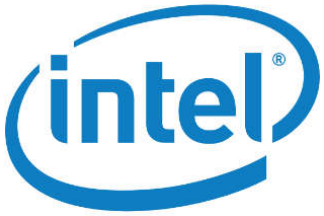

VDPA: VHOST-MDEV AS NEW VHOST PROTOCOL TRANSPORT

CUNMING(Steve) LIANG, Intel

cunming.liang AT intel.com

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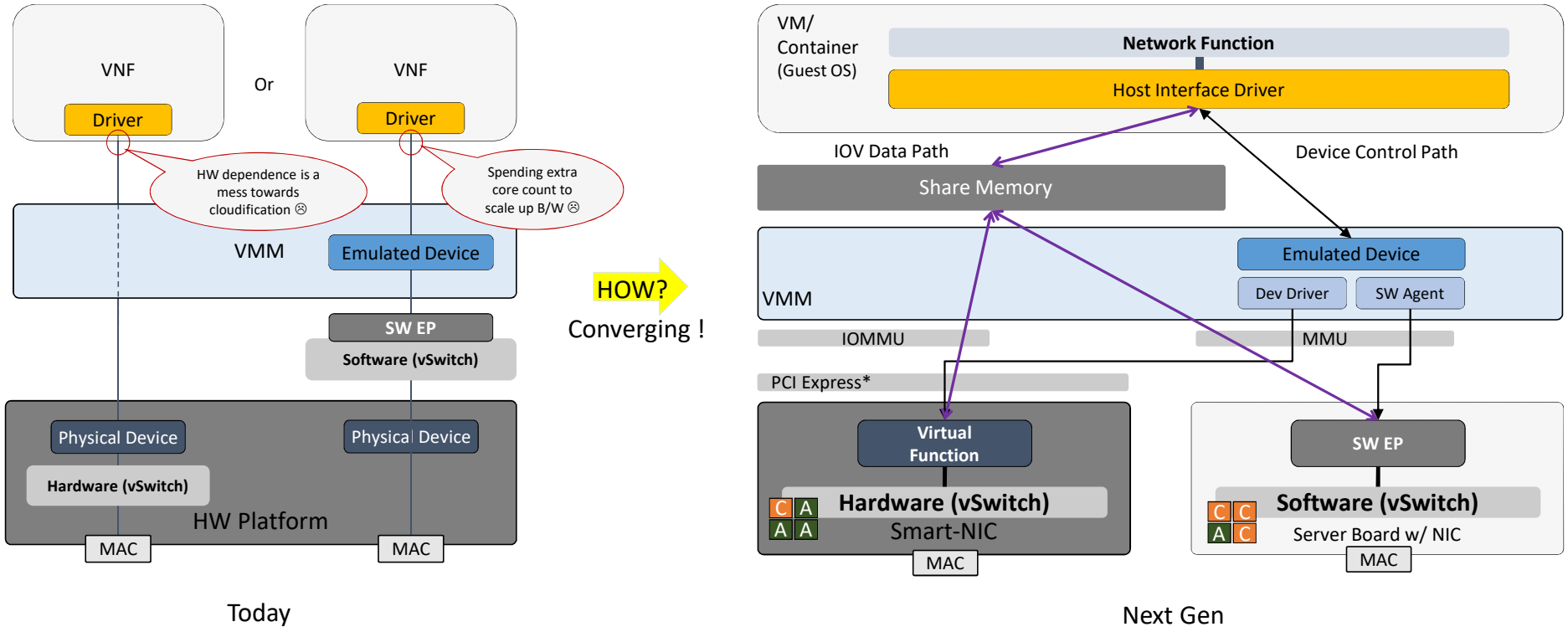
Background

VISION: NFV NEXT-GEN VIRTUAL END POINT

- Transforming from virtualization to **Cloud-Ready** **Challenges**
- Incremental demands of VNF **B/W** (10Gb/s -> 25Gb/s -> 100Gb/s)



