
DPDK
Scalable High-Performance User Space Networking for Containers
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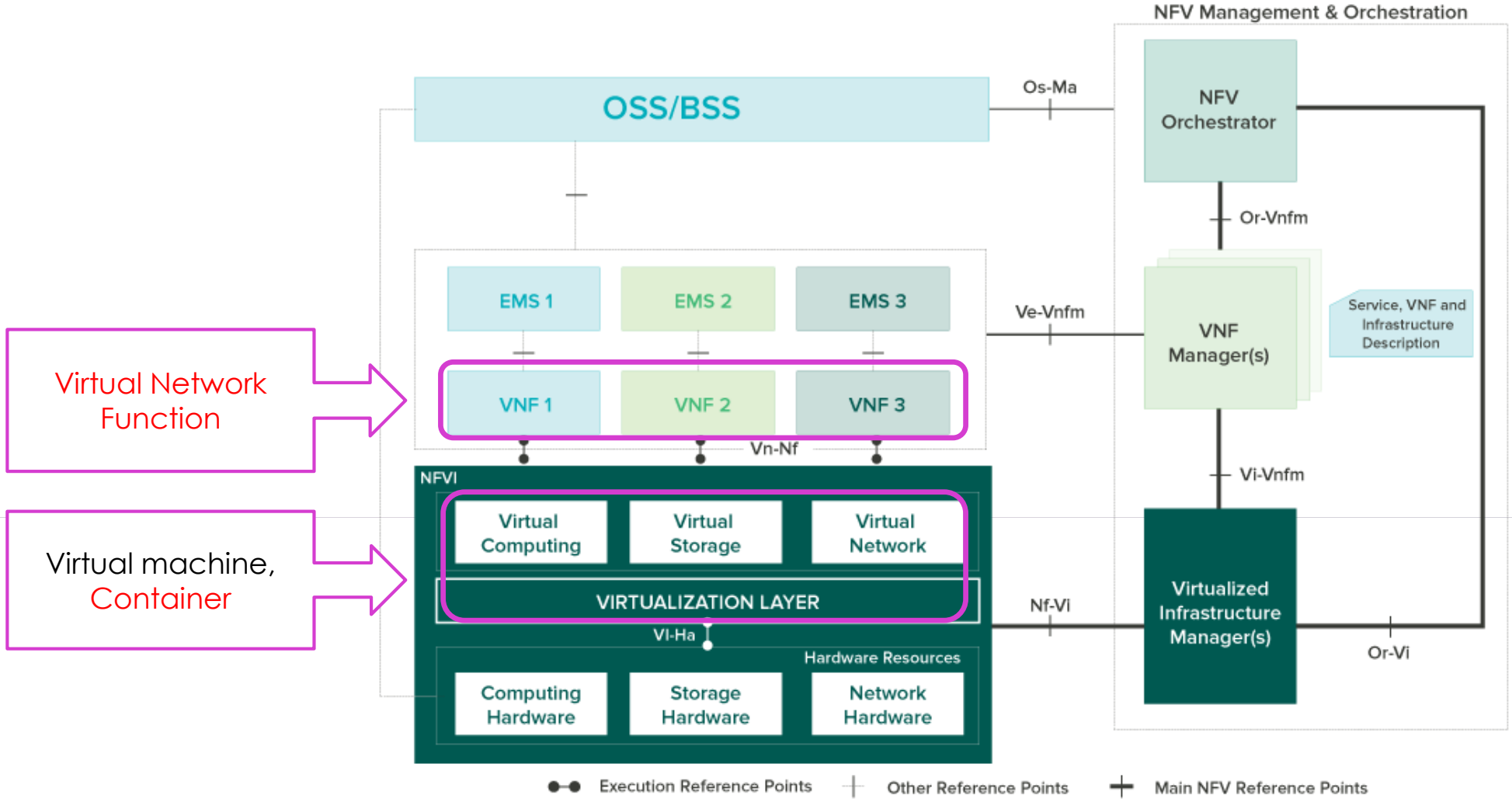
DPDK US Summit - San Jose - 2016

