Making VirtIO sing

Implementing virtio-sound in rust-vmm project

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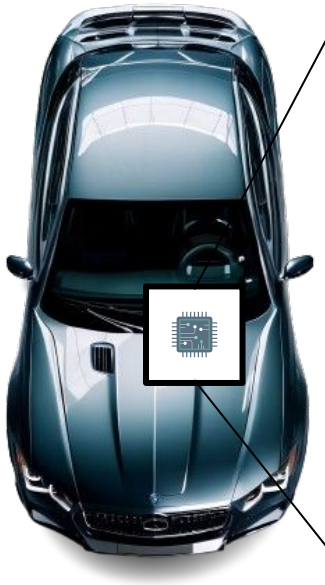
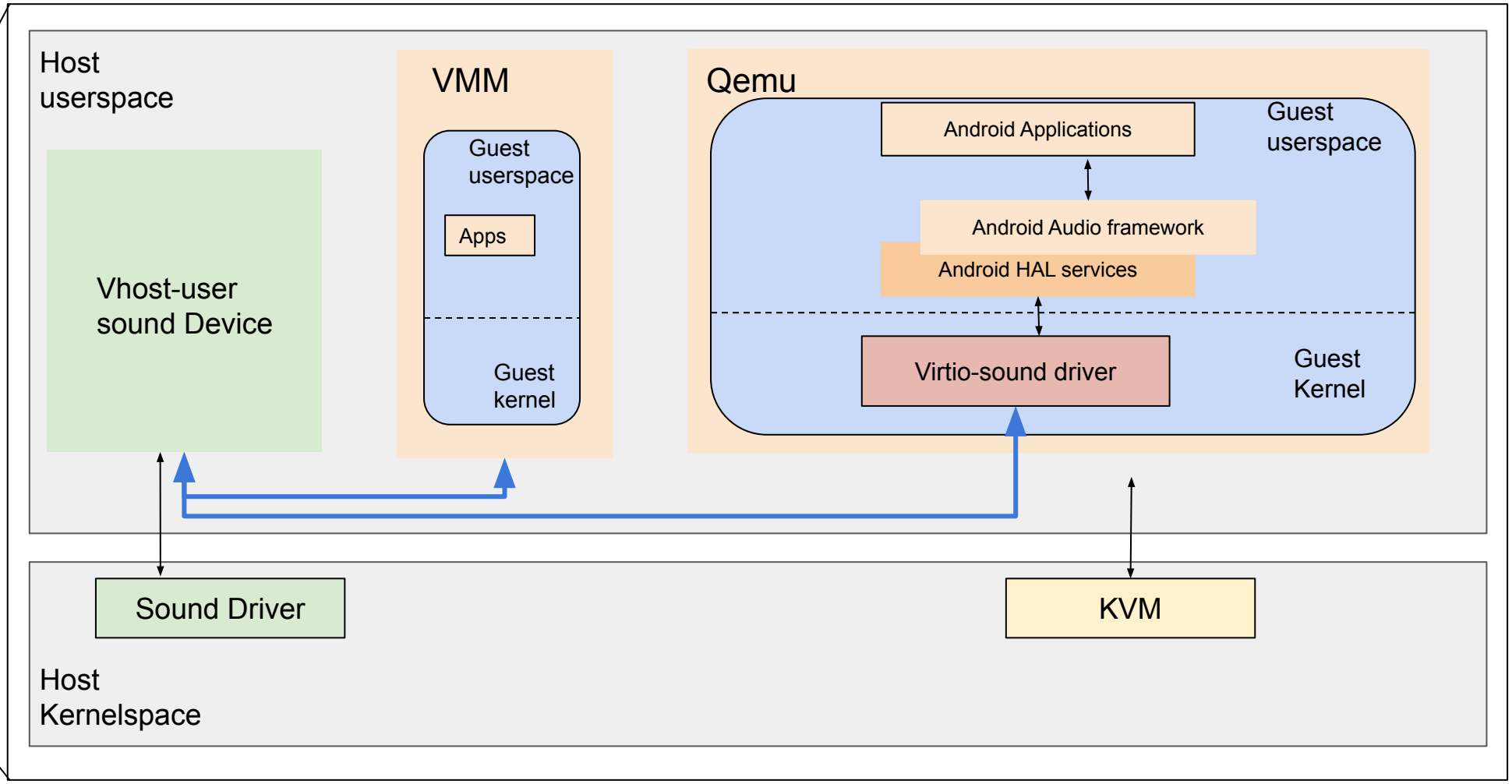
Outline

- Automotive use case
- Protocol Overview
- Virtio-sound device and driver
- Vhost-user implementation
- Audio backend architecture
- Upstream status
- Questions

Use case: Automotive





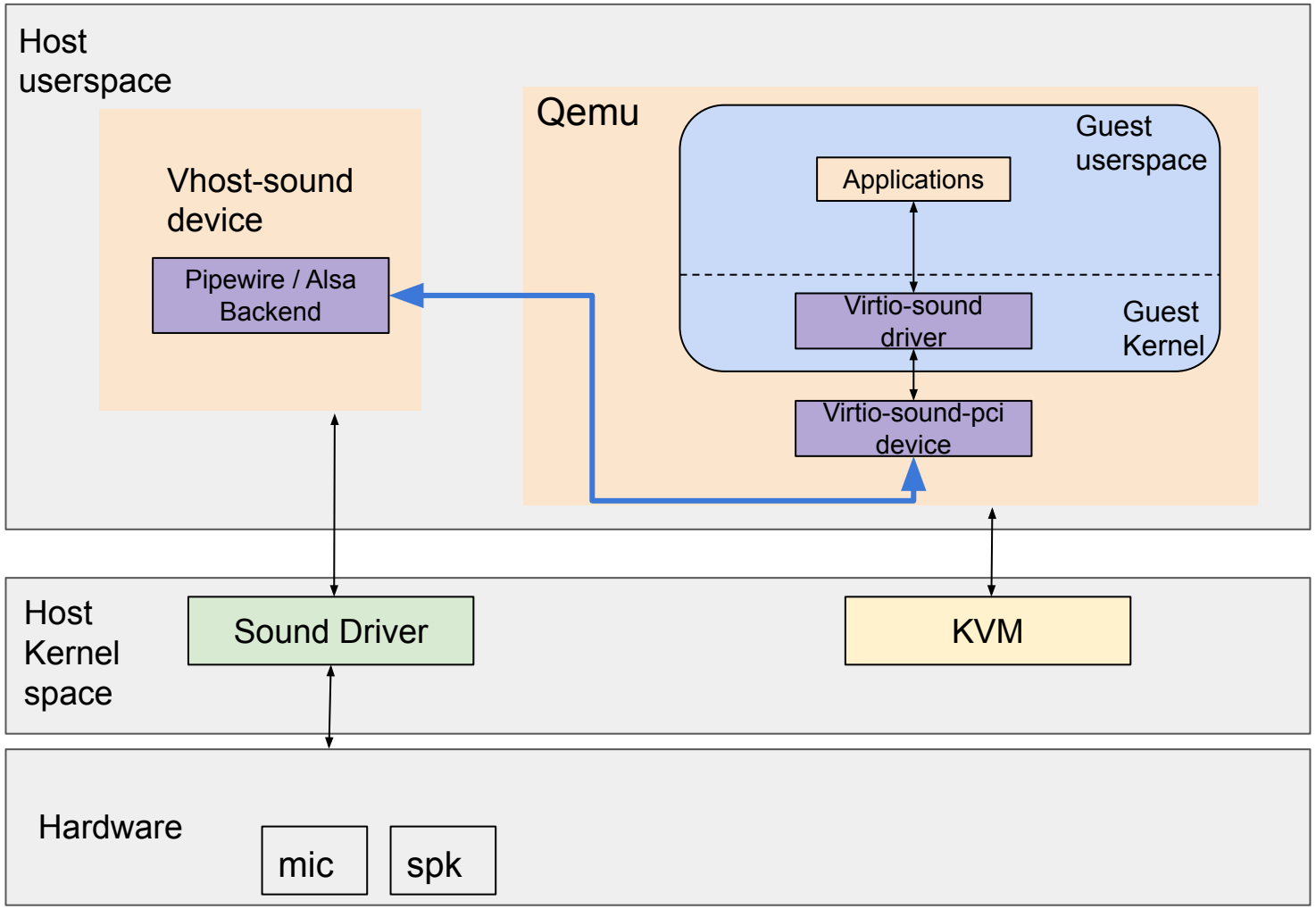
https://source.android.com/docs/automotive/virtualization/reference_platform

What is virtio-sound?