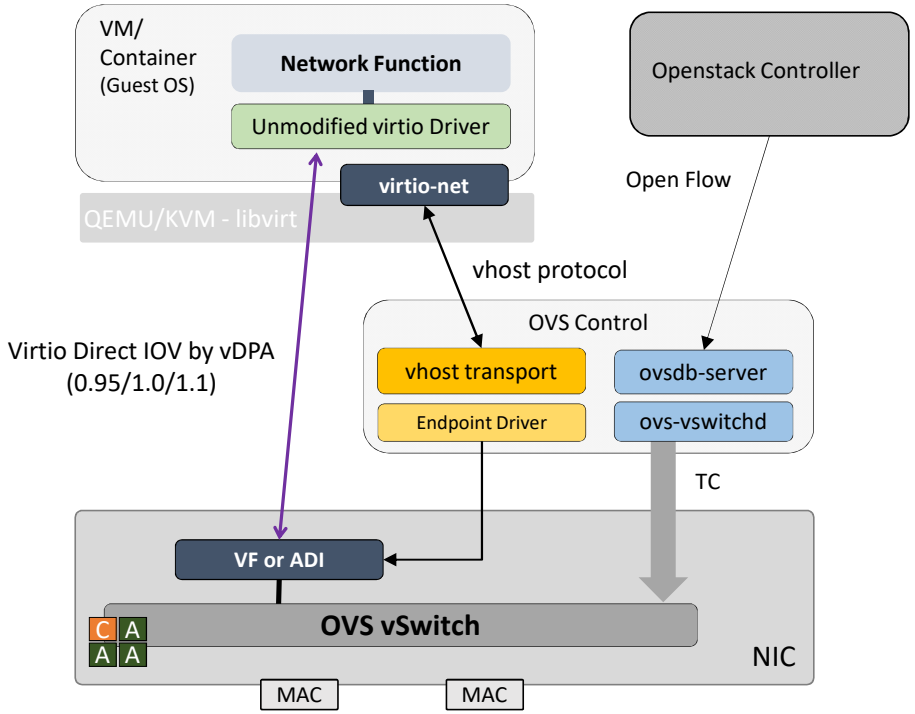
Today

Next Gen

VHOST DATA PATH ACCELERATION

- Direct Virtio IOV – I/O device read/write directly from/to the VM memory, performs like device assignment
- VDPA enables direct I/O to guest over a standard virtio device being emulated
- Benefits:
  - Device pass-thru equivalent packet rate
  - Live migration support
  - Unmodified virtio driver on uest
- DPDK 18.05, QEMU 3.0 as Pilot
  - Effort remains on vIOMMU supporting