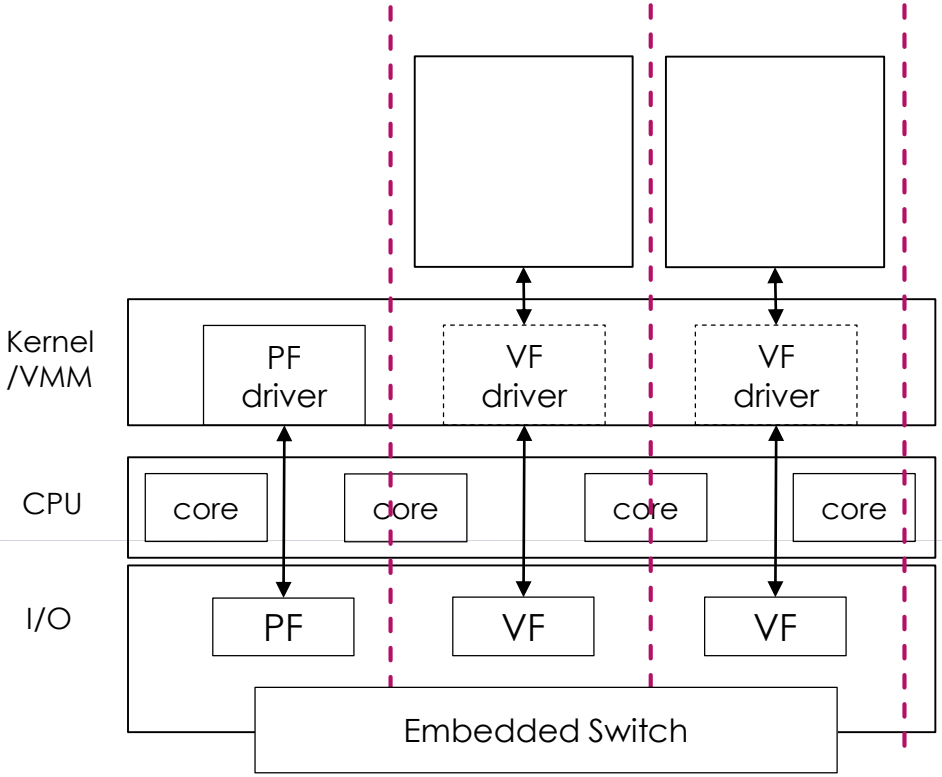
Outline

- Container-based VNF, why DPDK?
- Accelerate Network I/O for Container
- Be More Friendly to Container
- Future work