- Paravirtualized sound device
  - VIRTIO spec 1.2: [5.14 Sound Device]

Consisting of:

- Virtio-sound driver
- PCI transport
- Vhost-user sound device



Overview of the Protocol

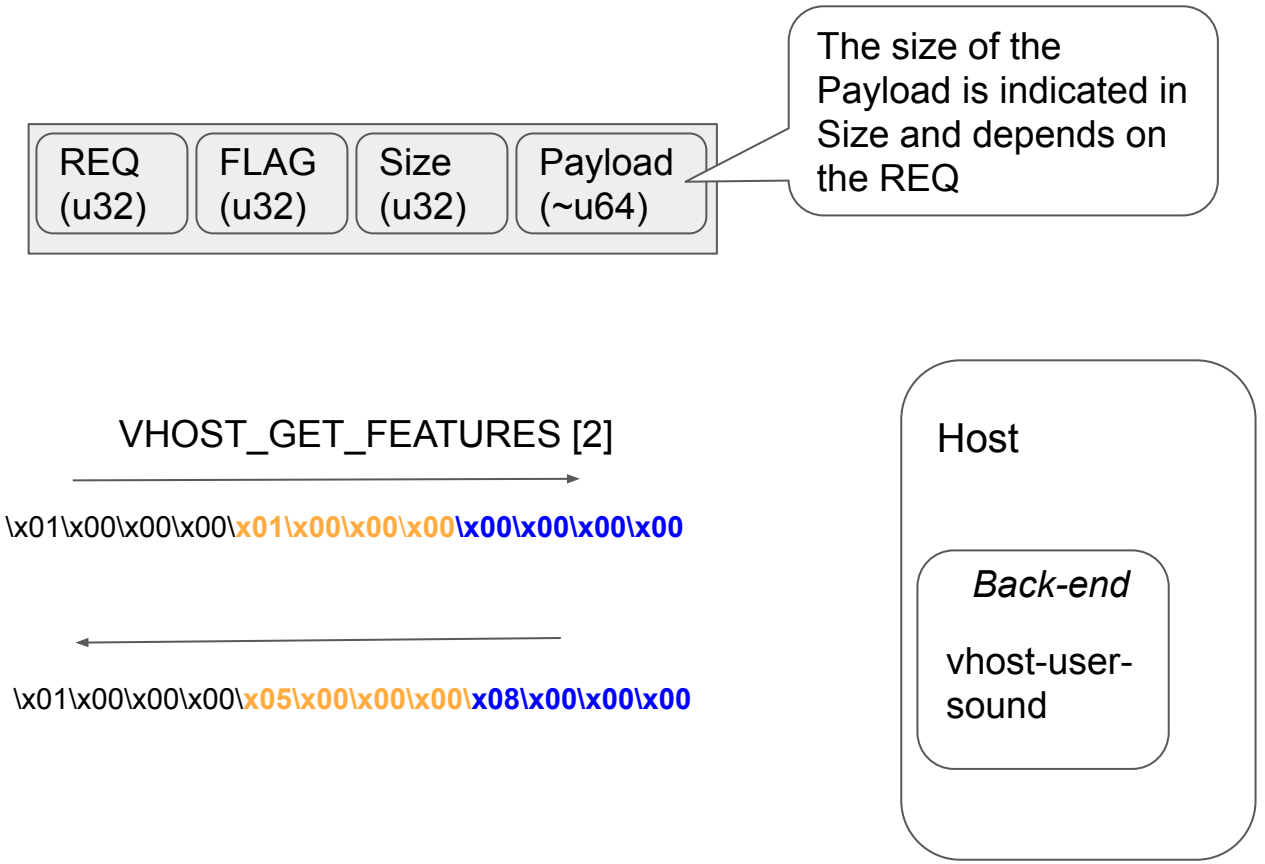
Vhost-user protocol

- Unix Domain socket for the control plane
- Consist of
  - Frontend sending message request
  - Backend sending message replies
- Establish Virtqueues sharing between the Host application and the virtio-sound driver in the Guest

Example of vhost-user protocol message

Dump unix domain socket traffic [1]

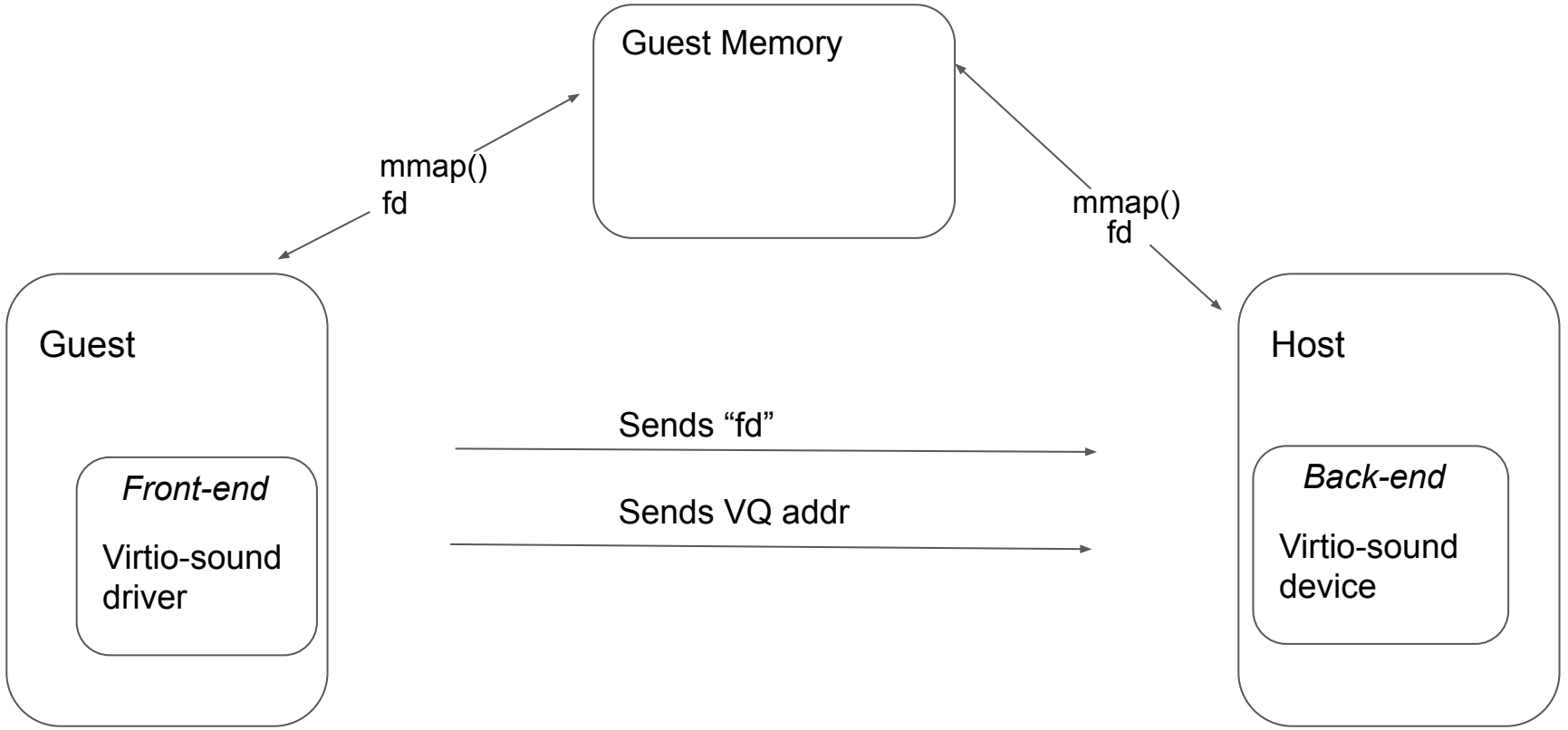
```
$ sudo ./sockdump.py --format hexstring /tmp/vhost4.socket
```



[1]https://medium.com/@dorindabassey/how-to-dump-unix-domain-socket-traffic-between-qemu-and-rust-vmm-with-sockdump-tool-d5adb45e4738

[2] https://www.qemu.org/docs/master/interop/vhost-user.html

Accessing guest's memory through vhost-user protocol



Virtio-sound device and driver

Feature Bits Negotiation:

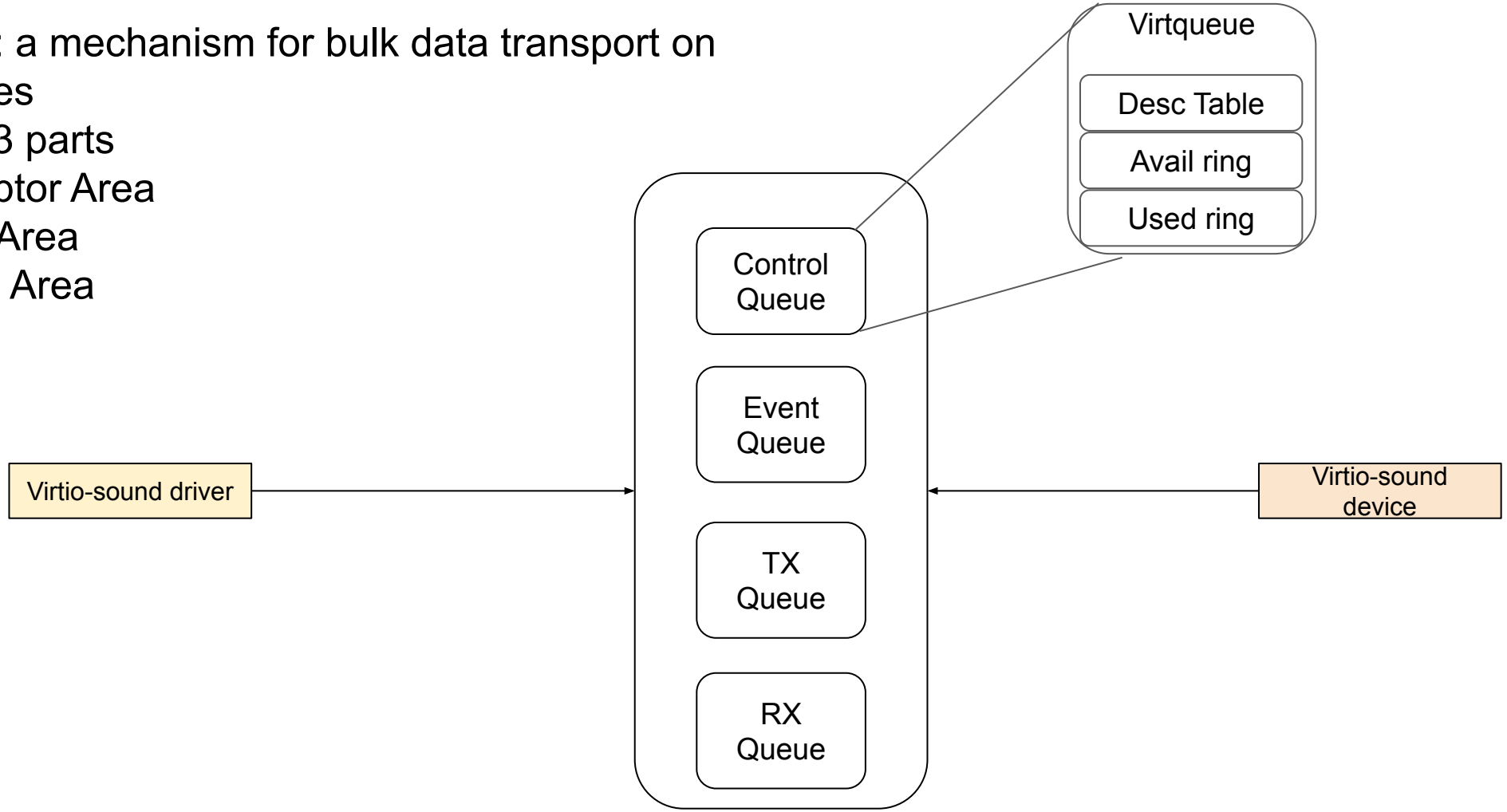
- At device initialization
- set feature flags based on the feature bits negotiated

```
fn features(&self) -> u64 {
        1 << VIRTIO_F_VERSION_1
        | 1 << VIRTIO_F_NOTIFY_ON_EMPTY
        | 1 << VIRTIO_RING_F_INDIRECT_DESC
        | 1 << VIRTIO_RING_F_EVENT_IDX
        | VhostUserVirtioFeatures::PROTOCOL_FEATURES.bits()
}
```

Virtio-sound device and driver

Virtqueues: a mechanism for bulk data transport on virtio devices
Consist of 3 parts

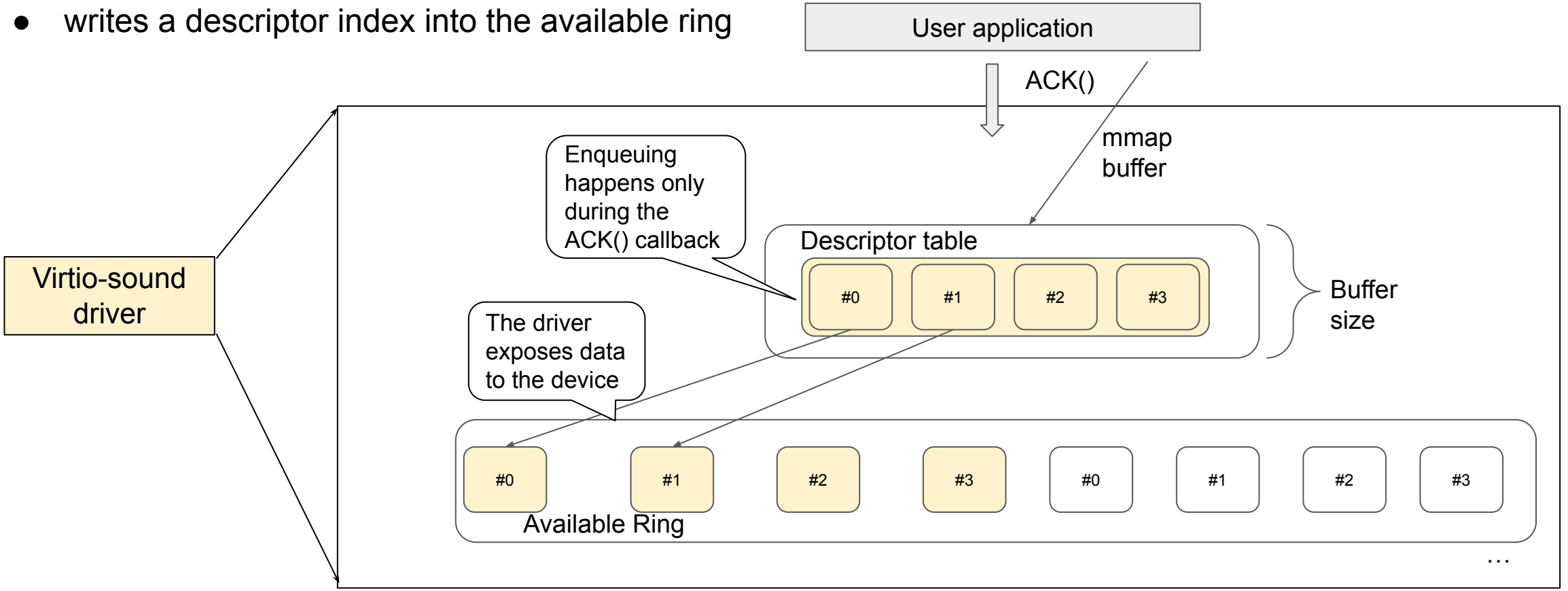
- Descriptor Area
- Driver Area
- Device Area



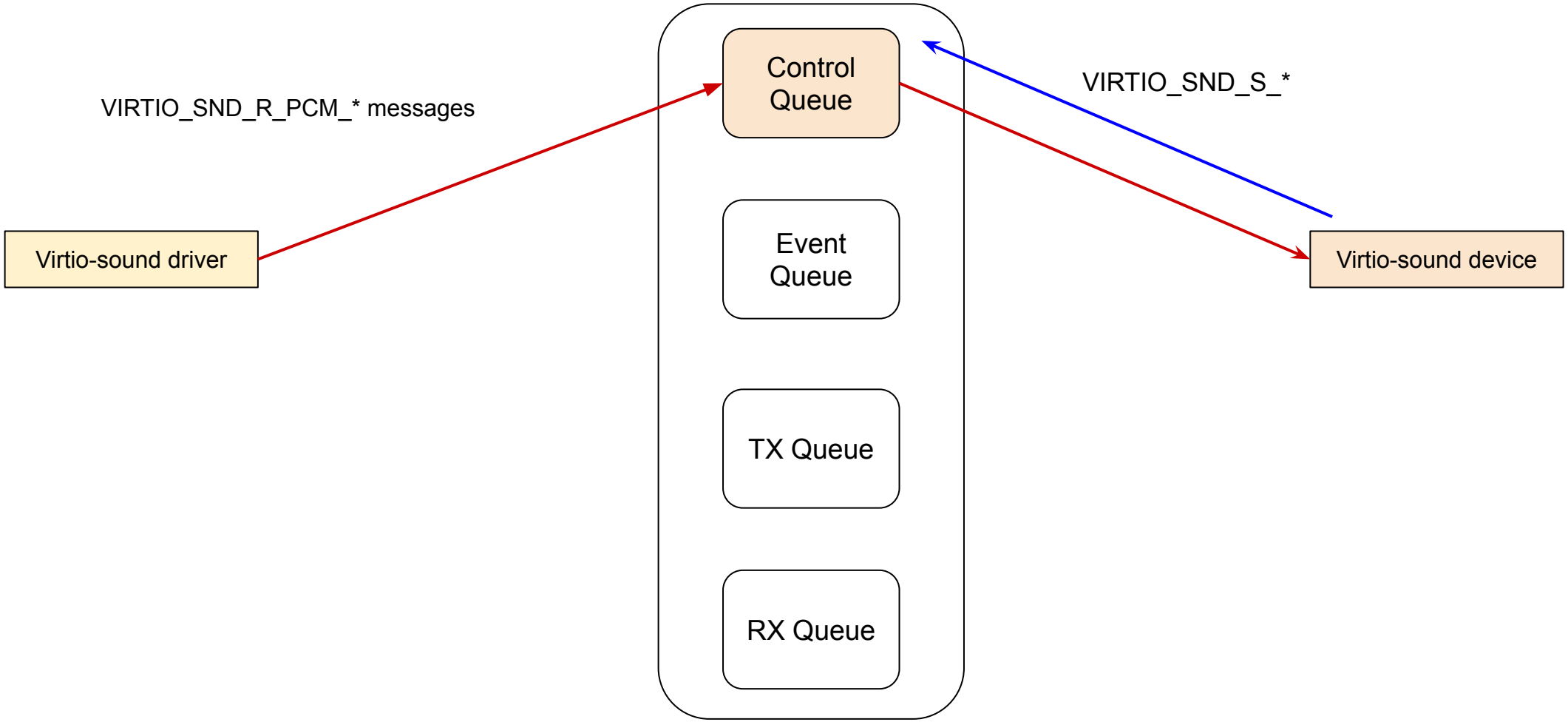
Virtio sound device and driver: How it works?