http://lists.nongnu.org/archive/html/qemu-devel/2018-09/msg02216.html

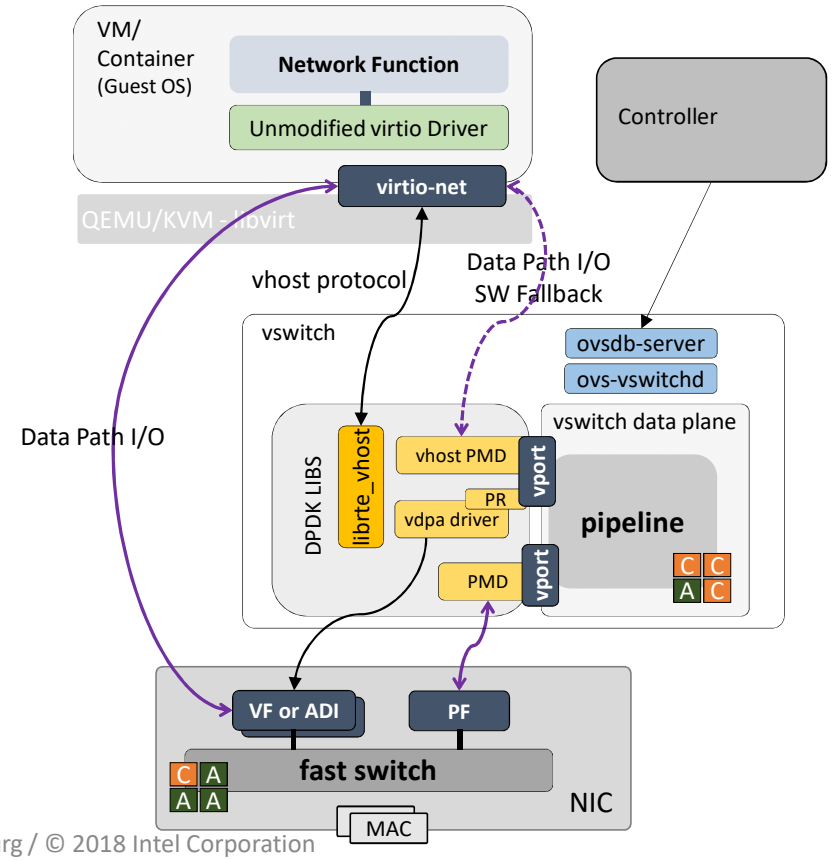


Virtio Direct IOV by VDPA

https://dpdksummit.com/Archive/pdf/2017Asia/DPDK-China2017-LiangWang-A-Better-Virtio-towards-NFV-Cloud.pdf
https://www.linux-kvm.org/images/8/87/KVM17vDPA-v4_0.pdf
https://www.dpdk.org/wp-content/uploads/sites/35/2018/09/xiao-wang-DPDK_Summit18_vDPA_for_vhost_acceleration-v4.pptx

HOW IT WORKS IN DPDK

- Add selective data path support in vhost-user library
- Associate device driver with vhost socket
- Attach with vswitch as port representor
- Being capable fallback to S/W data path



HUM, WHY NOT JUST PASS-THRU VIRTIO

- VDPA is Not Device Pass-thru
  - CANNOT live migrate from S/W backend to H/W and vice versa
  - CANNOT support stock VM using 0.95 w/ PIO
  - Any SPEC. change MAY impact more for large size H/W surface
  - Host endpoint CANNOT have more features than Guest endpoint
  - Lock H/W interface on VIRTIO is NOT Win-Win with IHVs
- VDPA is Not Vendor Specific
  - Min prerequisite is following SPEC. defined vring layout & operation
  - Optimal choice is supporting SPEC. defined doorbell
  - Even H/W specific design follows backend design interface

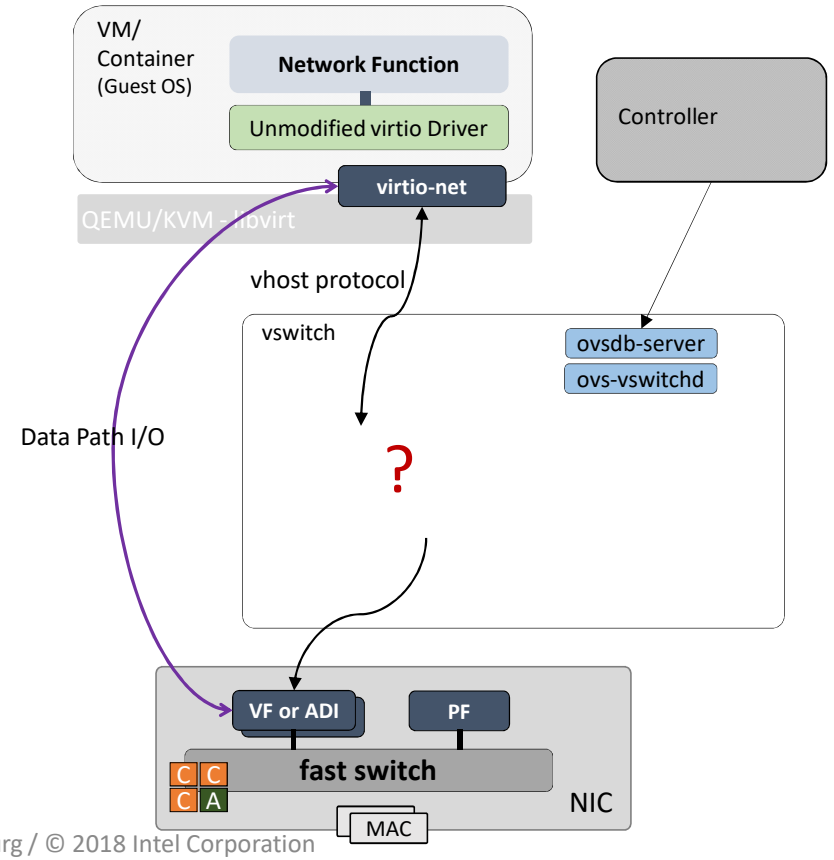
Data Path effort is not in today's agenda