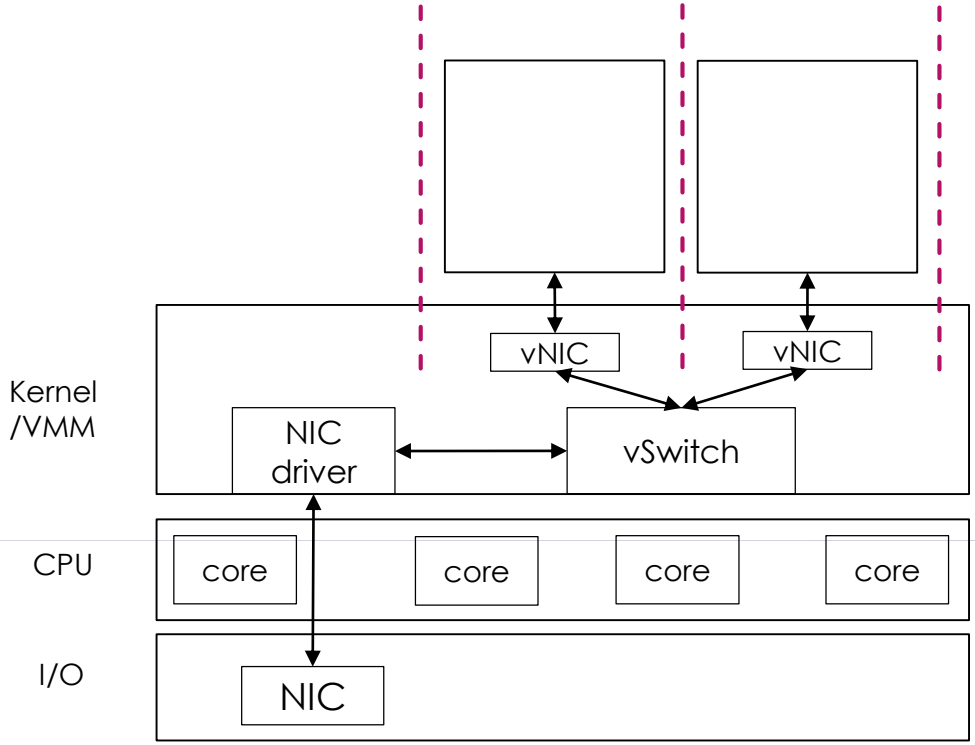
NFV and Container



I/O Virtualization Model for NFVi



Slicing

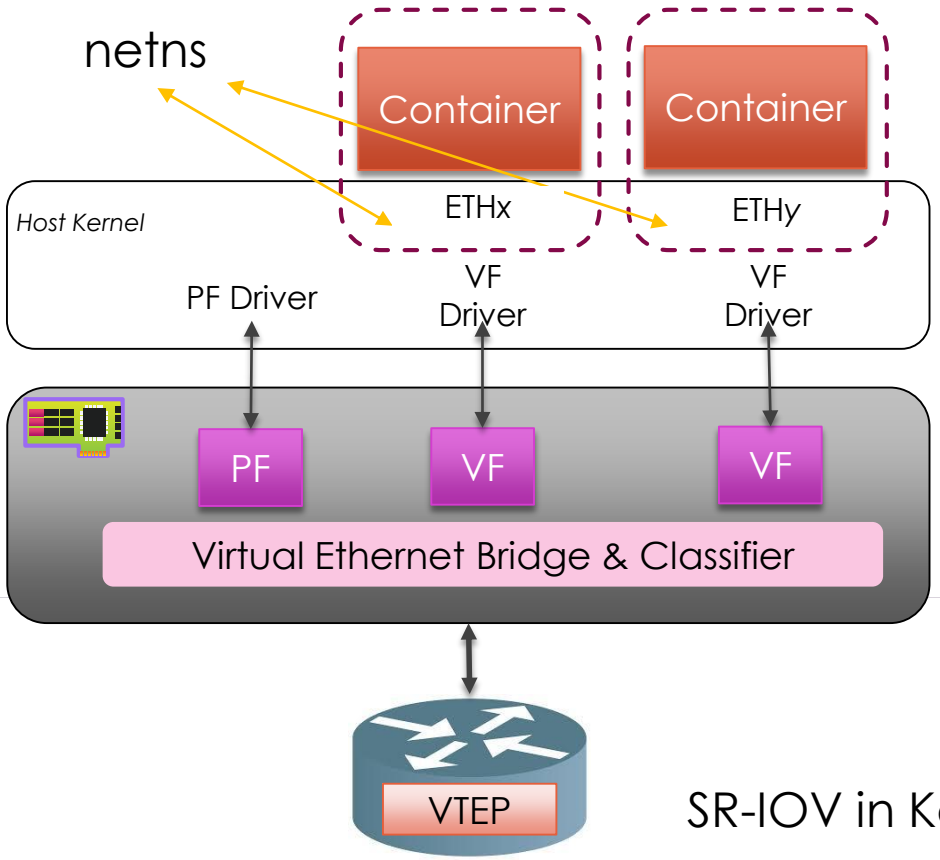


Aggregation

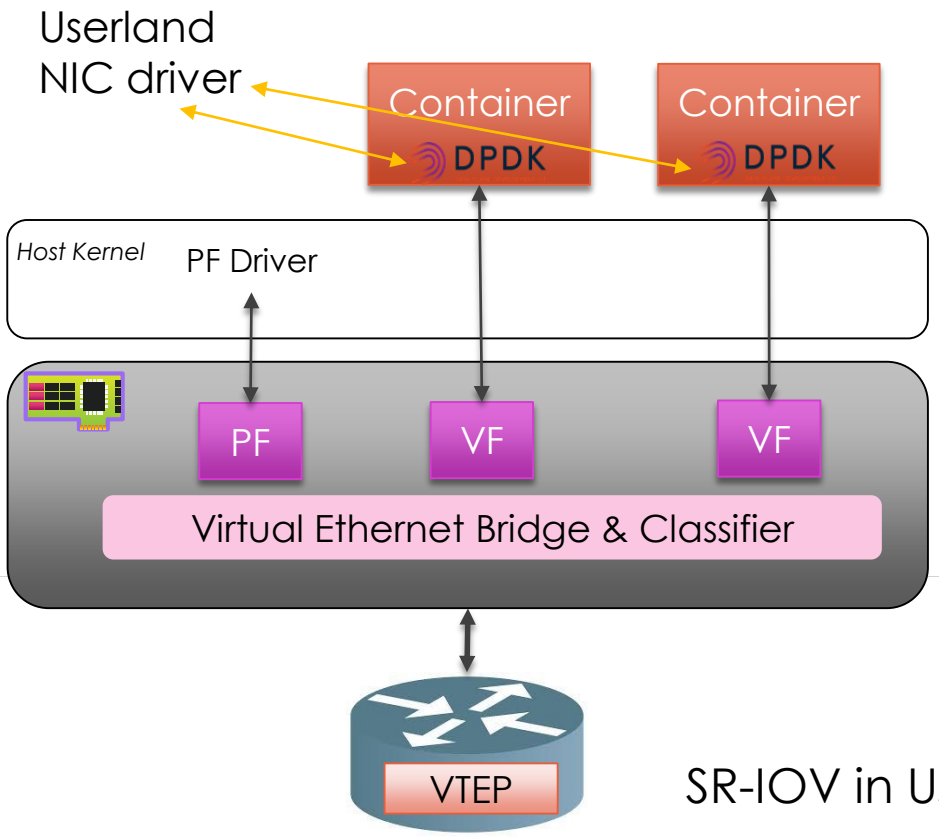
Accelerate Container-based VNF

- VNFs
  - LB, FW, IDS/IPS, DPI, VPN, pktgen, Proxy, AppFilter, etc
- Benefits
  - Provisioning time - SHORT
  - Runtime performance overhead - LOW
- Challenges
  - Security/Isolation
  - **High performance networking**
    - High throughput
    - Low latency
    - Jitter (deterministic)

DPDK SR-IOV PMD for Container



SR-IOV in Kernel



SR-IOV in Userland

Setup Userland SR-IOV with DPDK

- Prepare VFs

```
$ echo 1 > /sys/bus/pci/devices/0000\:81\:00.0/sriov_numvfs
$ ./tools/dpdk_nic_bind.py --status
…
0000:81:00.0 '82599ES 10-Gigabit SFI/SFP+ Network Connection' if=eth1
drv=ixgbe unused=
0000:81:10.0 '82599 Ethernet Controller Virtual Function' if=eth5 drv=ixgbevf
unused=
…
```

- Bind to vfio driver

```
$ modprobe vfio-pci
$ ./tools/dpdk_nic_bind.py -b vfio-pci 0000:81:10.0
```

- Prepare hugetlbfs

```
$ mount -t hugetlbfs -o pagesize=2M,size=1024M none /mnt/huge_c0/
```

- Start container

```
$ docker run … -v /dev/vfio/vfio0:/dev/vfio/vfio0 -v
/mnt/huge_c0/:/dev/hugepages/ …
```

http://developers.redhat.com/blog/2015/06/02/can-you-run-intels-data-plane-development-kit-dpdk-in-a-docker-container-yep/

Deterministic Environment (1)

- Deterministic CPU env
  - Boot-time: disable timer / task scheduler
    - … default_hugepagesz=1G isolcpus=16-19 …
    - Reducing scheduling-clock ticks: *adaptive-tick* mode
  - Run-time: core-thread affinity
    - cpuset tool: taskset / numactl
    - cgroup.cpuset: cset / docker run … --cpuset-cpus …
  - BIOS setting: if necessary, disable *Hyper-Threading*