Virtio-sound Driver:

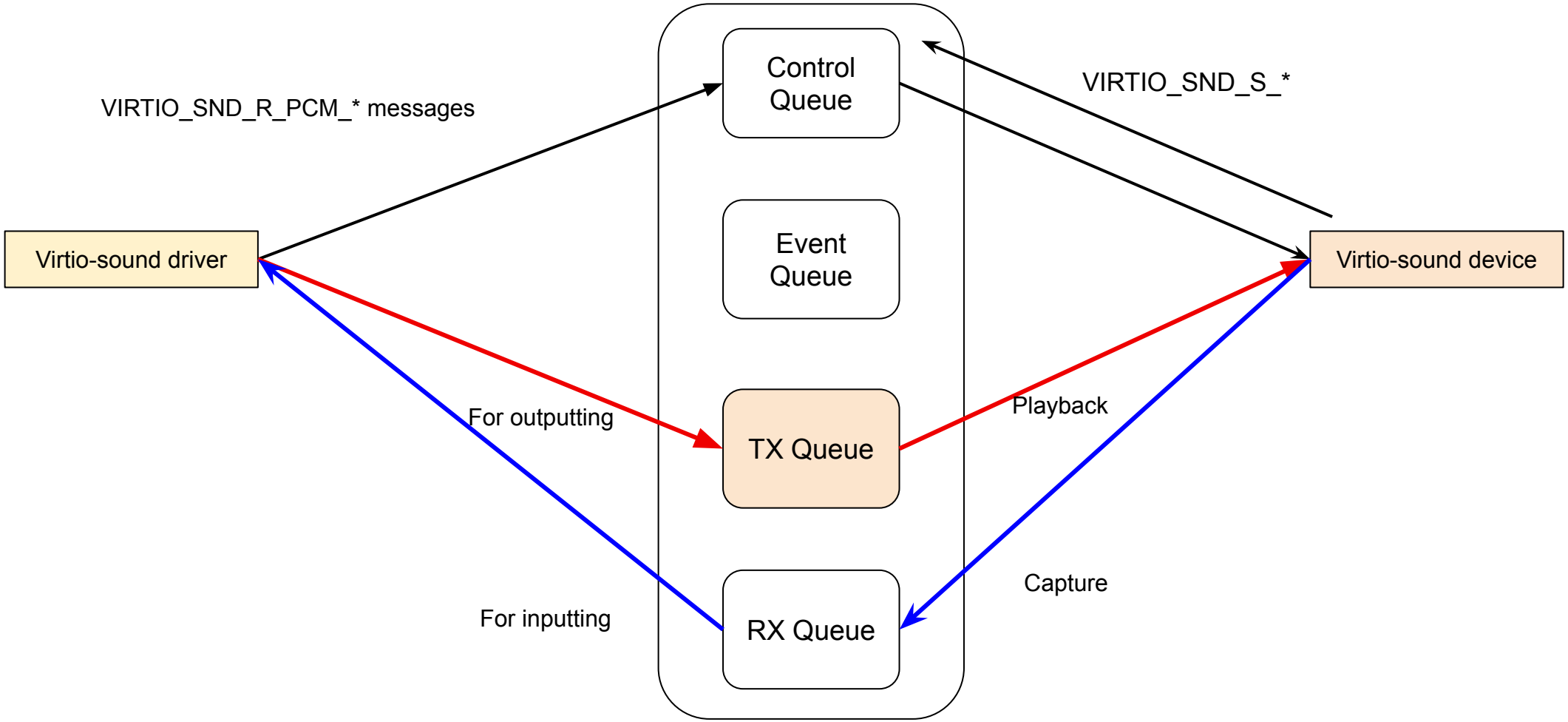
- creates a descriptor chain
- writes a descriptor index into the available ring



