OvS
Open vSwitch

Ciara Loftus

Intel Corporation

DPDK vHost User Improvements

Agenda

- DPDK vHost User Introduction/Refresh
- Time Line of DPDK vHost User in OVS
- Recent Improvements
  - NUMA Awareness
  - Client Mode & Reconnect
- Future Improvements
  - vHost User PMD
  - Zero Copy

DPDK vHost User Refresh

What is DPDK vHost User?

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- Data Plane Development Kit

DPDK

DATA PLANE DEVELOPMENT KIT

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DPDK
DATA PLANE DEVELOPMENT KIT

- Userspace drivers & libraries for accelerated network I/O

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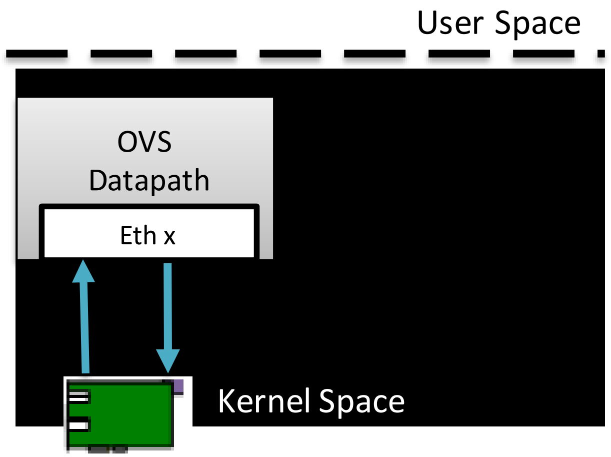

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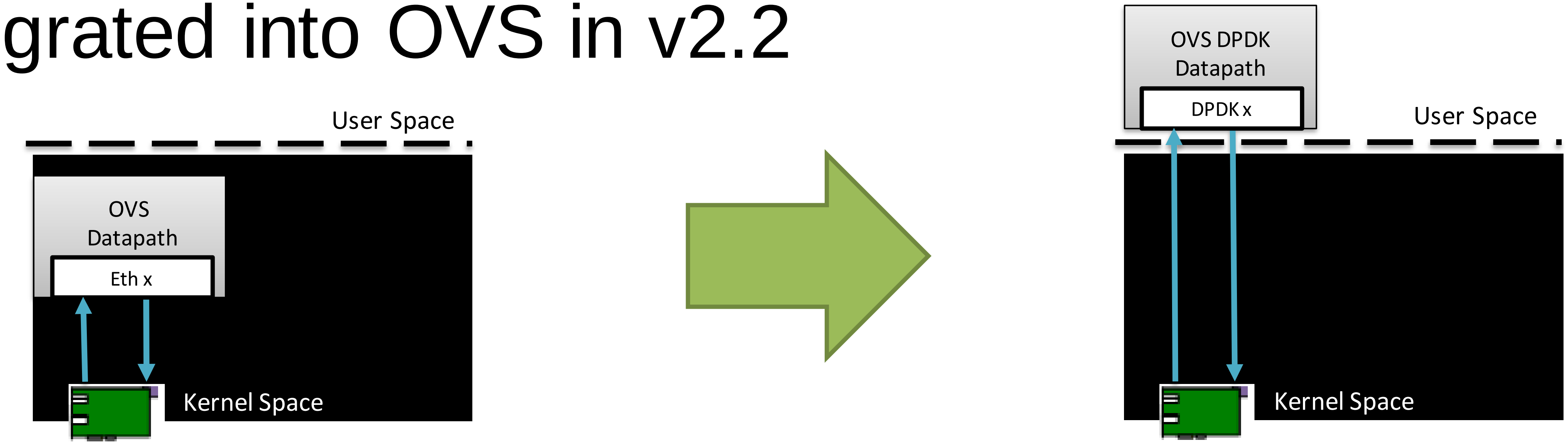
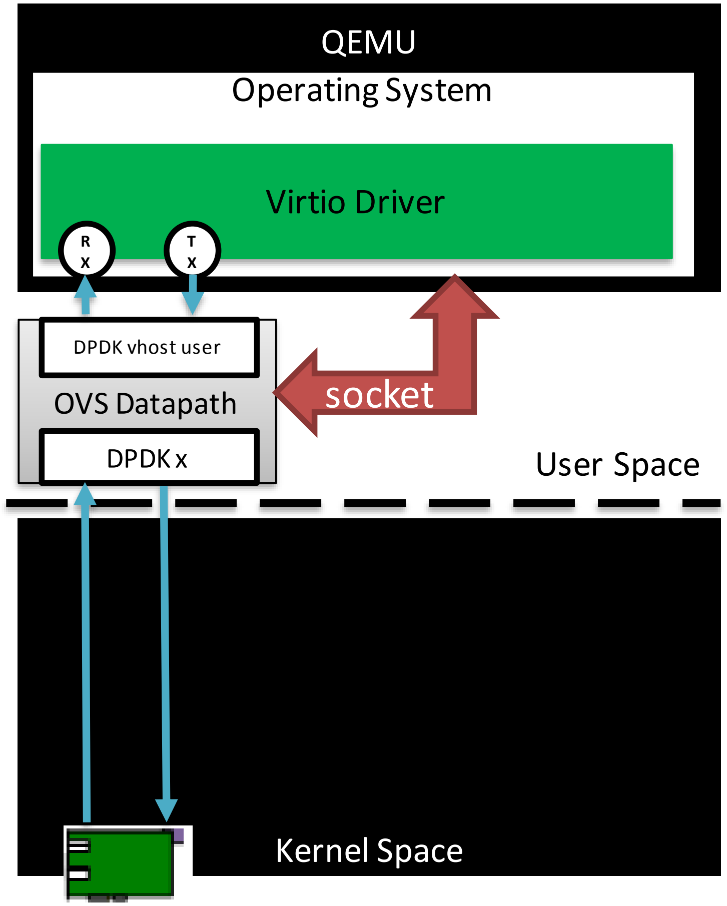
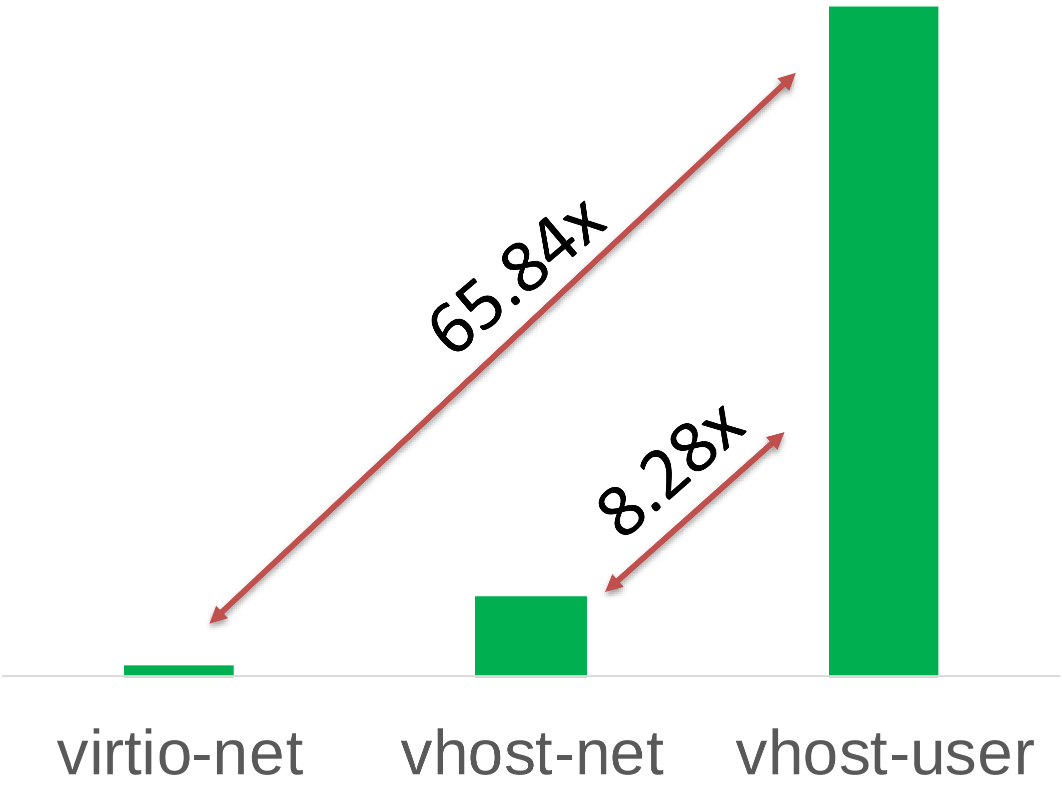
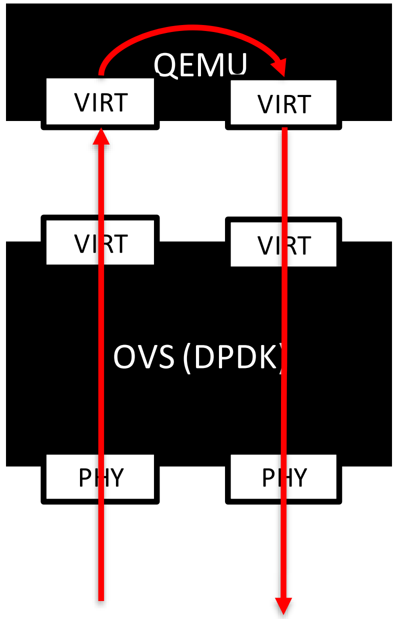