Deterministic Environment (2)

- Deterministic cache env
  - Data Direct I/O (DDIO) technology
  - Cache Allocation Technology (CAT)

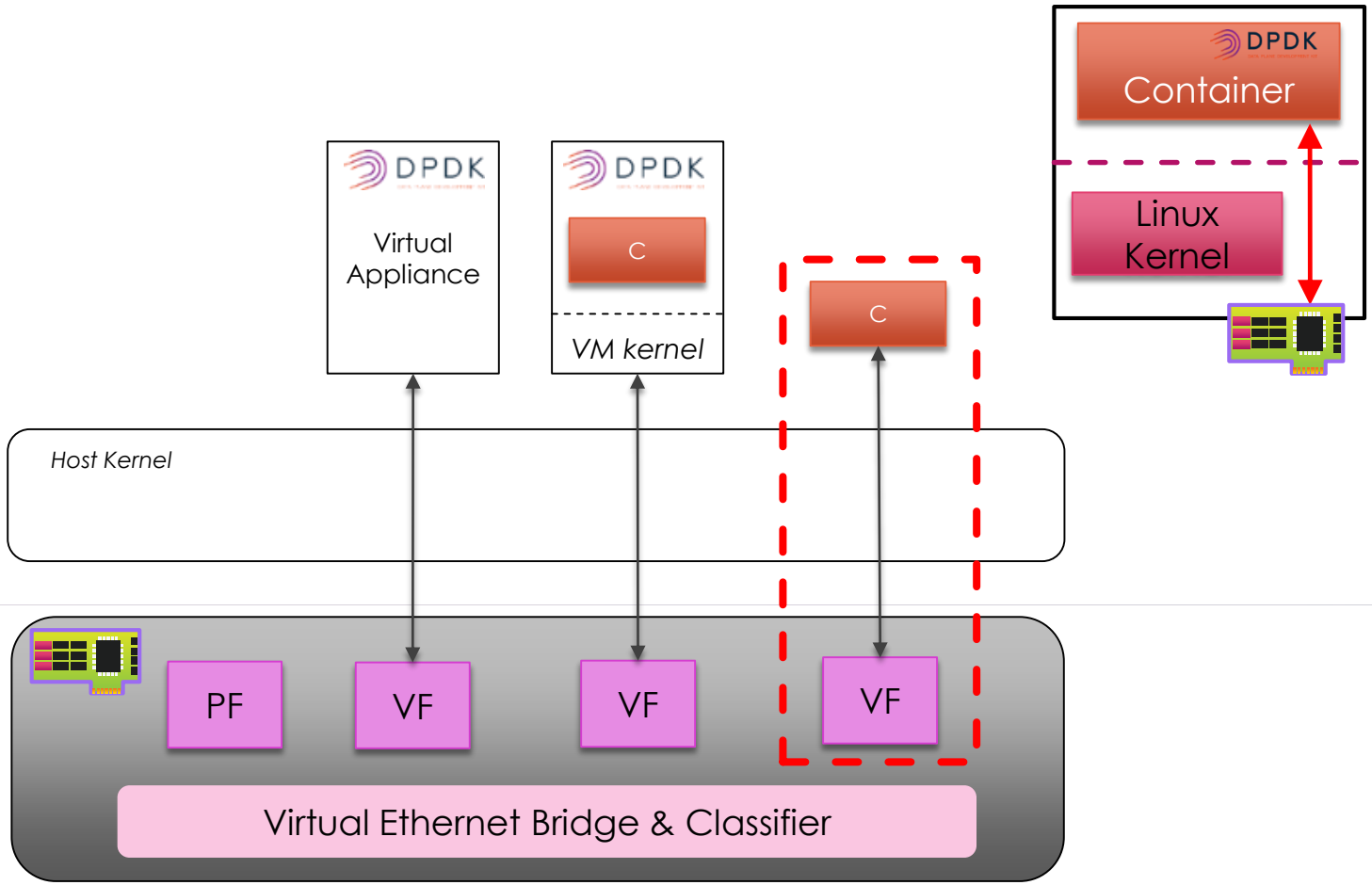
```
$ pqos -e "llc:2=0x00003"
$ pqos -a "llc:2=8,9,10"
```

CAT	Noisy Neighbor	DPDK IP Pipeline Application (Packet size = 64 Bytes, Flows = 16 Millions)	
		Throughput (Mpps)	LLC Occupancy (MB)
Not Present	Present	9.8	4.5
Present	Present	15	13.75

http://www.intel.com/content/www/us/en/communications/increasing-platform-determinism-pqos-dpdk-white-paper.html