Focus on the way to construct data path

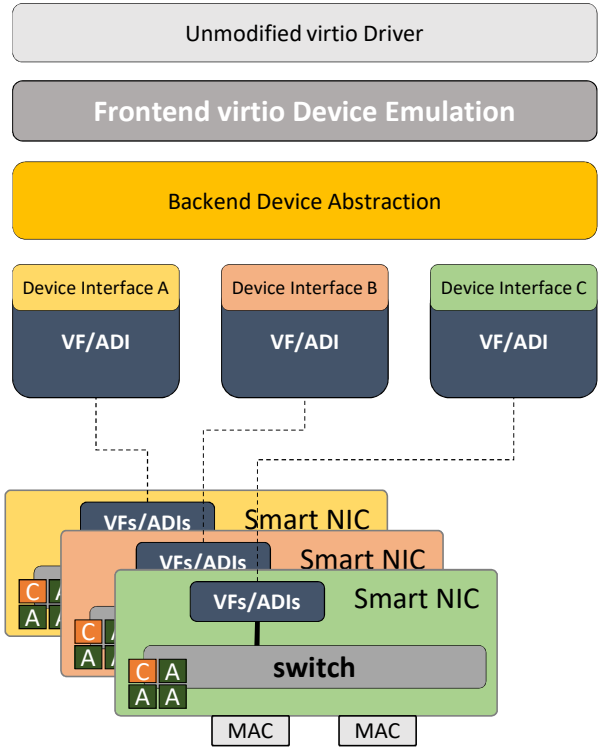
PROBLEM & PROPOSAL

WHAT ABOUT DATA PLANE SEPARATION

- Entire data plane separate to discrete system on card
- VMM emulates machine but no longer supply I/O
- Needs intermediate to connect vhost CMD/MSG and device driver

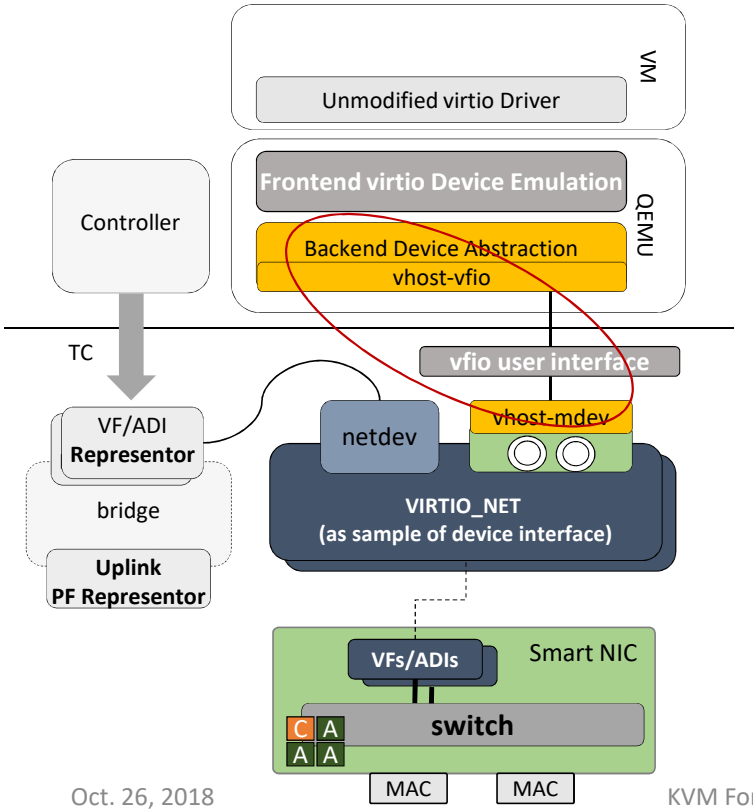


REVISIT VDPA DEVICE ABSTRACTION



- Different Device Interface
  - Not always exact virtio like
  - Needs backend device abstraction
- vhost + vfio = vhost-vfio
  - vhost: natural backend abstraction
  - vfio: unified device control for QEMU
- Consolidate direct virtio around vhost
  - Remains decoupling frontend/backend
  - Remains diverse backend adaption