DPDK vHost User Refresh

Accelerated guest access method offered by DPDK capable of outperforming traditional methods by >8x*



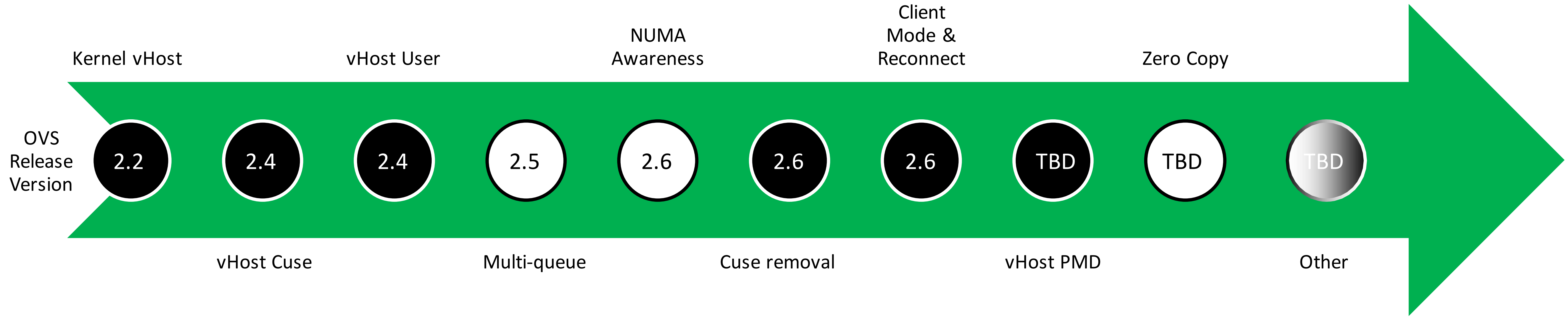




Single core, unidirectional loopback test with 64B packets

* Platform Configuration and Test Result in Backup

Timeline of vHost User in OVS



OVS Release Version

Kernel vHost 2.2

2.4 vHost Cuse

vHost User 2.4

2.5 Multi-queue

NUMA Awareness 2.6

2.6 Cuse removal

Client Mode & Reconnect 2.6

TBD vHost PMD

Zero Copy TBD

TBD Other

● = Functional Improvement

○ = Performance Improvement

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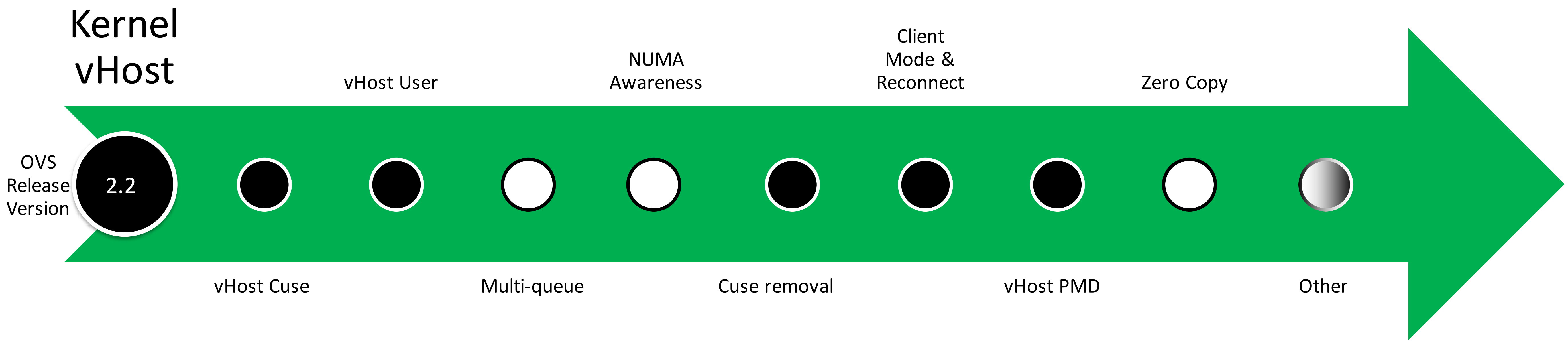

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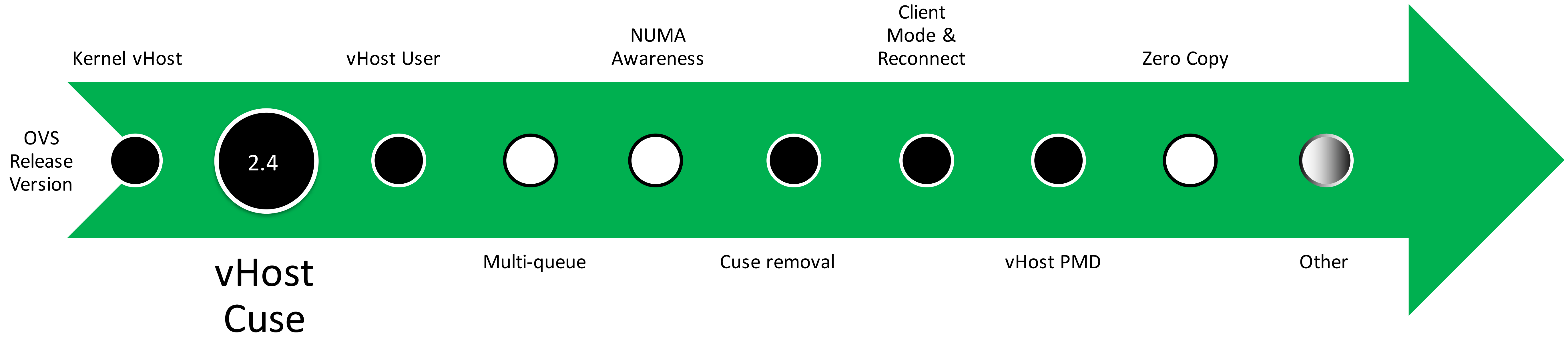