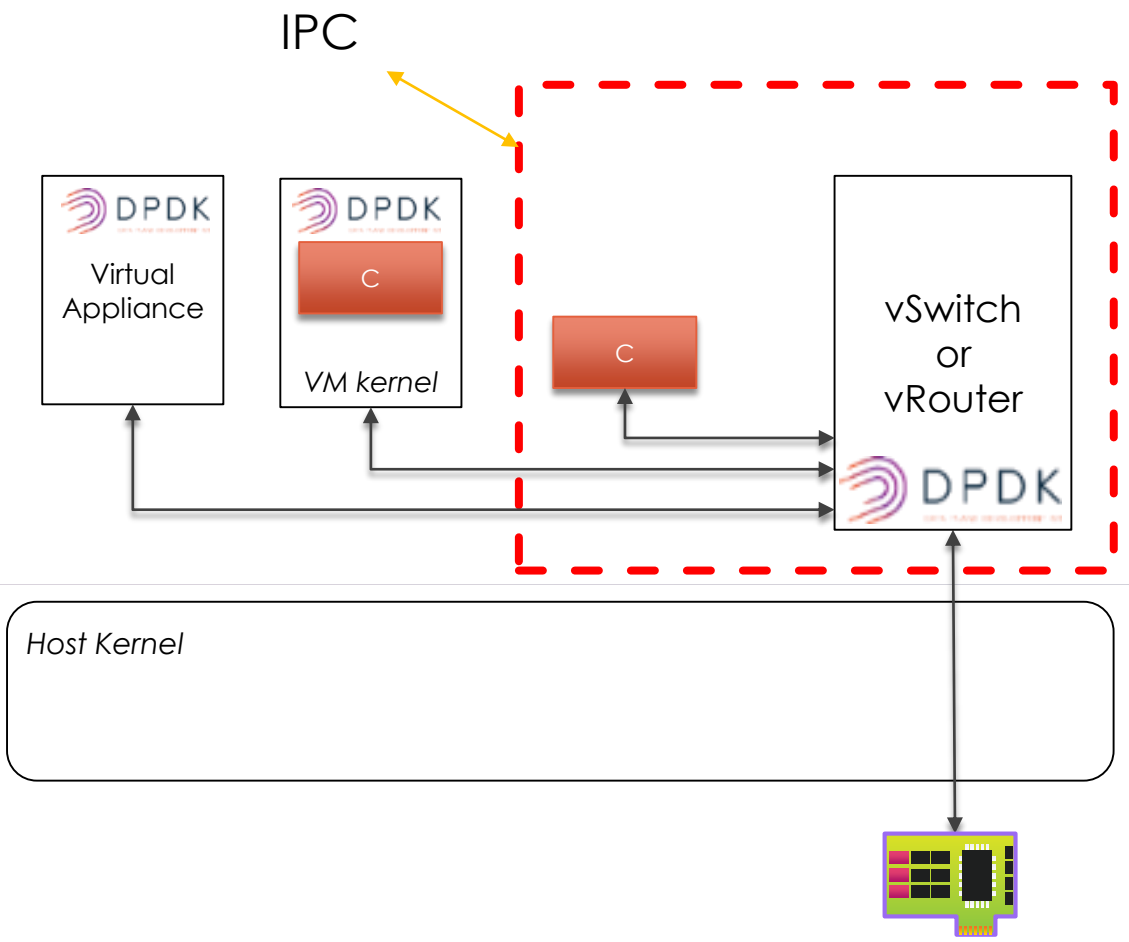
Userland SR-IOV in Container

- Pros:
  - Line rate even with small packets
  - Low latency
  - HW-based QoS
- Cons:
  - # of VFs is limited (64 or 128)
  - Not flexible (in need of router or switch with support of VTEP)



DPDK virtio_user for Container

- Problem statement from PV to IPC
- virtio ring as IPC, why?
  - Standard Protocol in Spec.
  - Consistent host backend
  - Performance
    - Bypass kernel
    - Share memory based
    - Smarter notification
    - Cache friendly
  - Security



