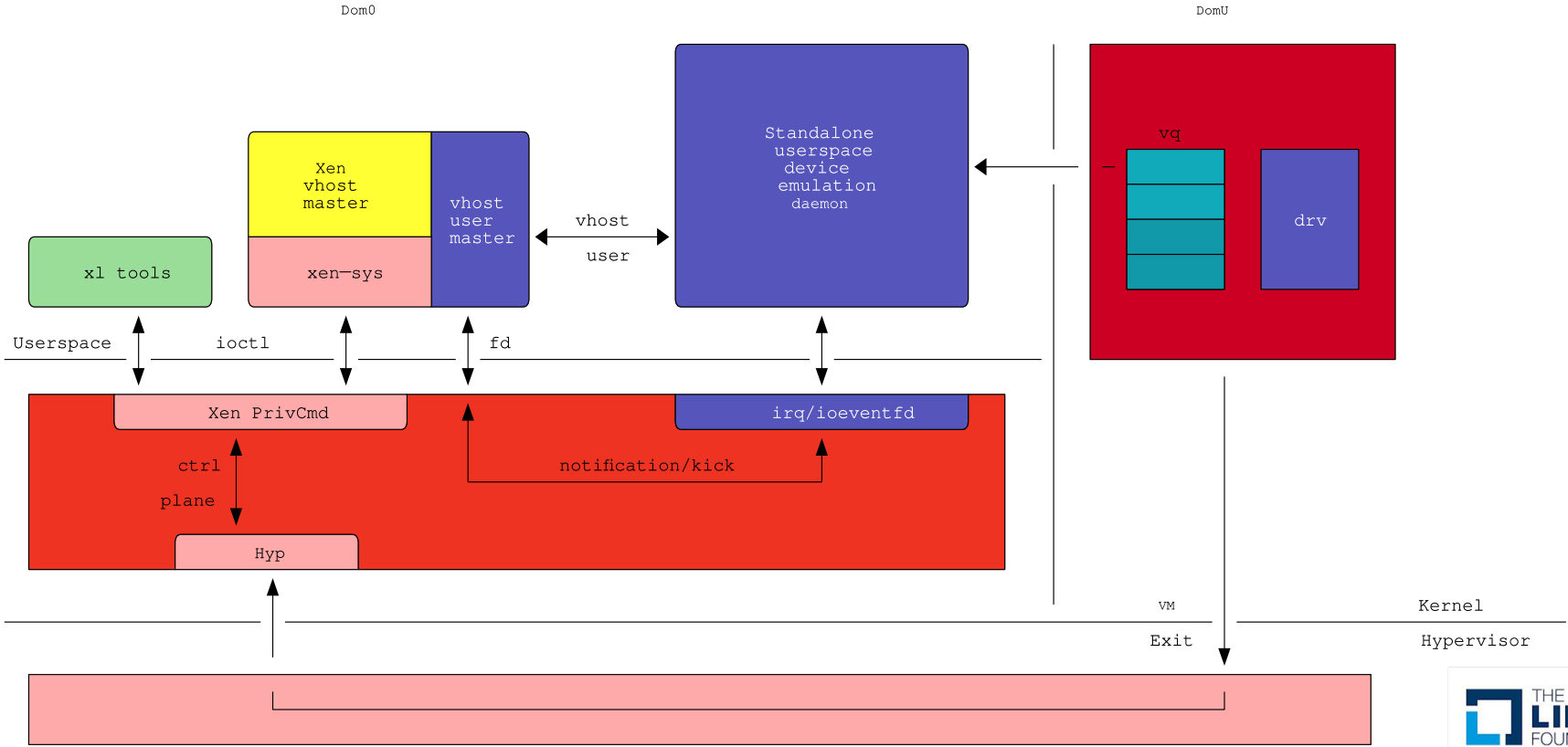
Adapting Xen's Mmap API

- Require mmap() followed by ioctl().
- Rust backends call standard mmap().
- Breaks hypervisor agnosticism.
- Workaround: hacked kernel to perform everything from mmap().