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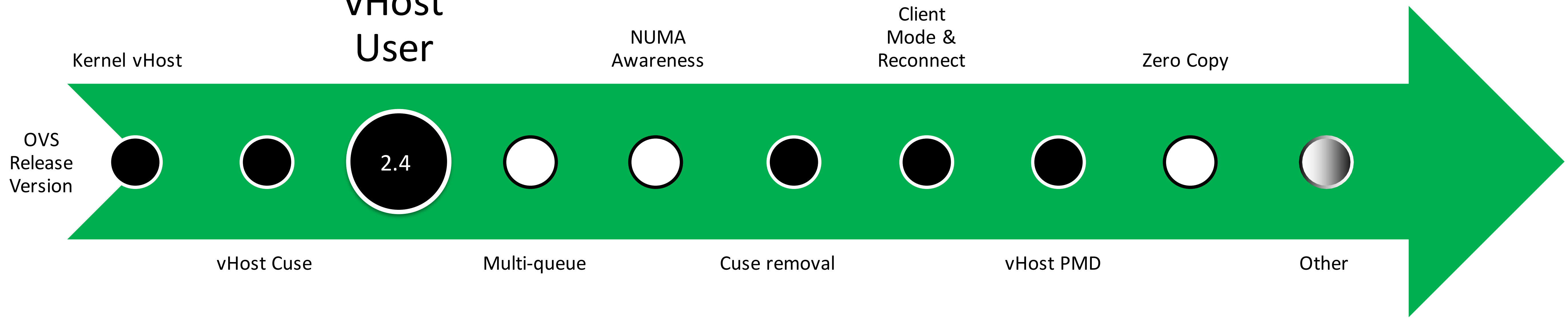

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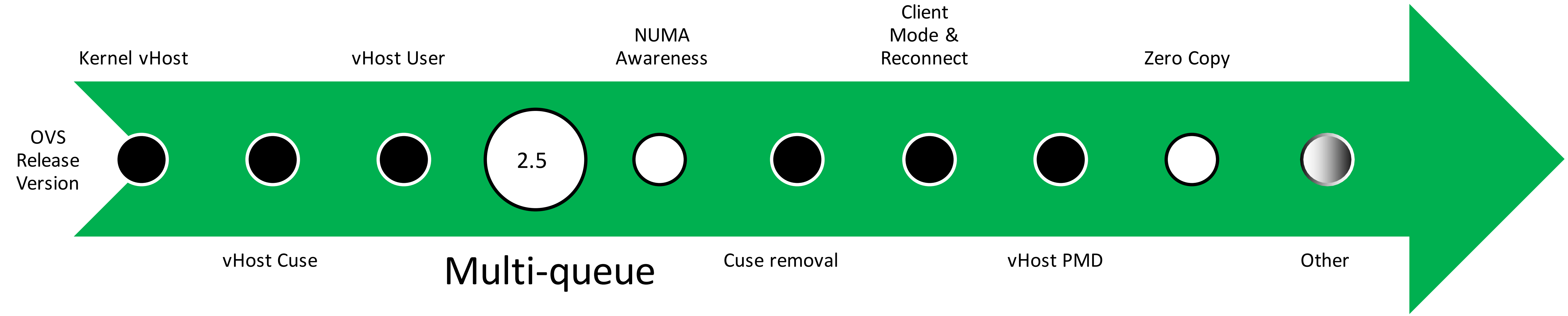

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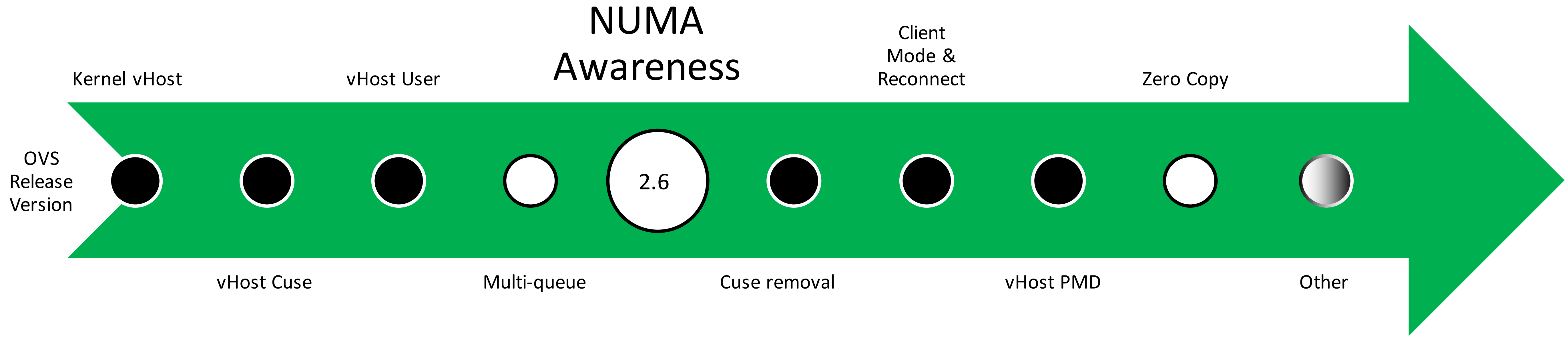

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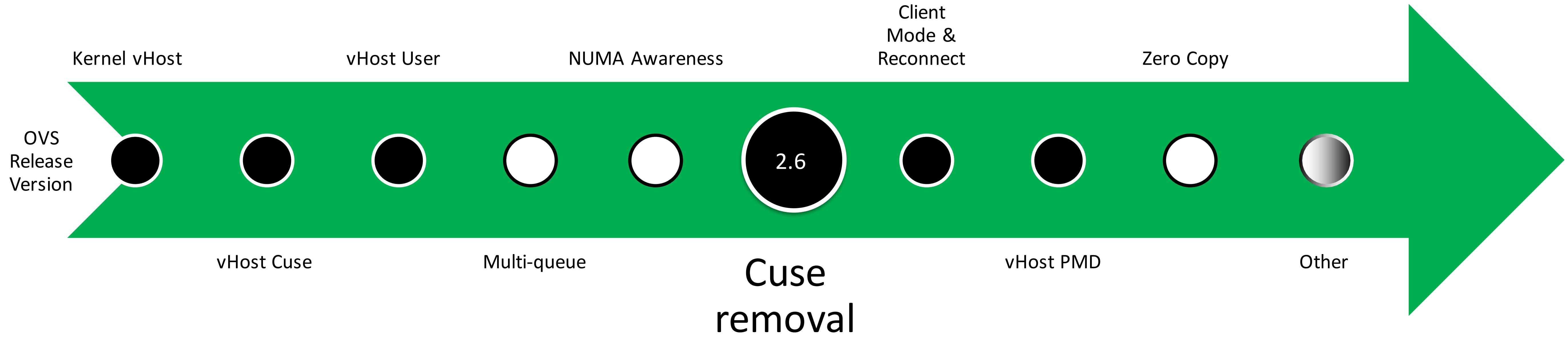