MDEV BASED H/W VHOST BACKEND

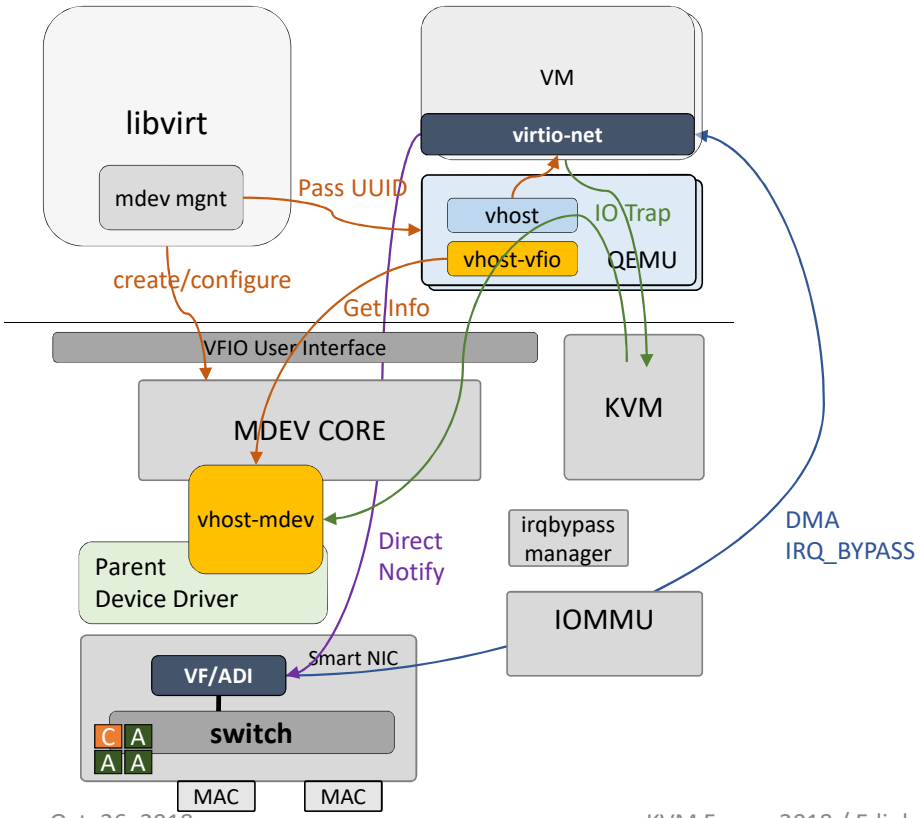


- QEMU: vfio-pci w/ quirks
  - Good for almost similar virtio device interface

  But what about
  - Other device interface
  - Control separation on the host
  - Host features beyond guest virtio device
- Kernel: vhost message over vhost-vfio
  - Reducing virtio spec. change impact
  - Independent with virtio emulation device
  - Avoid introducing IHV drivers in QEMU
  - Max flexibility on the hardware design

DEEP DIVE

INTRODUCING NEW NET CLIENT



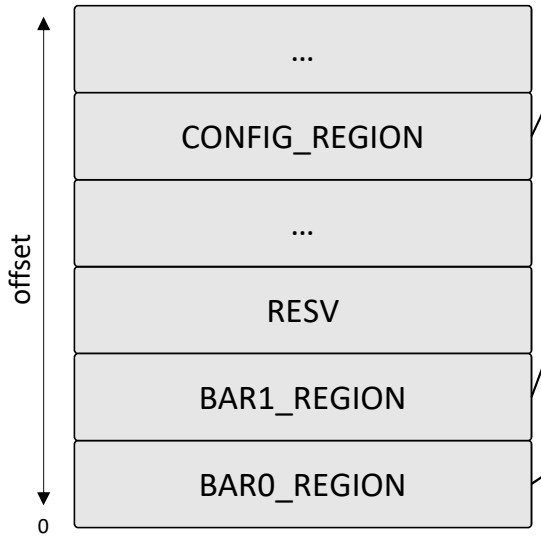

```
# Query the number of available mdev instances
$ cat /sys/class/mdev_bus/0000:84:00.3/.../available_instances

# Create a mdev instance
$ echo $UUID > /sys/class/mdev_bus/0000:84:00.3/.../create

# Launch QEMU with a virtio-net device
$ qemu-system-x86_64 -cpu host -enable-kvm \
    <snip>  \
    -netdev type=vhost-vfio,sysfsdev=/sys/bus/mdev/devices/$UUID,id=net0 \
    -device virtio-net-pci,netdev=net0,page-per-vq=on \
```