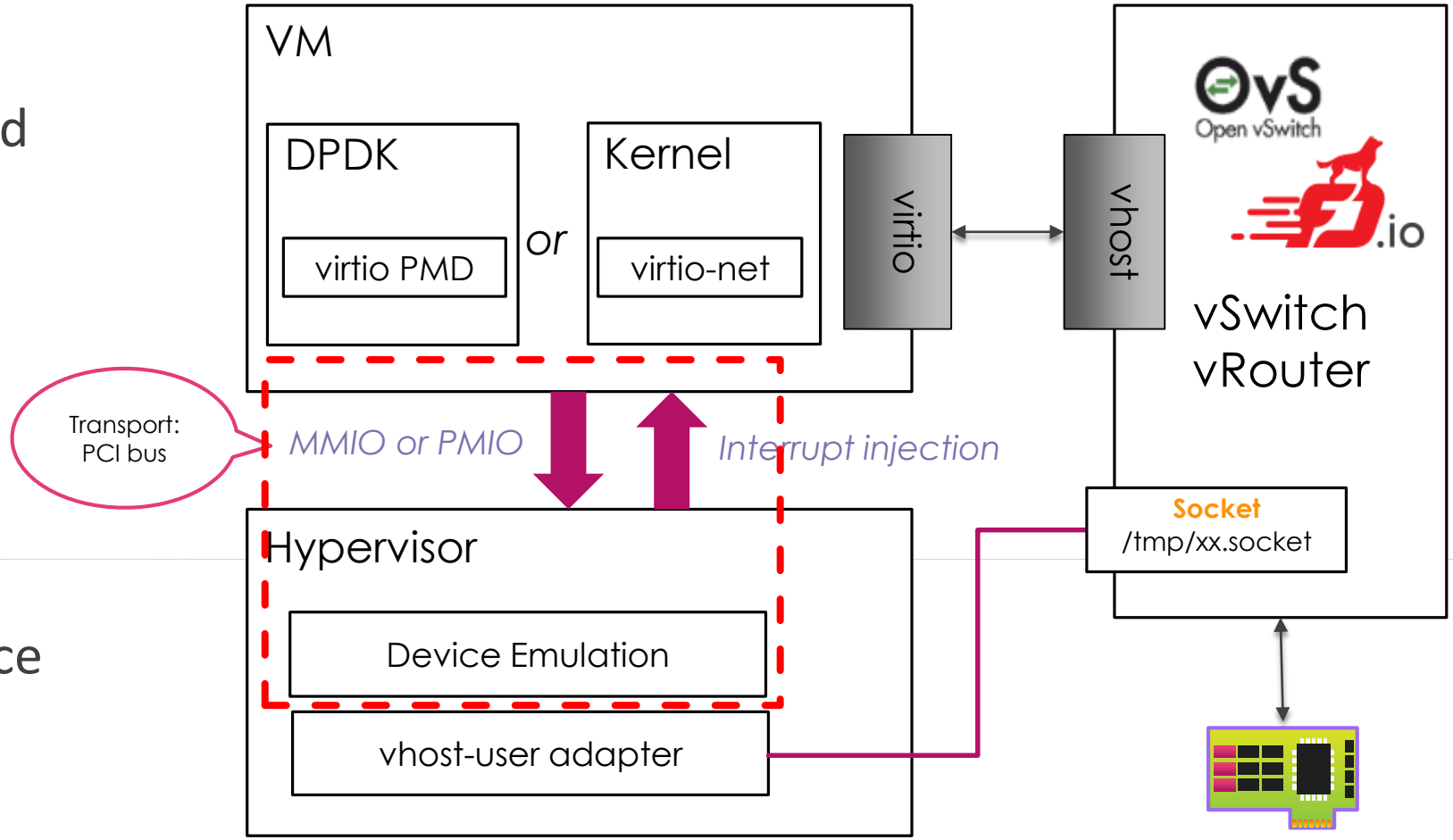
virtio approach for IPC

PV based

- virtio device is emulated in QEMU
- virtio can use various different bus (PCI Bus, MMIO, Channel I/O)

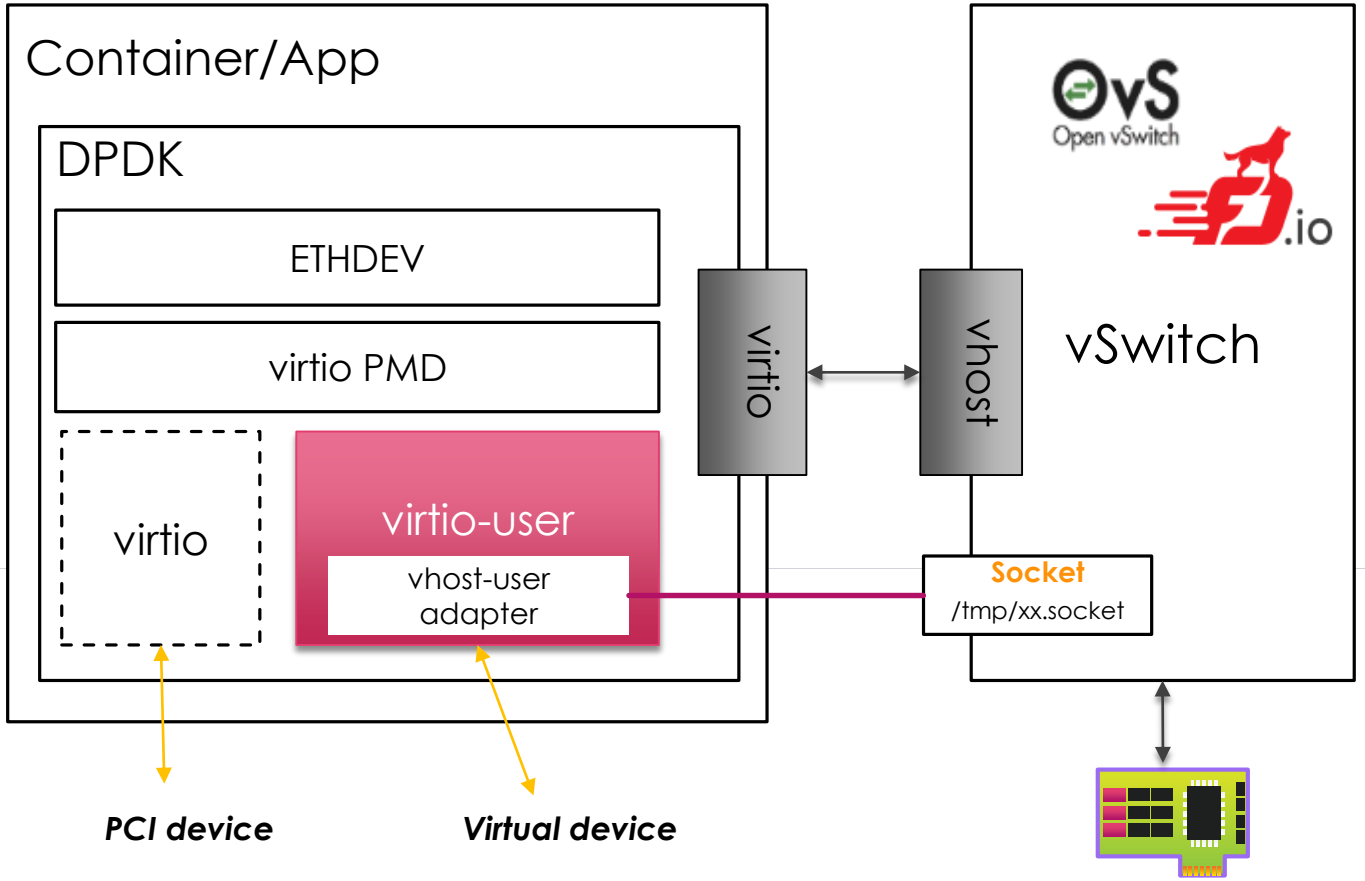
IPC based

- Transport bus and device emulation is no longer used.