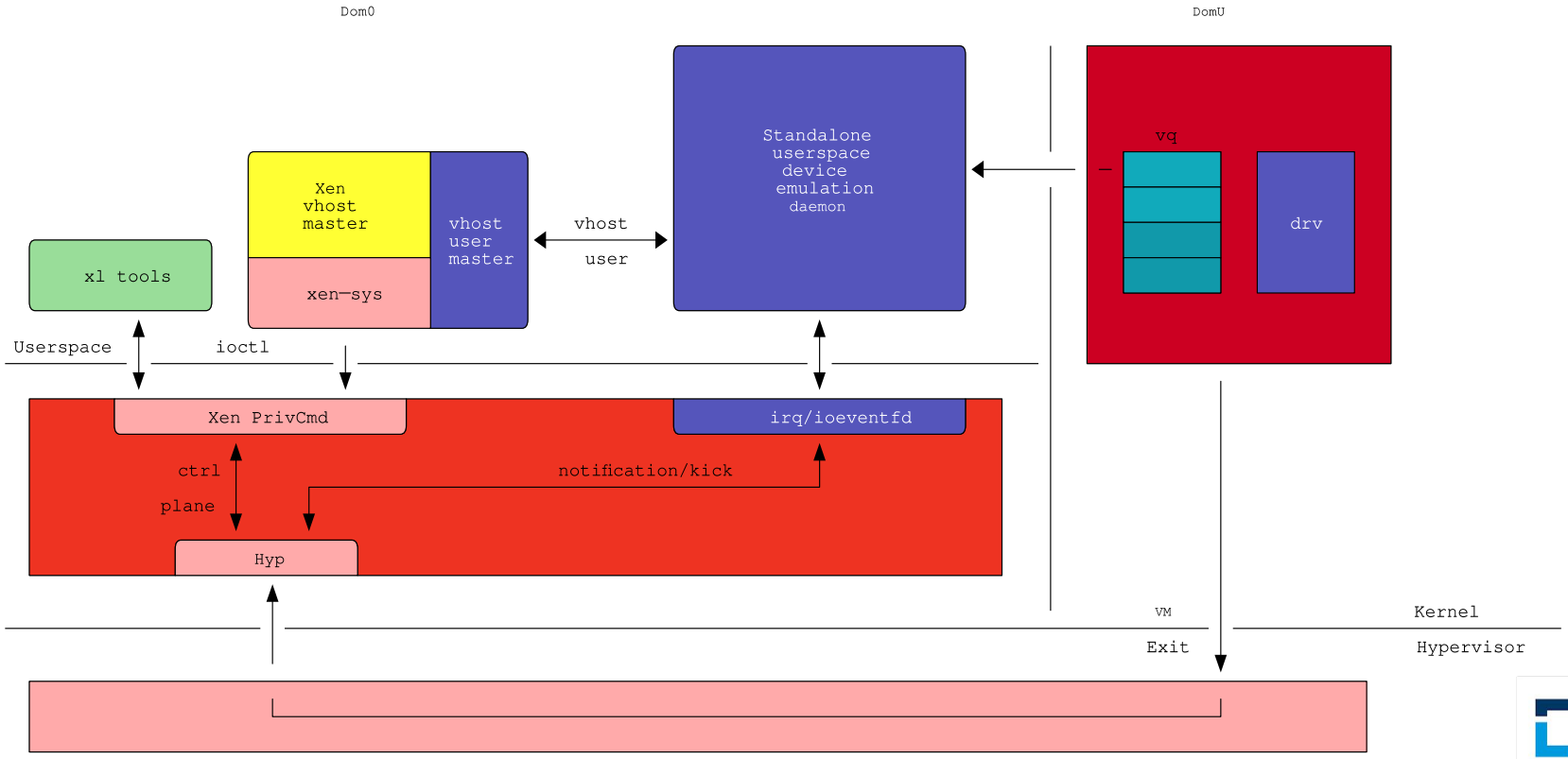
What's next

- Upstreaming
  - vhost-user-master (from Cloud Hypervisor)
  - xen-vhost-master (from Stratos)
- Standard mmap()
- Direct irqfd / eventfd routing
- Guest memory-space privatization

Indirect irqfd / eventfd



Direct irqfd / eventfd



Guest memory-space privatization

- Backend can access entire guest space.
- Limit to virtqueues and buffers.

Approach	**Pro**	**Con**
Per request map (grant / iommu)	Fits existing models	Slow?
Carved out regions (swtlb)	Single mapping	No zero copy, dimensioning
Fat virt queues (data in vq)	Only map virtqueues	API assumptions, low data rate only

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- Fortnightly Rust-vmm Sync

KVM FORUM