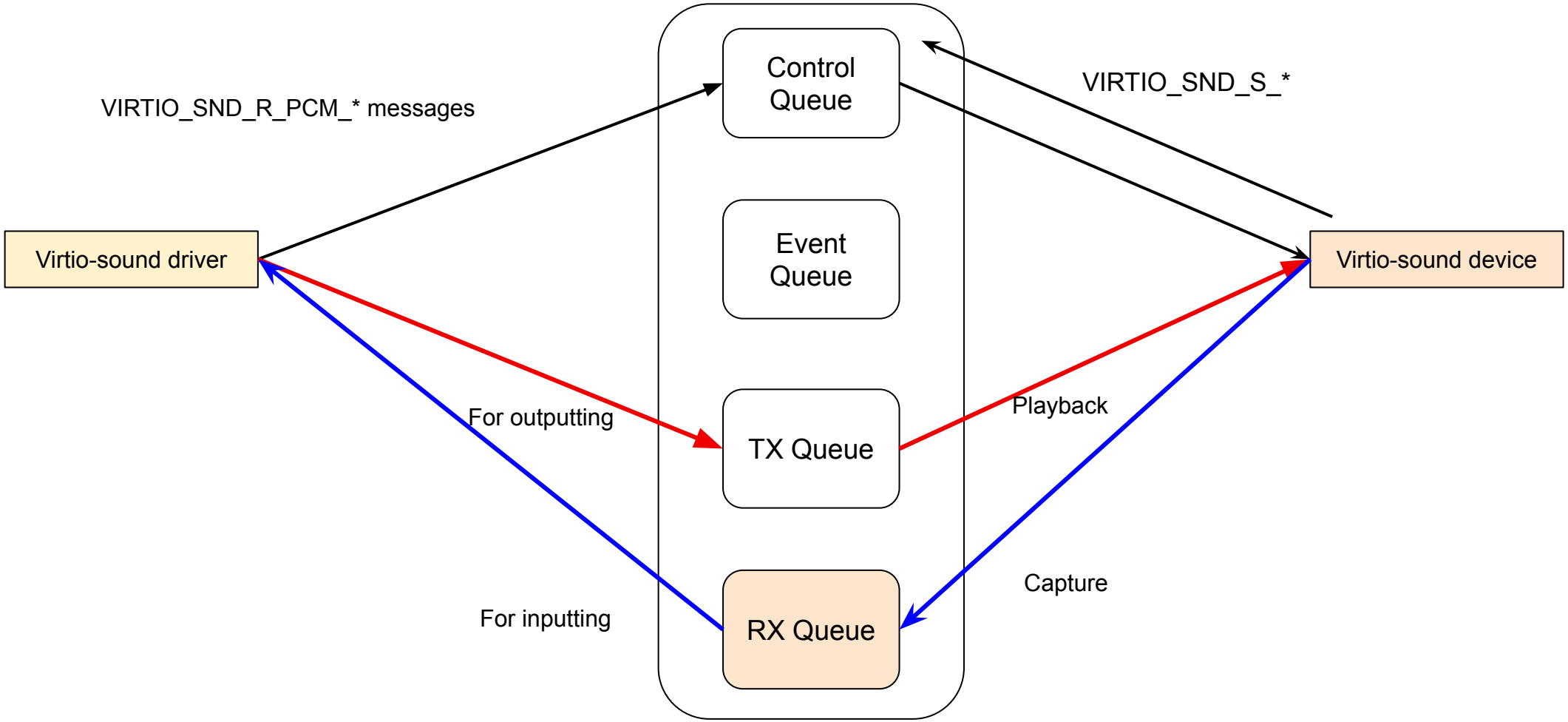
Virtio-sound device and driver



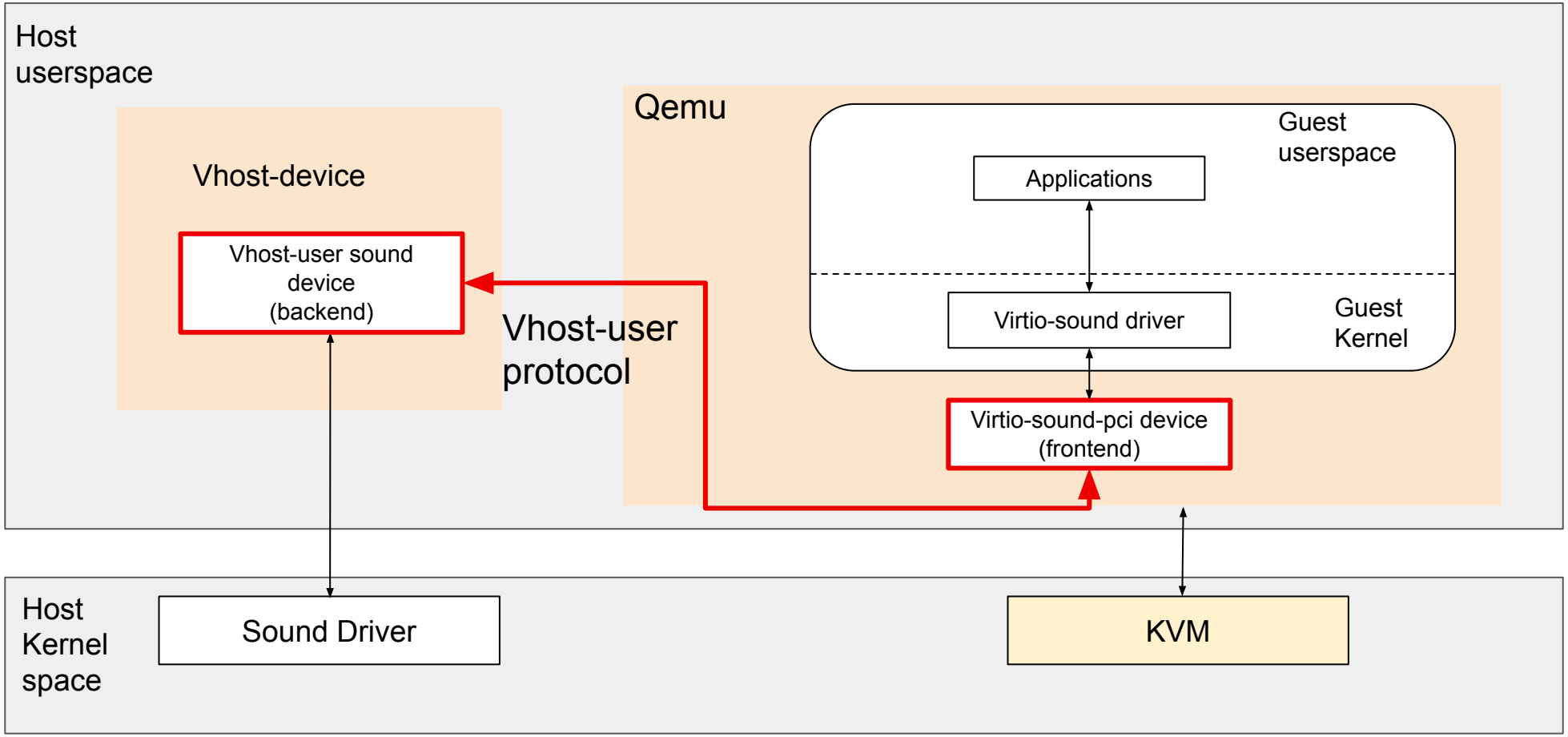
Virtio-sound device and driver



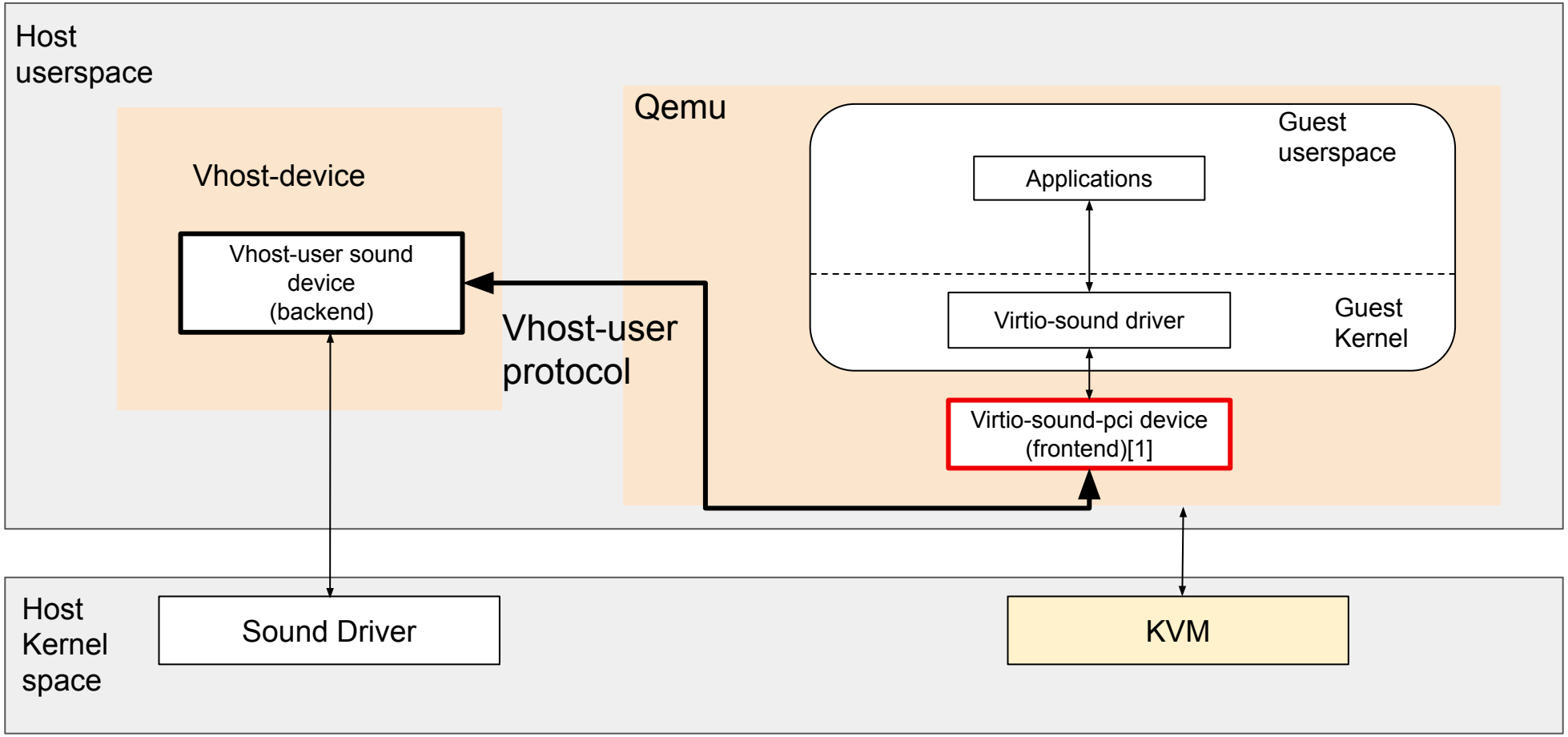
Virtio-sound device and driver



Vhost-user-sound device implementation

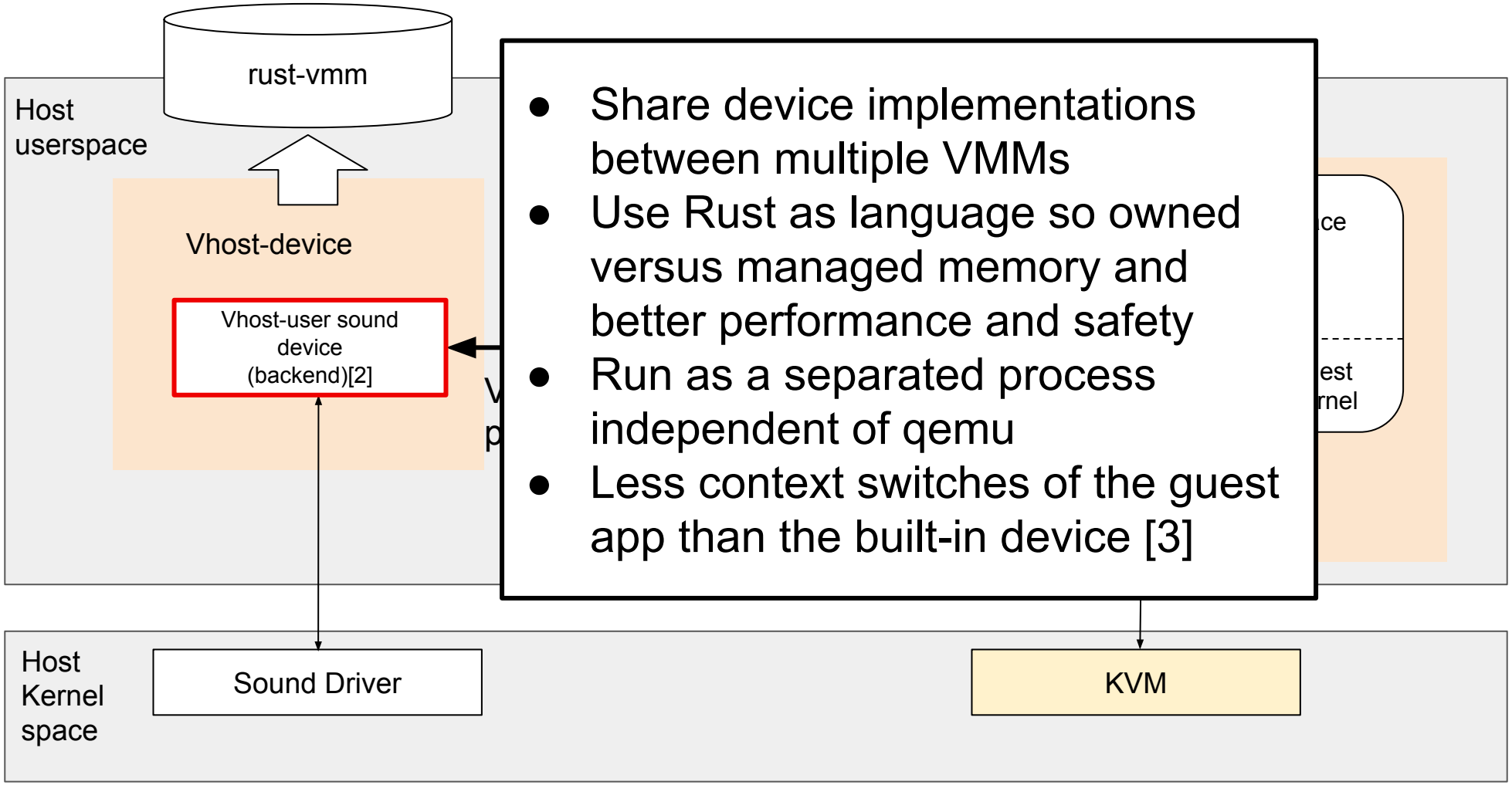


Vhost-user-sound device implementation



[1] [PATCH v9 00/11] virtio: cleanup vhost-user-generic and reduce c&p + vhost-user-input

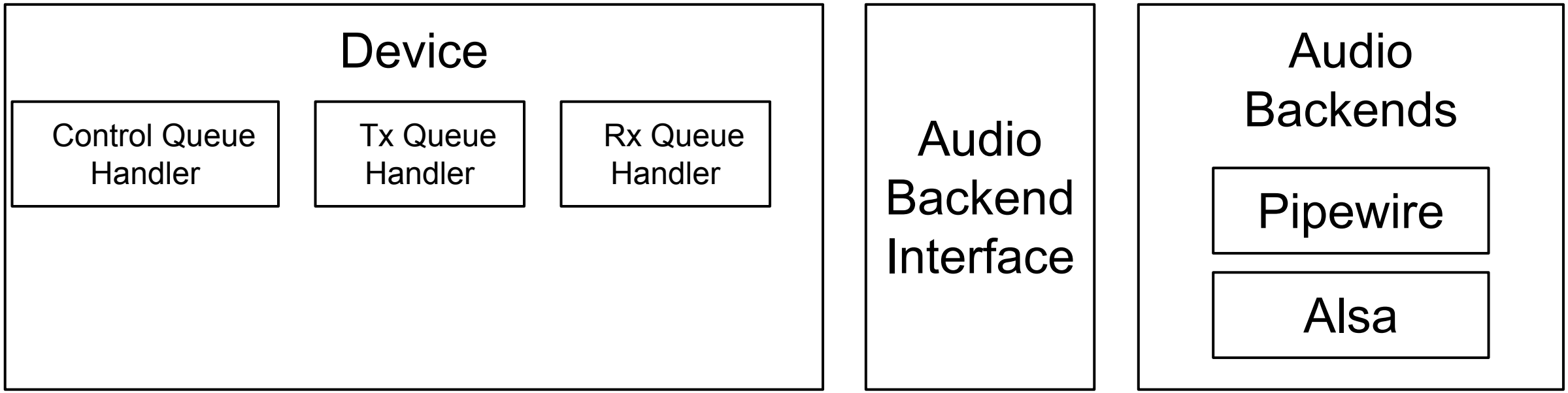