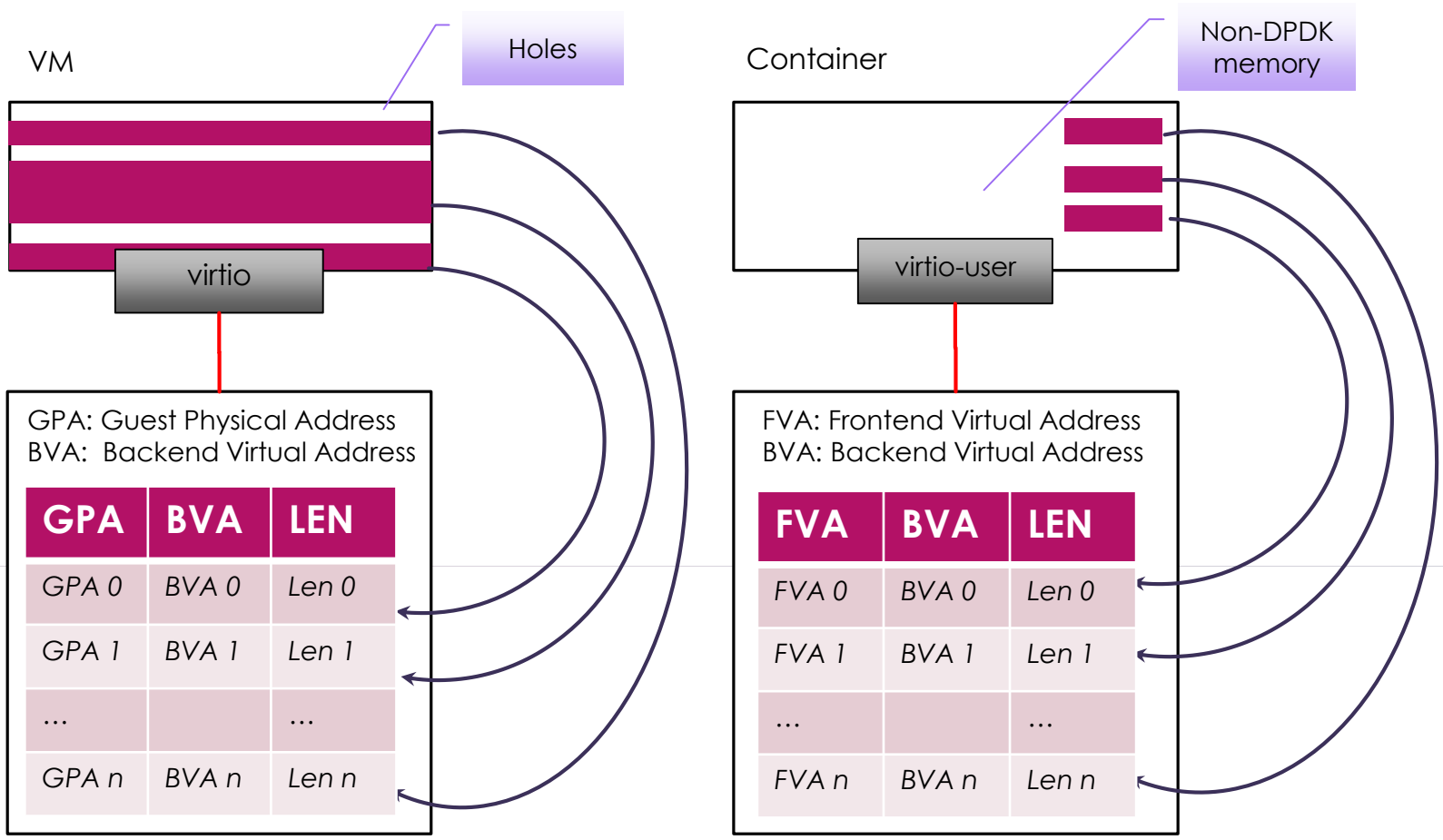
virtio_user intro (1)

- virtio-user as a DPDK virtual device (vdev)
- Talk to backend by vhost-user adapter w/o device emulation
- Single consistent vhost PMD on the backend



virtio_user intro (2)

- FVA to BVA address translation
- Memory mapping only for DPDK used memory
- Number of memory region is limited !



Setup virtio_user with OVS-DPDK

- Add a bridge and a vhost-user port in ovs-dpdk

```
$ ovs-vsctl add-br br0 -- set bridge br0 datapath_type=netdev
$ ovs-vsctl add-port br0 vhost-user-1 -- set Interface vhost-user-1
type=dpdkvhostuser
```

- Prepare hugetlbfs

```
$ mount -t hugetlbfs -o pagesize=2M,size=1024M none /mnt/huge_c0/
```

- Run container

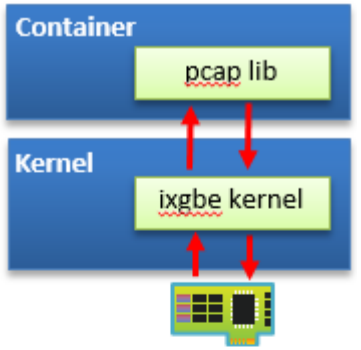
```
$ docker run … \
-v /usr/local/var/run/openvswitch/vhost-user-1:/var/run/usvhost \
-v /mnt/huge_c0/:/dev/hugepages/ \
…
-c 0x4 -n 4 --no-pci  --vdev=virtio-user0,path=/var/run/usvhost \
…
```