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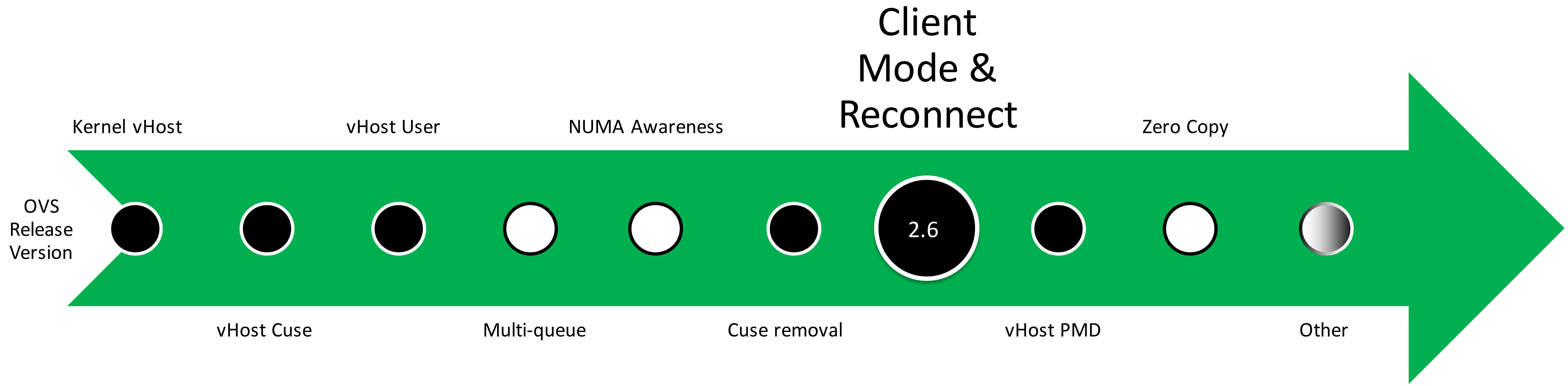

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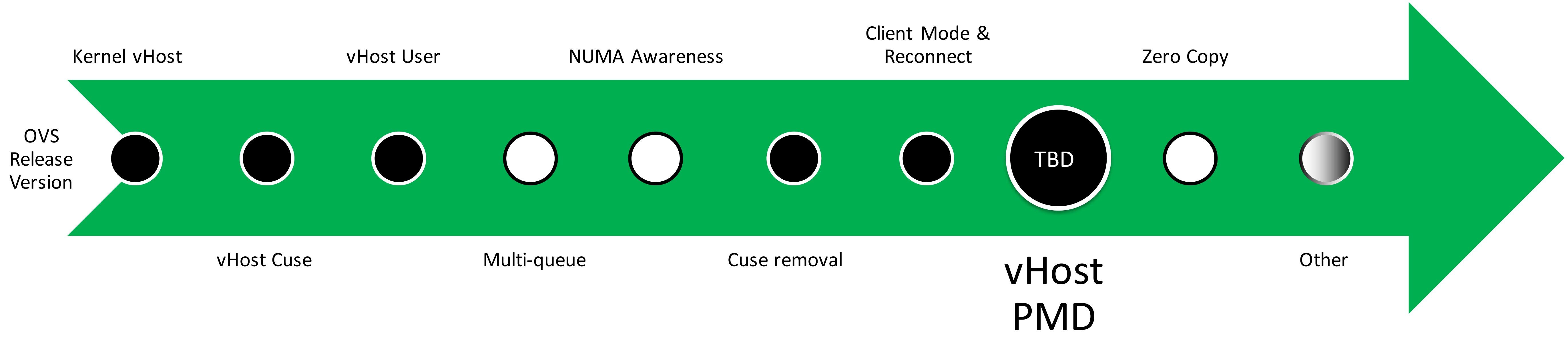

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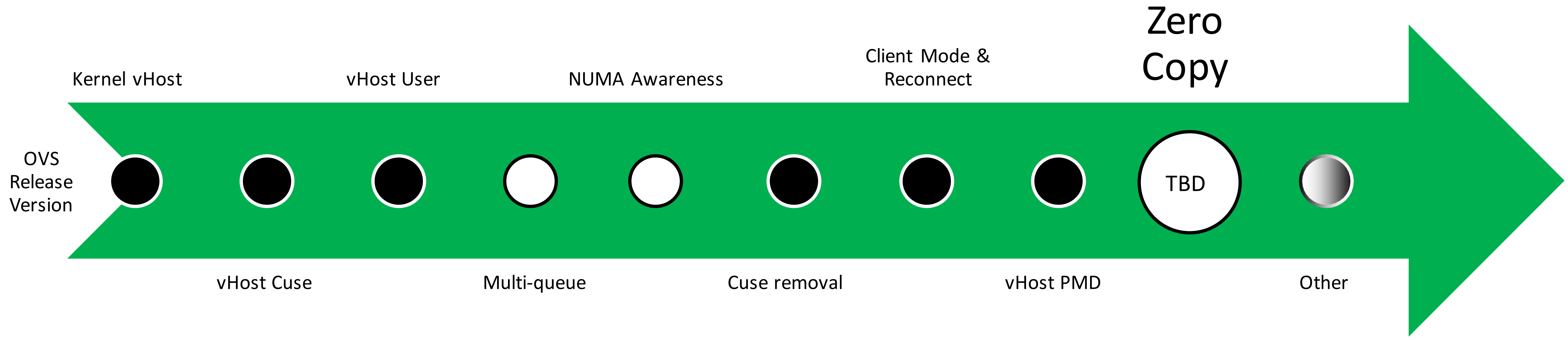

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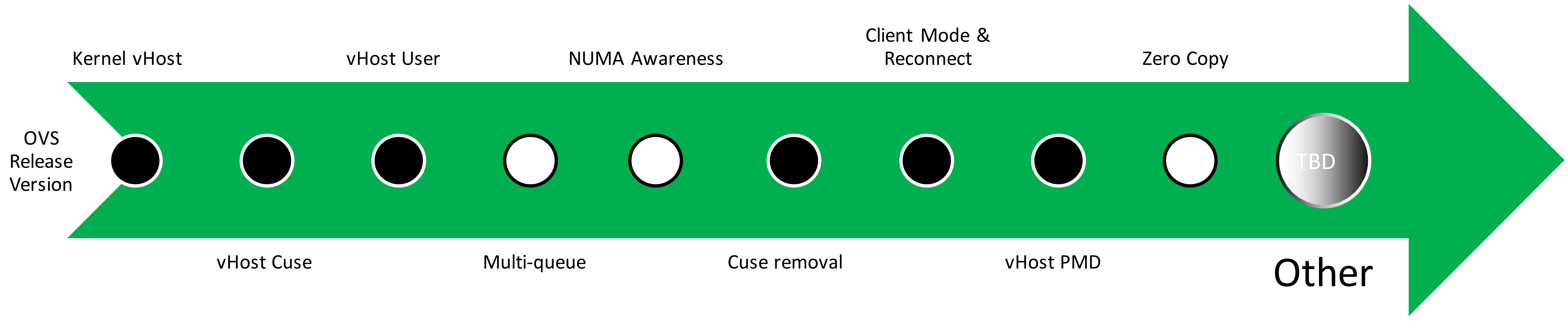