- Device Setup
  - Generate instance by mdev sysfs
  - Pass UUID to net client vhost-vfio
- I/O Trap & Emulation
  - CSR, PIO/MMIO BAR, Doorbell Relay
- Direct Mapped Doorbell
  - Page aligned per queue doorbell
- DMAR/INTR
  - Direct DMA ring/packet buffer
  - Interrupt notification

VHOST-MDEV DEVICE LAYOUT



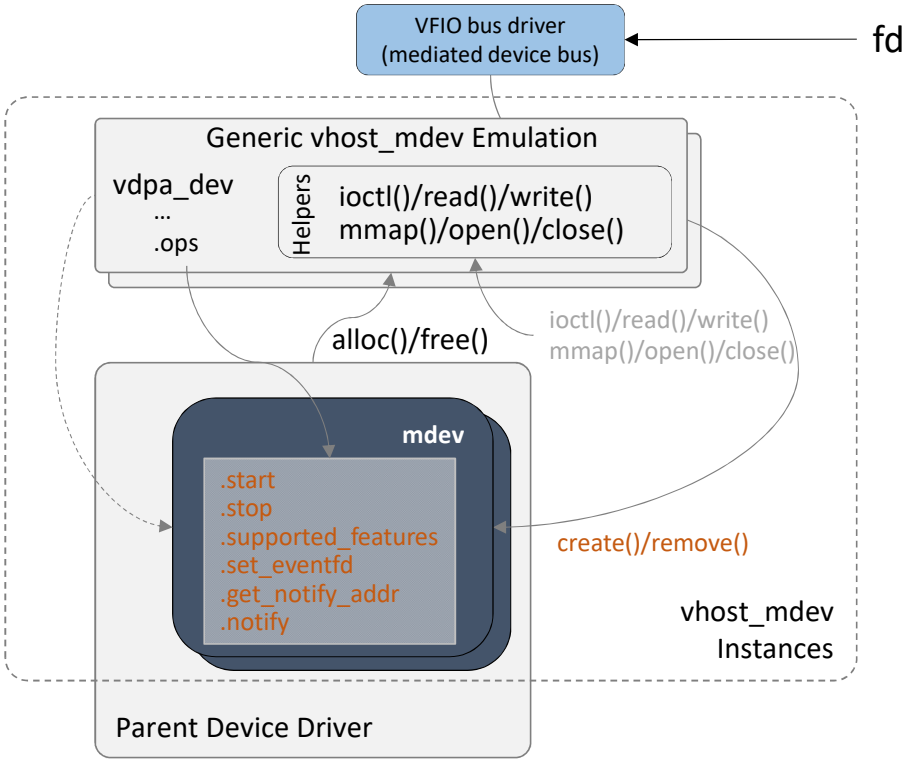
- Configure Space
  - ID to identify device type
  - Others are dummy
- BAR1 (mmap-able)
  - Mmap-able, direct notify
  - Write-able, notify relay
- BAR0
  - main control interface
  - vhost message by read/write
  - 'request' remains the same as vhost-kernel ioctl cmds

```
struct vhost_vfio_op {
        __u64 request;
        __u32 flags;
        /* Flag values: */
#define VHOST_VFIO_NEED_REPLY 0x1 /* Whether need reply */
        __u32 size;
        union {
                __u64 u64;
                struct vhost_vring_state state;
                struct vhost_vring_addr addr;
                struct vhost_memory memory;
        } payload;
};
```