Vhost-user-sound device implementation



- Share device implementations between multiple VMMs
- Use Rust as language so owned versus managed memory and better performance and safety
- Run as a separated process independent of qemu
- Less context switches of the guest app than the built-in device [3]

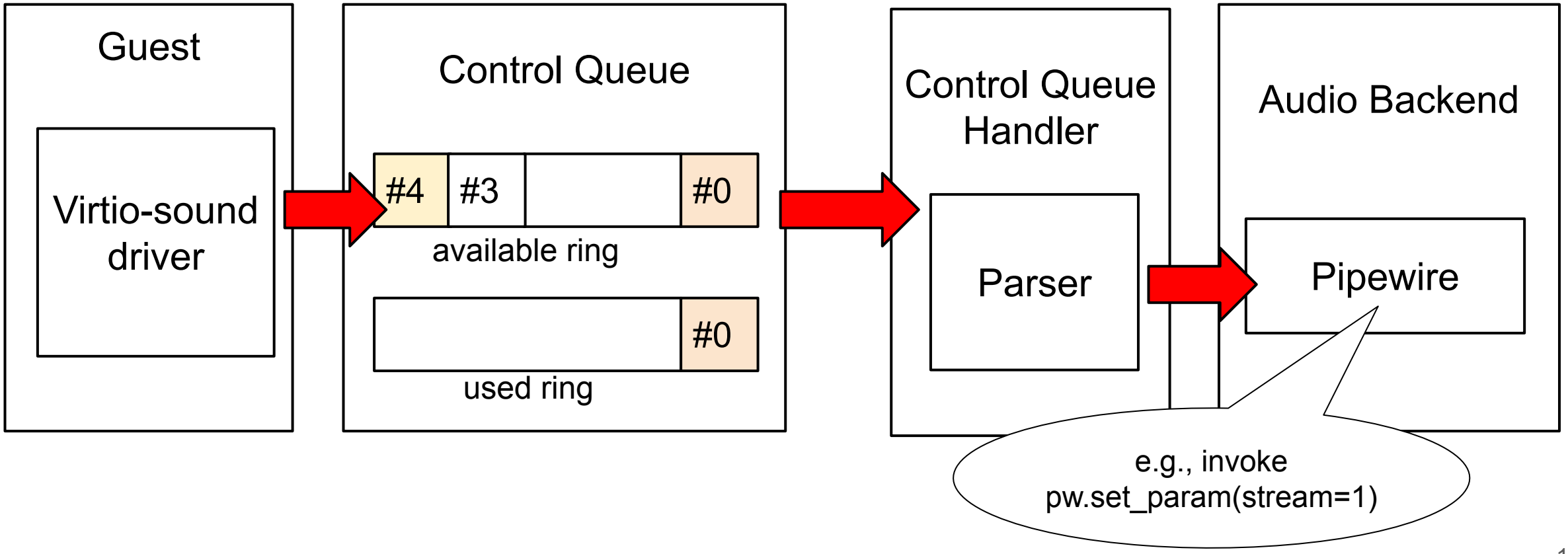
[2] https://github.com/rust-vmm/vhost-device
[3] https://gist.github.com/MatiasVara/c69a70a1547ecea0044ece43e4ab9e41