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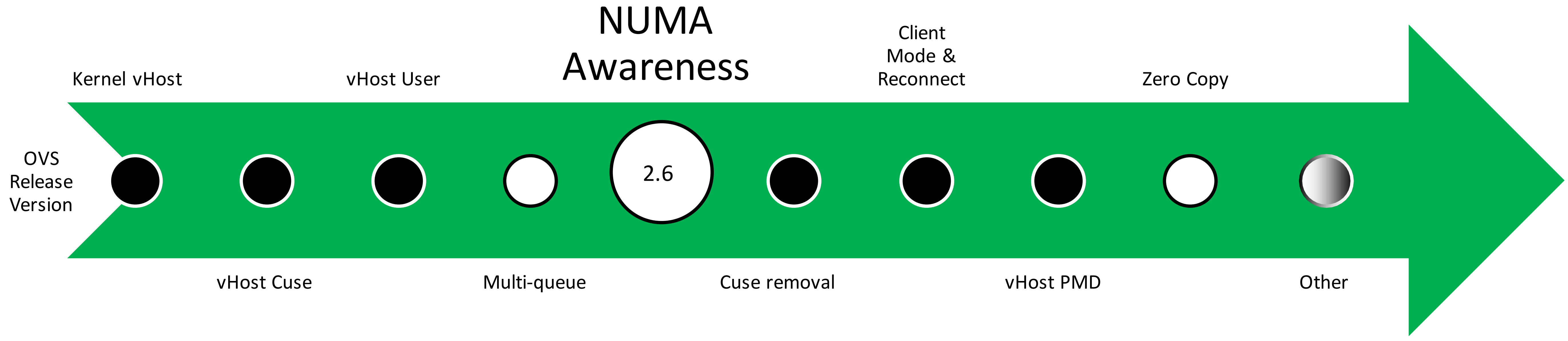

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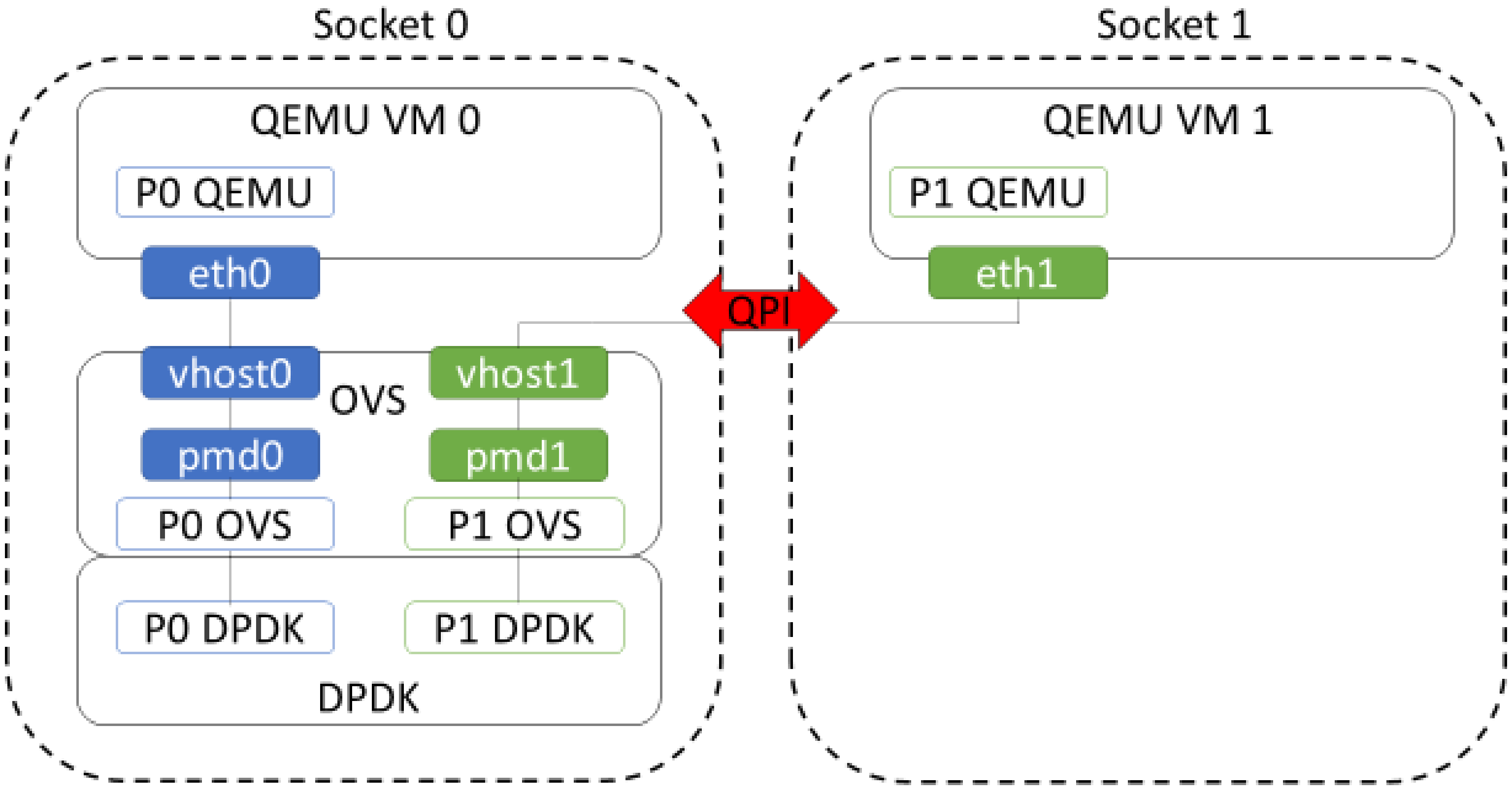

QEMU, DPDK & OVS vHost memory need to be co-located for optimal performance.