Performance Evaluation

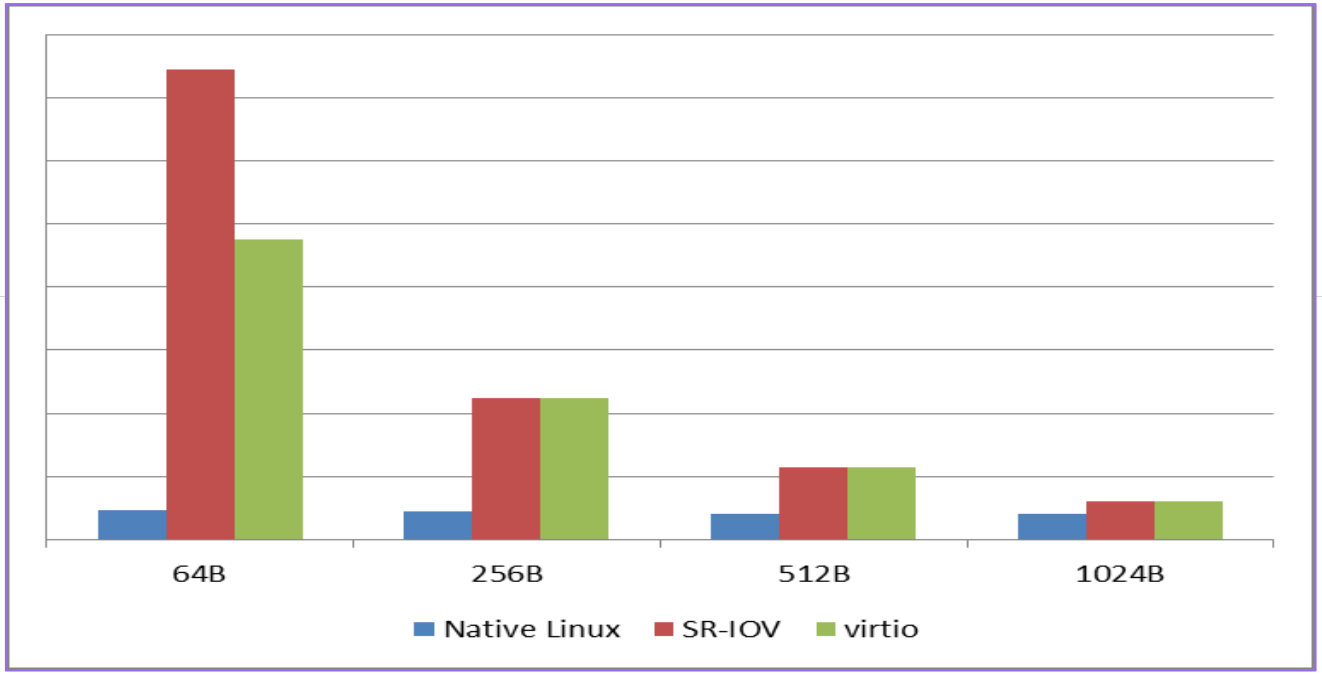
DPDK

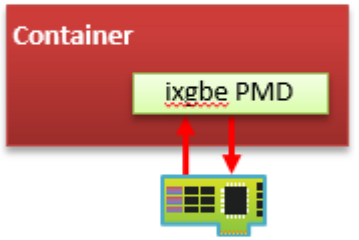
Latency

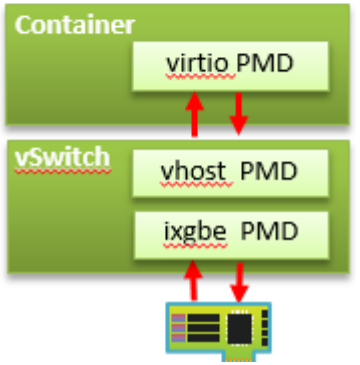
- For native Linux, ms level
- For the other two, us level
  - Polling mode, Batching, SIMD



Throughput







DPDK efforts Towards Container

- Hugetlb initialization process
  - sysfs is not containerized, and DPDK allocates all free pages
    - Addressed by here, avoid to use *-m* or *--socket-mem*
- Cores initialization
  - When/how to specify cores for DPDK?
    - Addressed by here, avoid to use *-c* or *-l* or *--lcores*
- Reduce boot time
  - Addressed by here and here

Run DPDK in Container Securely

- One container a hugetlbfs
- Run without --privileged
  - Run with --privileged is not secure
  - Larger attack face by leveraging NIC DMA
  - Why DPDK needs this? virt-to-phy translation
  - How to address? (see here)
    - Virtio does not need physical address
    - VF uses virtual address as the IOVA for IOMMU

Future work

- Single mem-backed file
- DPDK support container legacy network interface
- Interrupt mode of virtio (to scale)
- Long path to handle VF interrupts in userland (low latency)
- Integrate with popular orchestrators

Summary

- Use DPDK to accelerate container networking
  - Userland SR-IOV
  - Userland virtio_user (available in DPDK 16.07)
- Compared to traditional ways, it provides
  - High throughput
  - Low latency
  - Deterministic networking

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Questions?

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