Vhost-user-sound device implementation

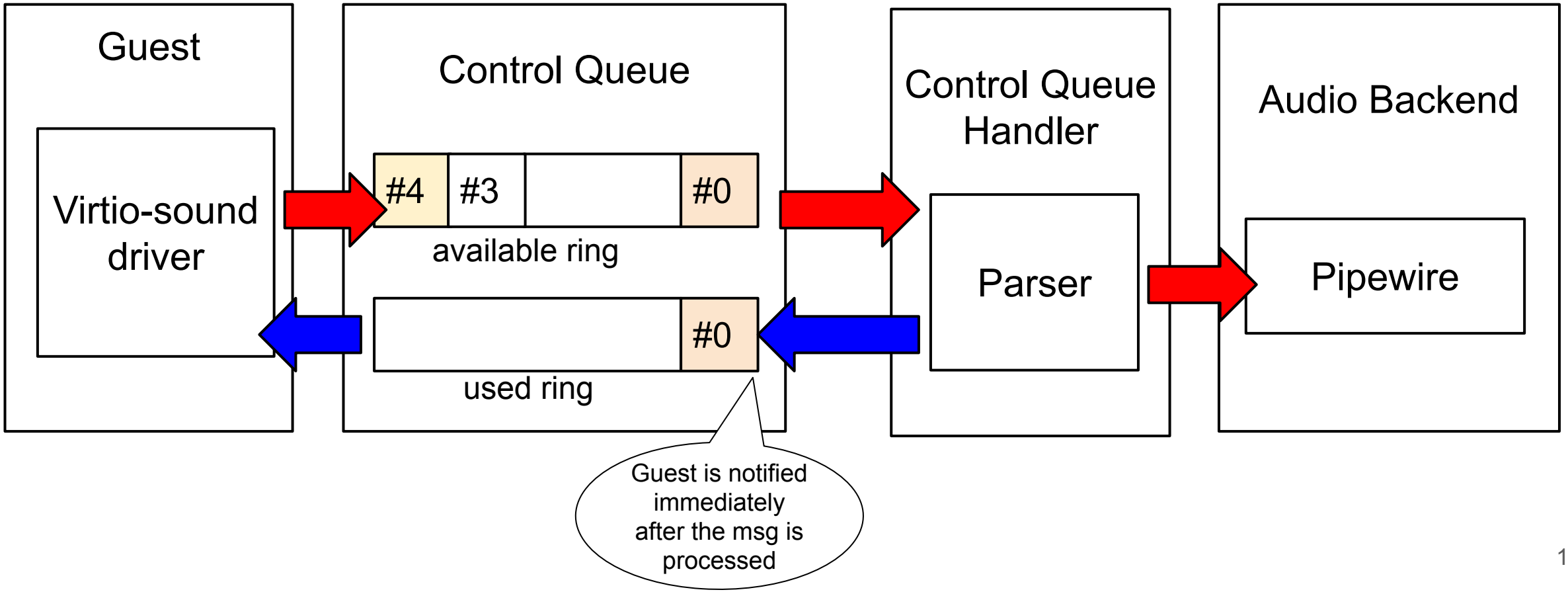


1 Thread for all queues
1 Thread per Stream
1 Stream for input
1 Stream for output

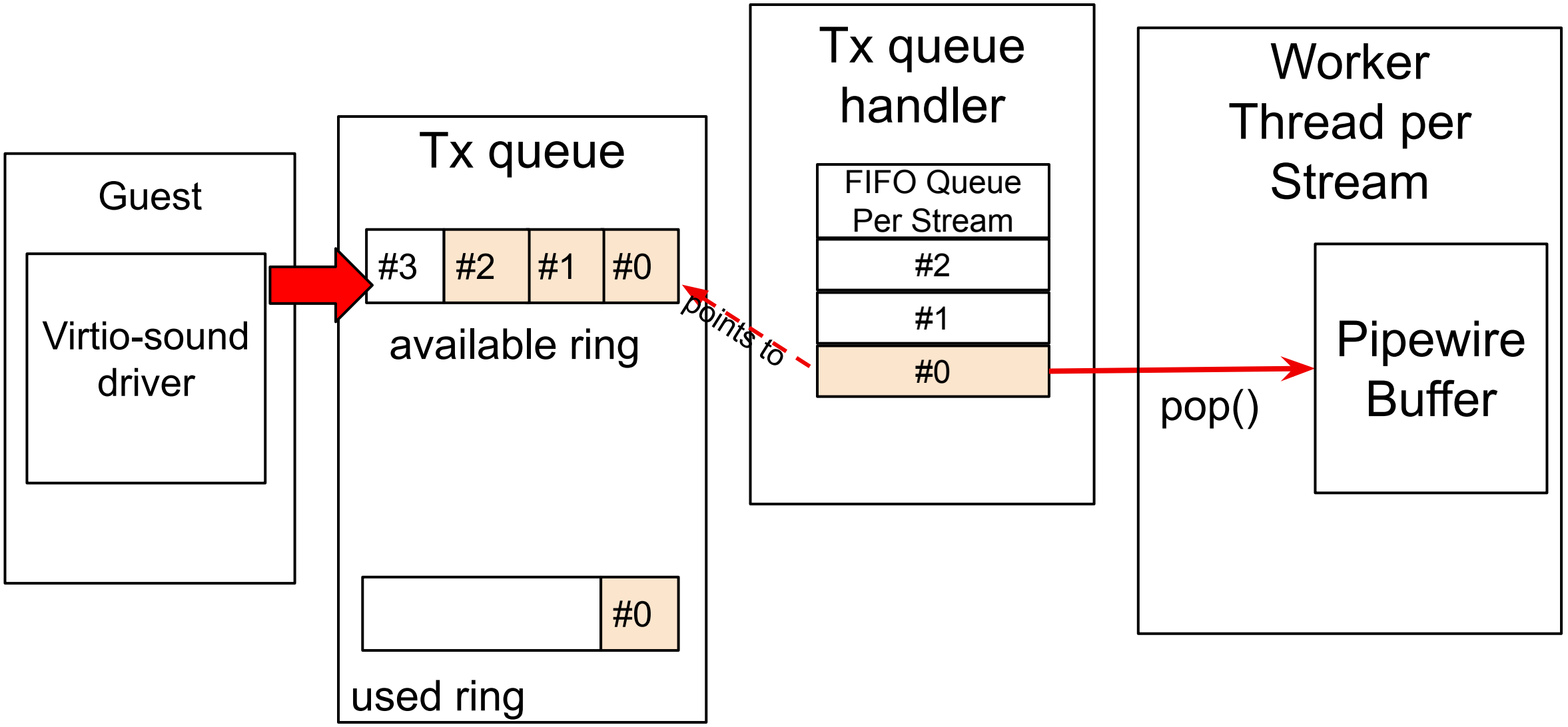
Control Messages Handler



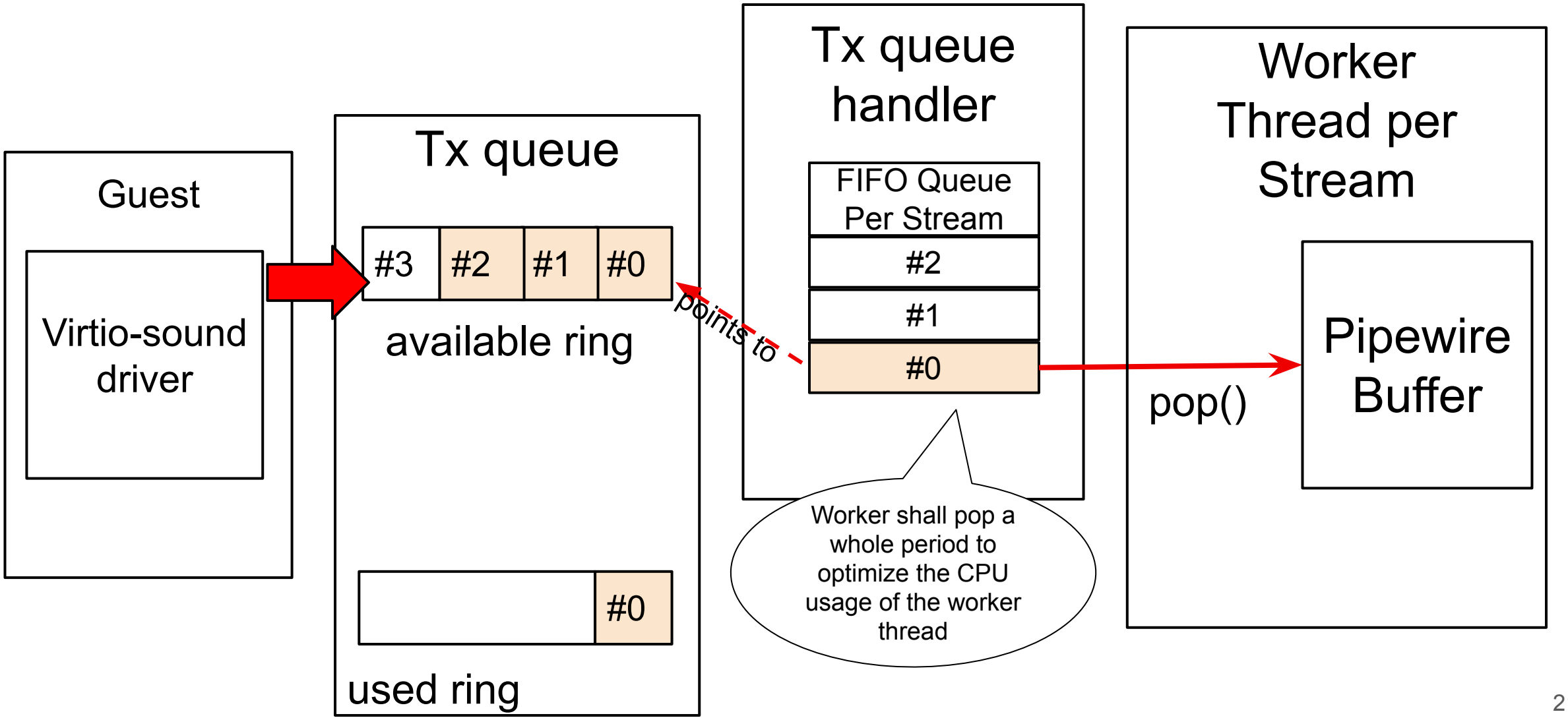
Control Messages Handler



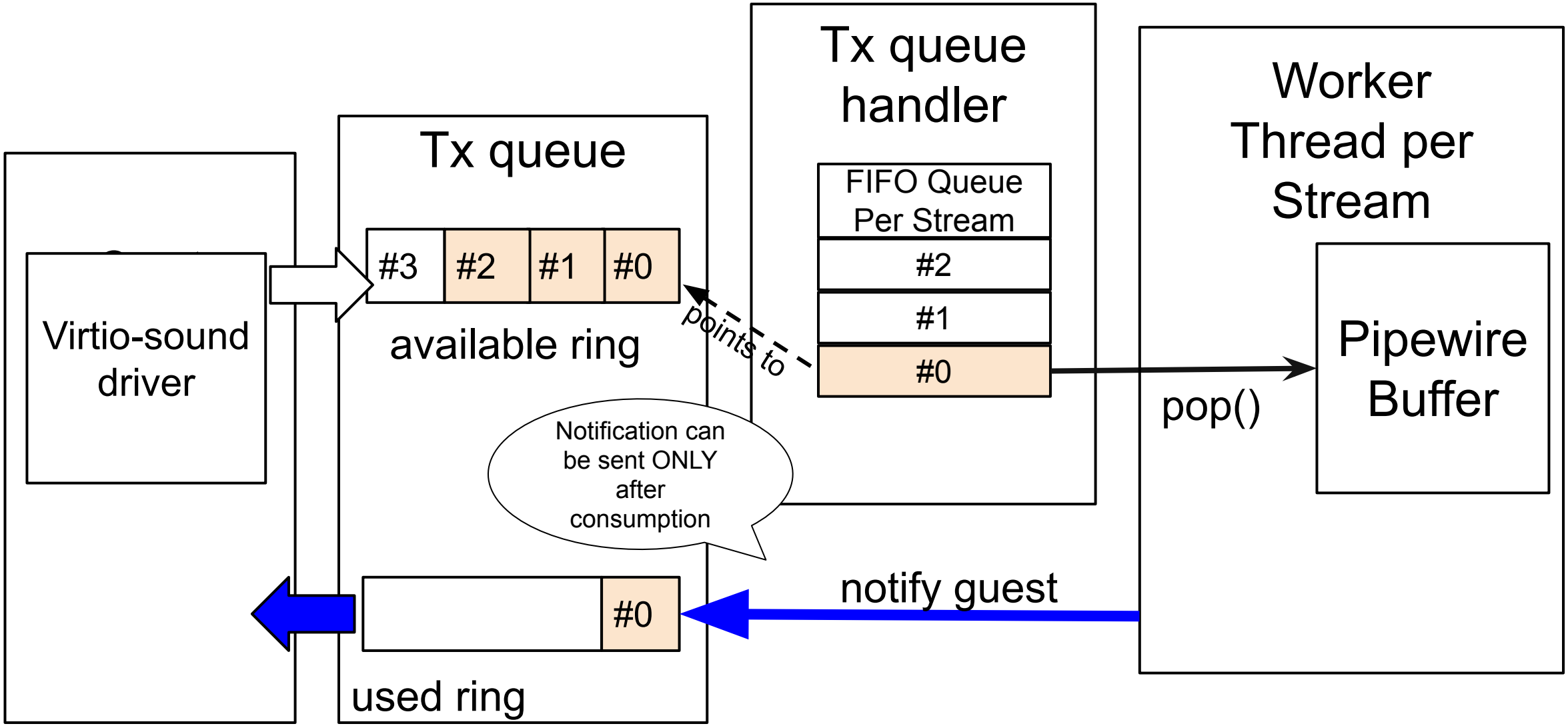
Transmission Messages Handler (playback)



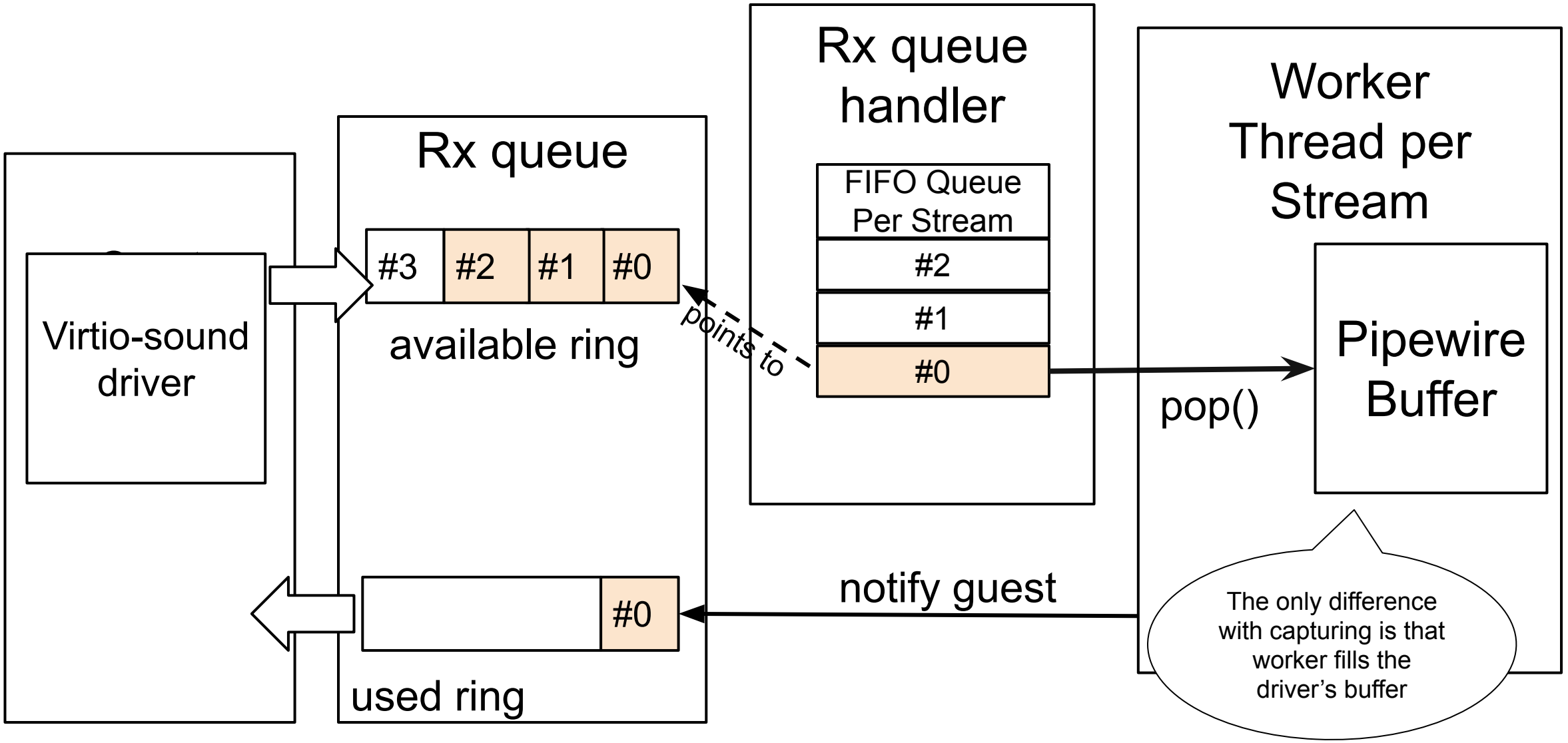
Transmission Messages Handler (playback)



Transmission Messages Handler (playback)



Reception Messages Handler (capture)



Virtio-sound device Example

How to launch the vhost-user-sound device daemon on the host

```
$ vhost-device-sound --socket /tmp/snd.sock --backend pipewire
```

Available backends: null, pipewire, alsa

The QEMU invocation to create a chardev socket to allow communication over the vhost-user protocol

```
$ qemu-system-x86_64    \
  -chardev socket,id=vsnd,path=/tmp/snd.sock        \
  -device vhost-user-snd-pci,chardev=vsnd,id=snd      \
  -machine YOUR-MACHINE-OPTIONS,memory-backend=mem    \
  -m 4096    \
  -object memory-backend-file,id=mem,size=4G,mem-path=/dev/shm,share=on    \
  …
```

Some upstream contributions

- Upstreaming patches for using ack() for the virtio-sound driver
- Upstreaming patches for the virtio-sound specification
- Adding descriptor_utils.rs from virtiofsd to virtio-queue crate
- Alex patches to add a generic vhost-user-device to reduce boilerplate code of all other vhost-user-devices in QEMU
- Developments in pipewire-rs crate:
  - Added thread_loop module and implementation
  - Added spa_ringbuffer FFI functions
  - Bug Fixes to ensure compatibility of virtio-sound device with pipewire-rs crate.

Get in touch!

- Get it from https://github.com/rust-vmm/vhost-device
- Find us at rust-vmm slack channel #virtio-sound at https://rust-vmm.slack.com/
- Take part in our Google Summer of code project, which adds an audio backend to GStreamer for the development of virtio-sound (see https://wiki.qemu.org/Internships/ProjectIdeas/GStreamerVhostDeviceSound)

- Contact us directly:
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