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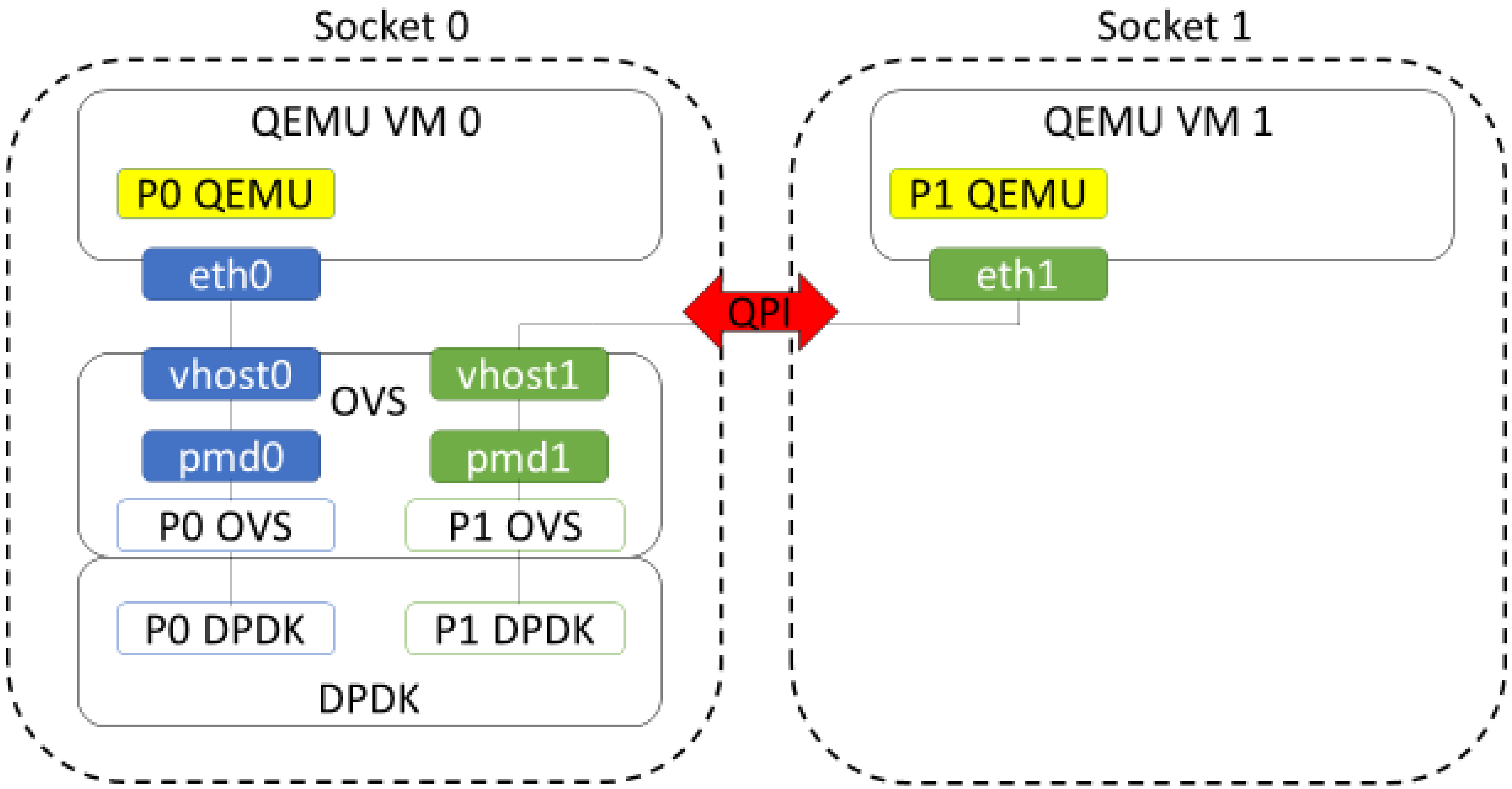

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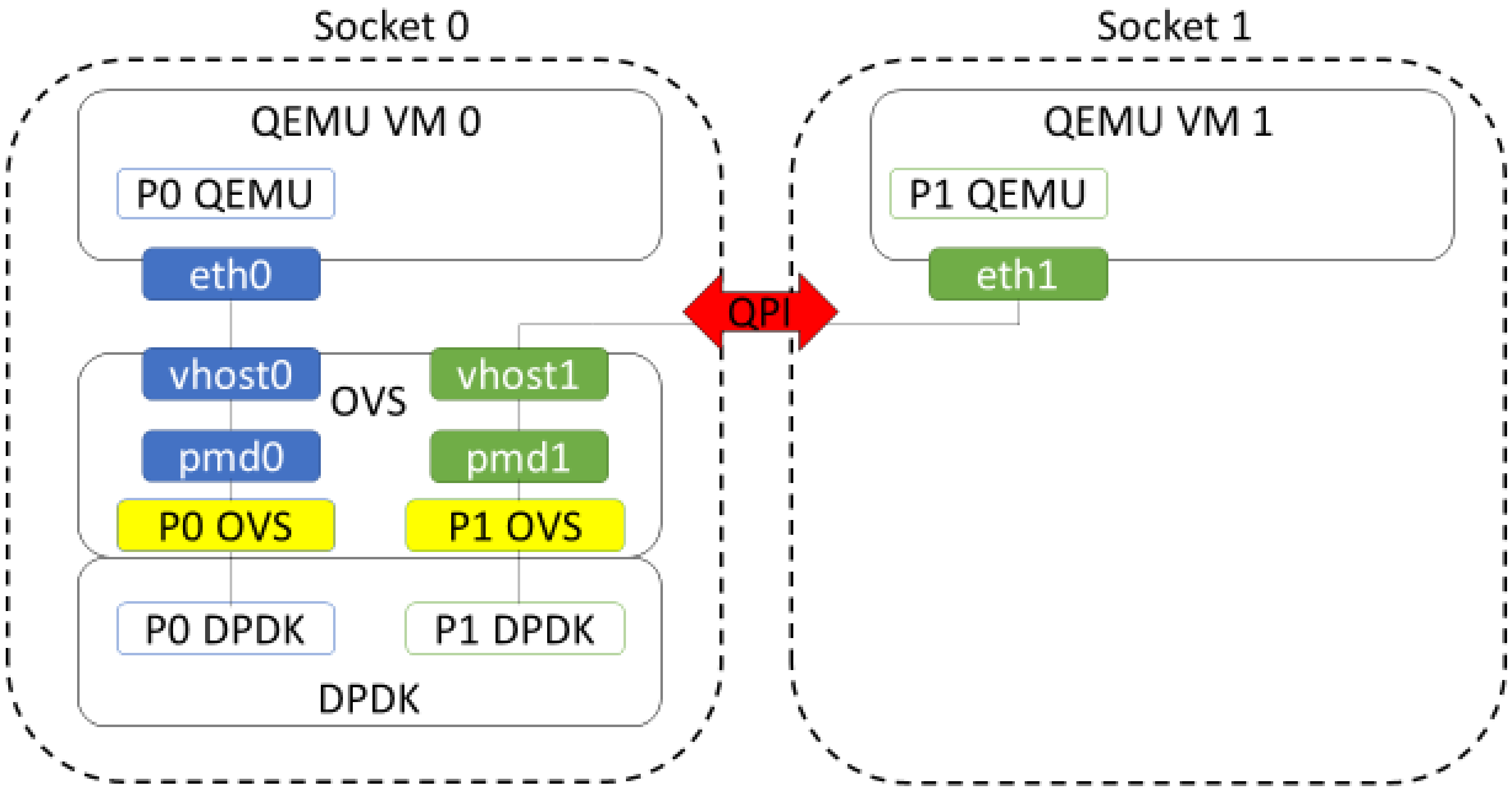