Message Format

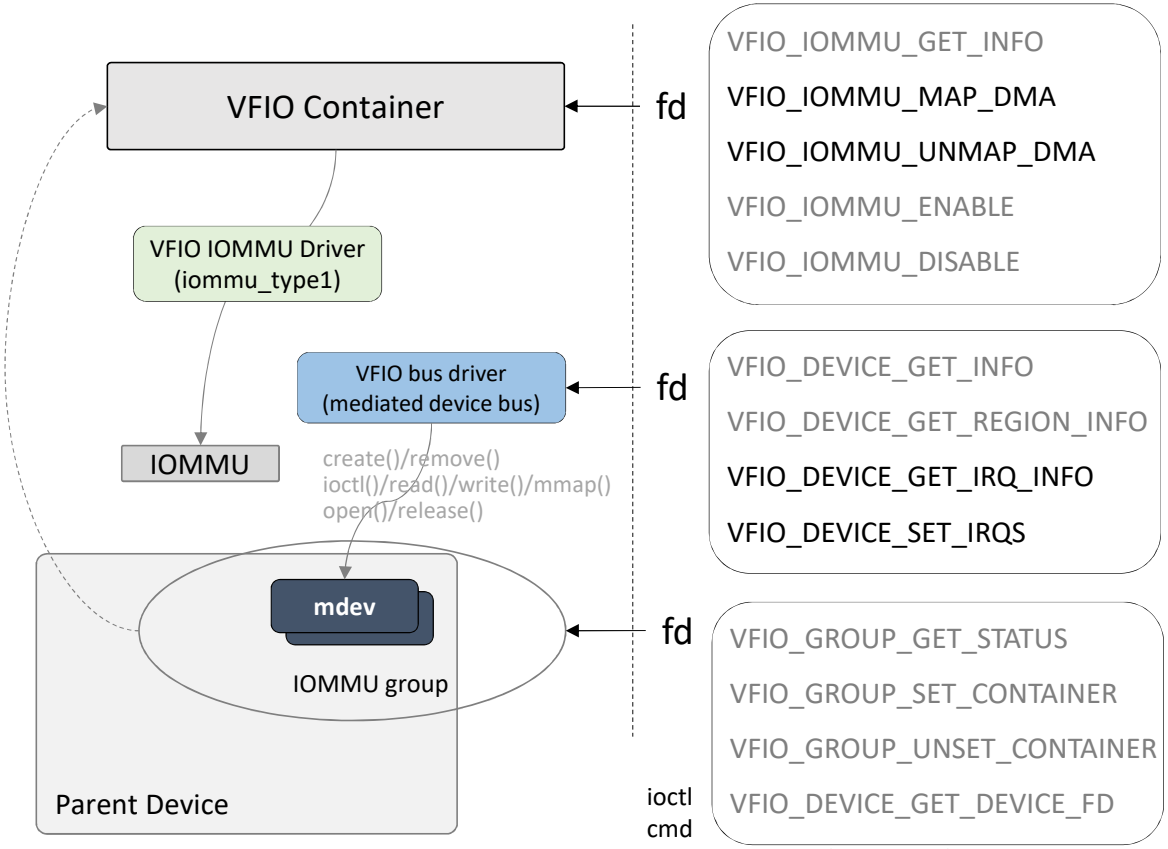
- Each message will be written to or read from BAR0_REGION at offset 0
- Set: write Req.
- Get: write Req. followed by read Resp.

GENERIC VHOST DEVICE EMULATION



- Needs to impl mdev parent ops$_{(.create/.remove)}$
- mdev parent calls alloc()/free() to populate mdev instances
- Other mdev ops$_{(.read/.write/.ioctl/.mmap/.open/.release)}$ have been provided by vhost helpers
- vdpa device ops$_{(.start/.../.notify)}$ is called by the generic vhost mdev emulation

DMA & Interrupt



DMA

- VFIO DMA ioctl API is used to remap memory
- vfio/mdev: IOMMU aware mediated device
  https://lkml.org/lkml/2018/10/12/225

Interrupt

- VFIO interrupt ioctl API is used to setup device interrupts
- VFIO IRQ eventfd associate with IRQFD
- IRQ Bypass Manager to connect Prod/Cons
- VFIO_PCI_MSIX_IRQ_INDEX in the 1st

Status & Plan

- Key Developers
  - TIWEI BIE (tiwei.bie AT intel.com)
  - XIAO WANG (xiao.w.wang AT intel.com)
- Kernel RFC Patch
  https://lwn.net/Articles/750770/
- QEMU RFC Patch
  https://patchwork.ozlabs.org/patch/984764/
  https://patchwork.ozlabs.org/patch/984765/
- Next Step: a Sample Parent Device Driver to use mdev-vhost
  - virtio-net device to support mdev-vhost
- Welcome to DPDK-Virtio Monthly Meeting

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Questions?

Thank You