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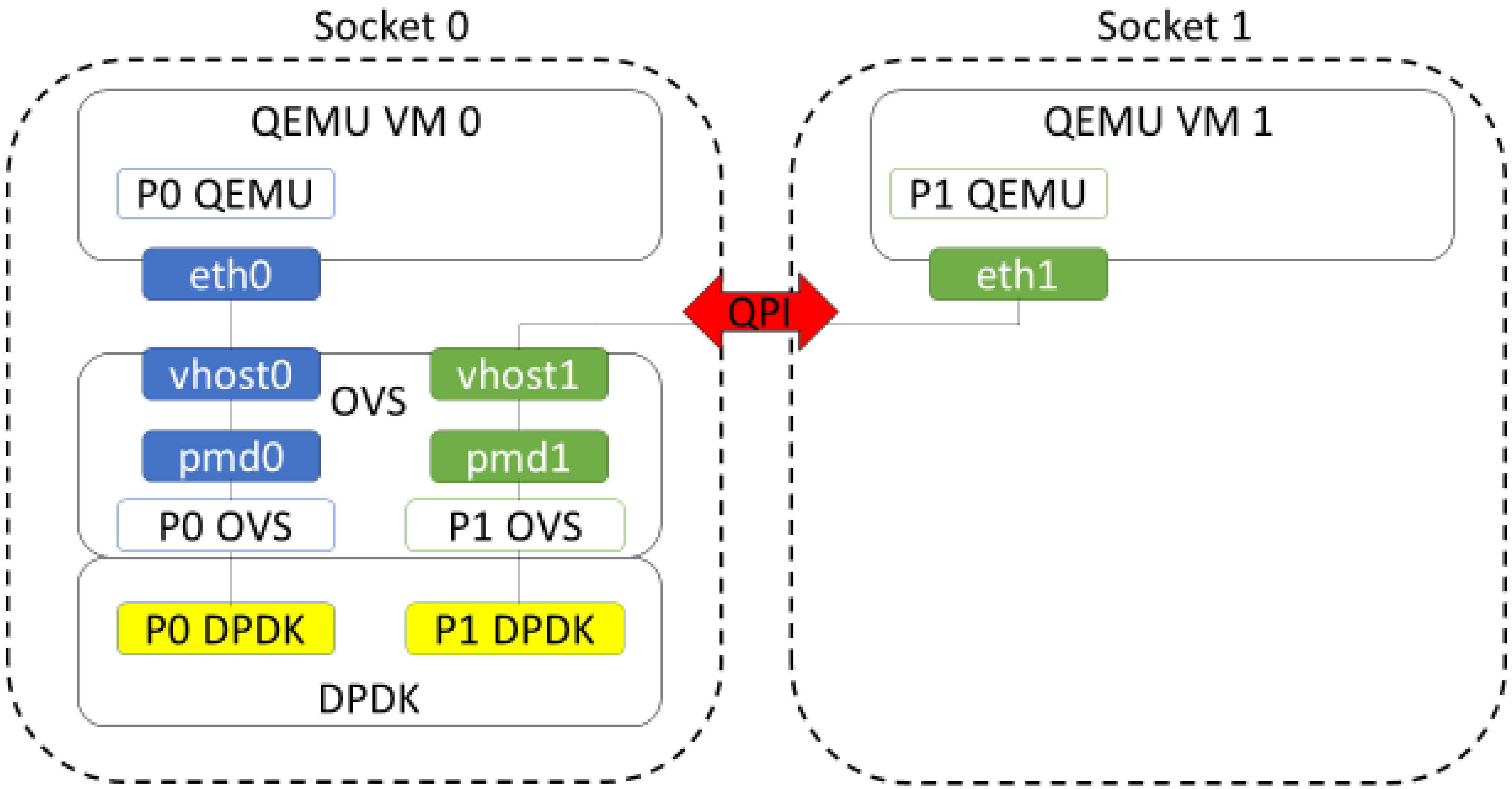

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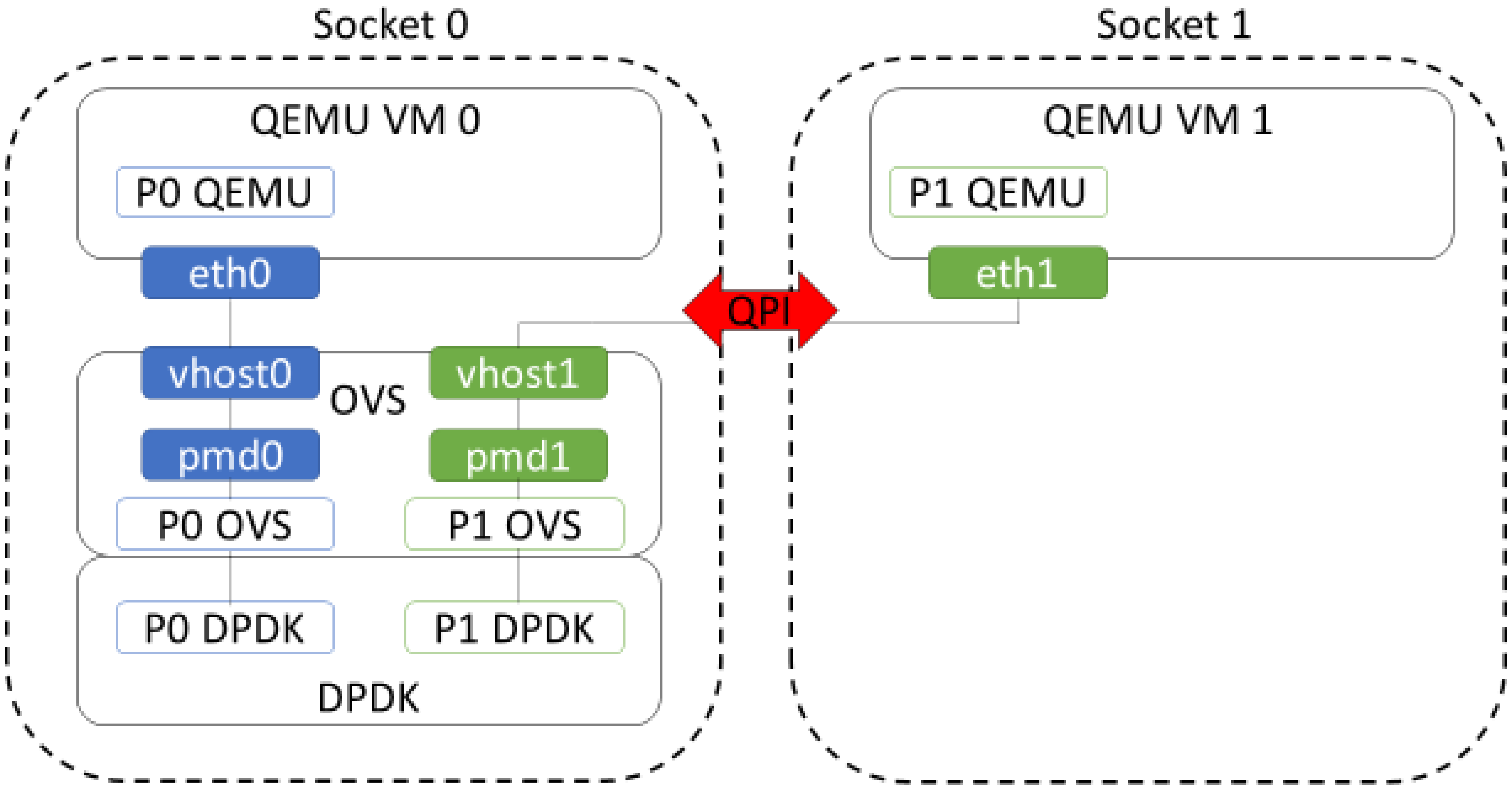
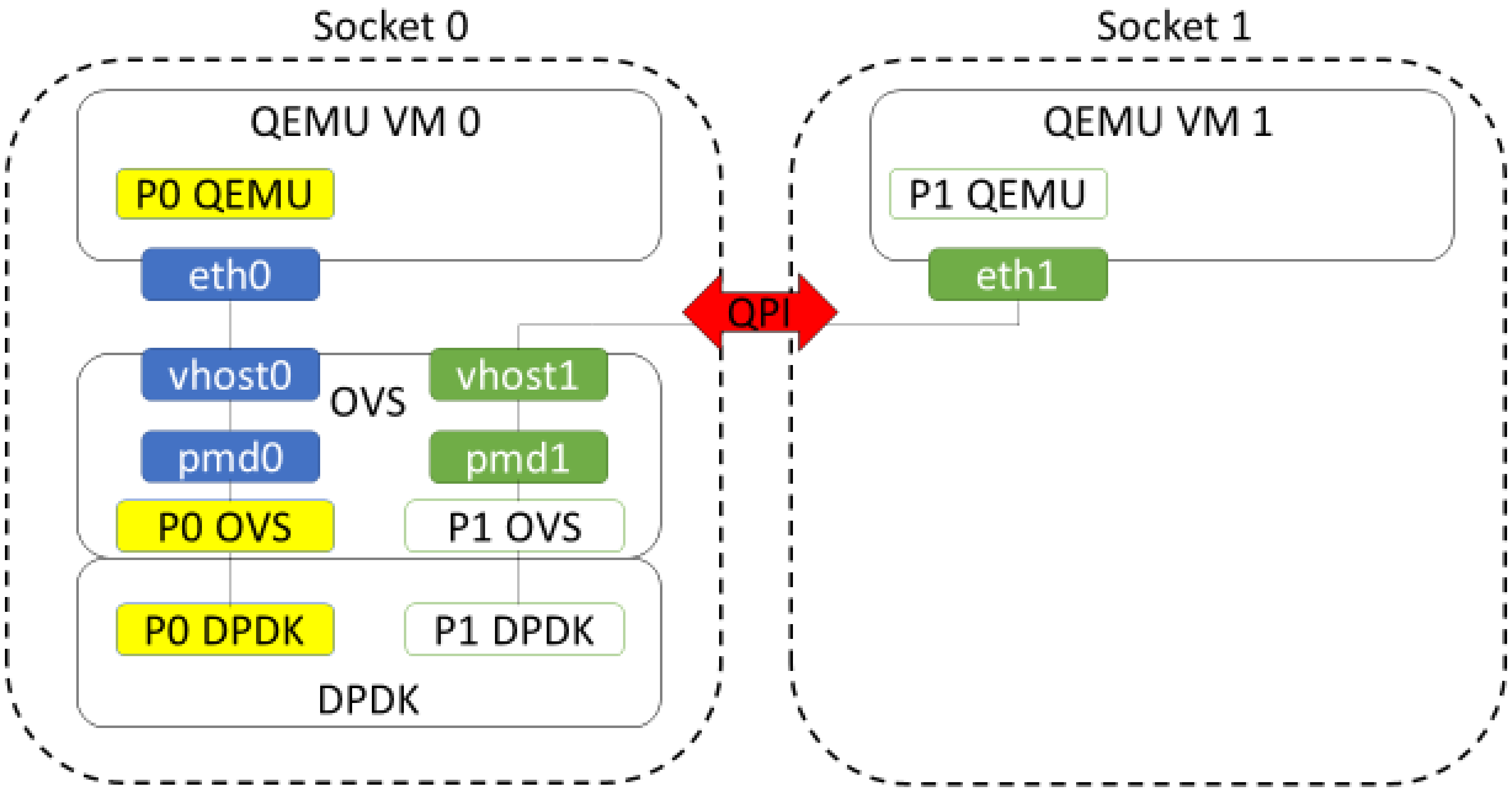


Previous limitation:

All DPDK vHost memory must come from the same NUMA node.

NUMA Awareness



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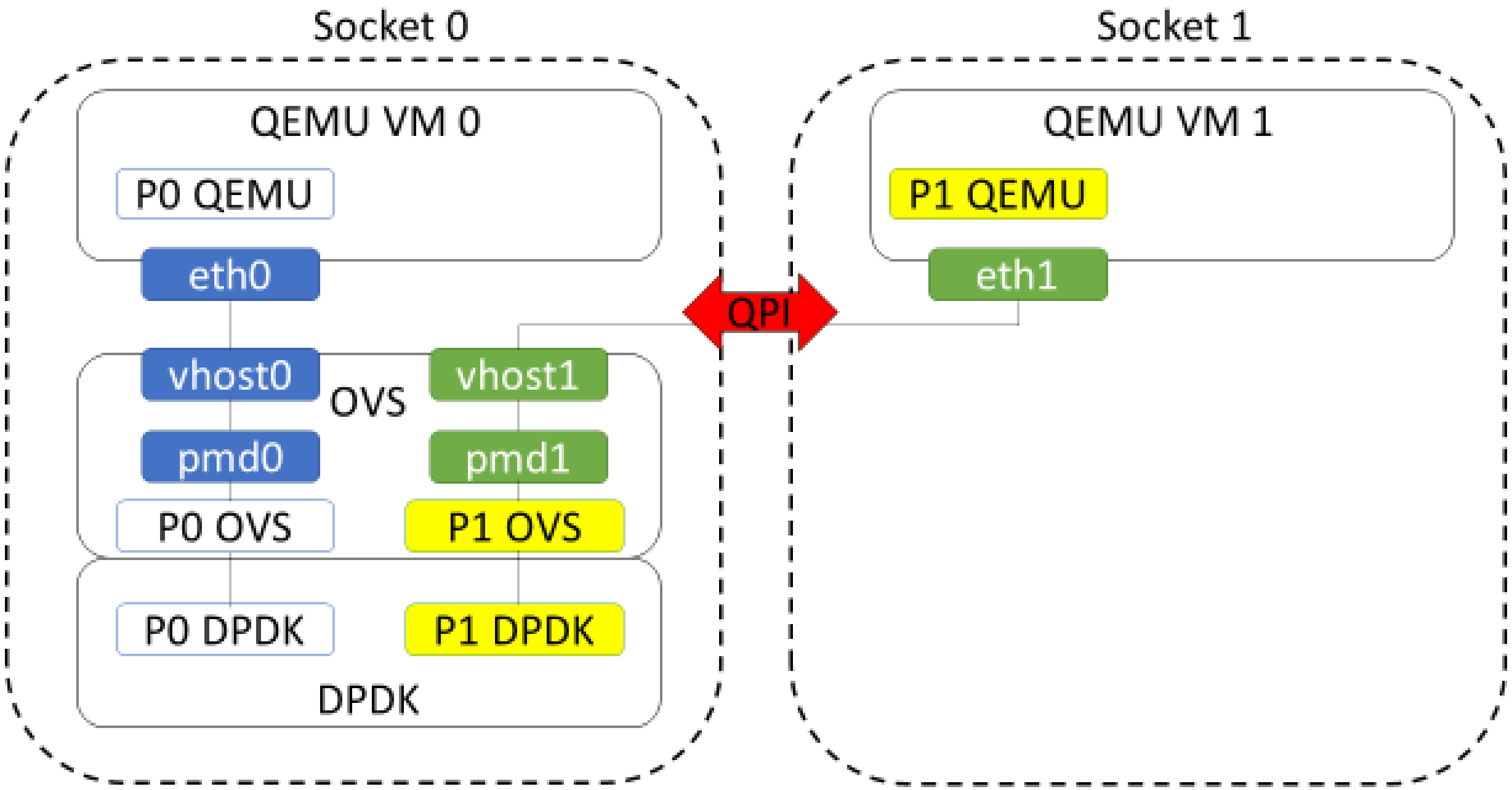

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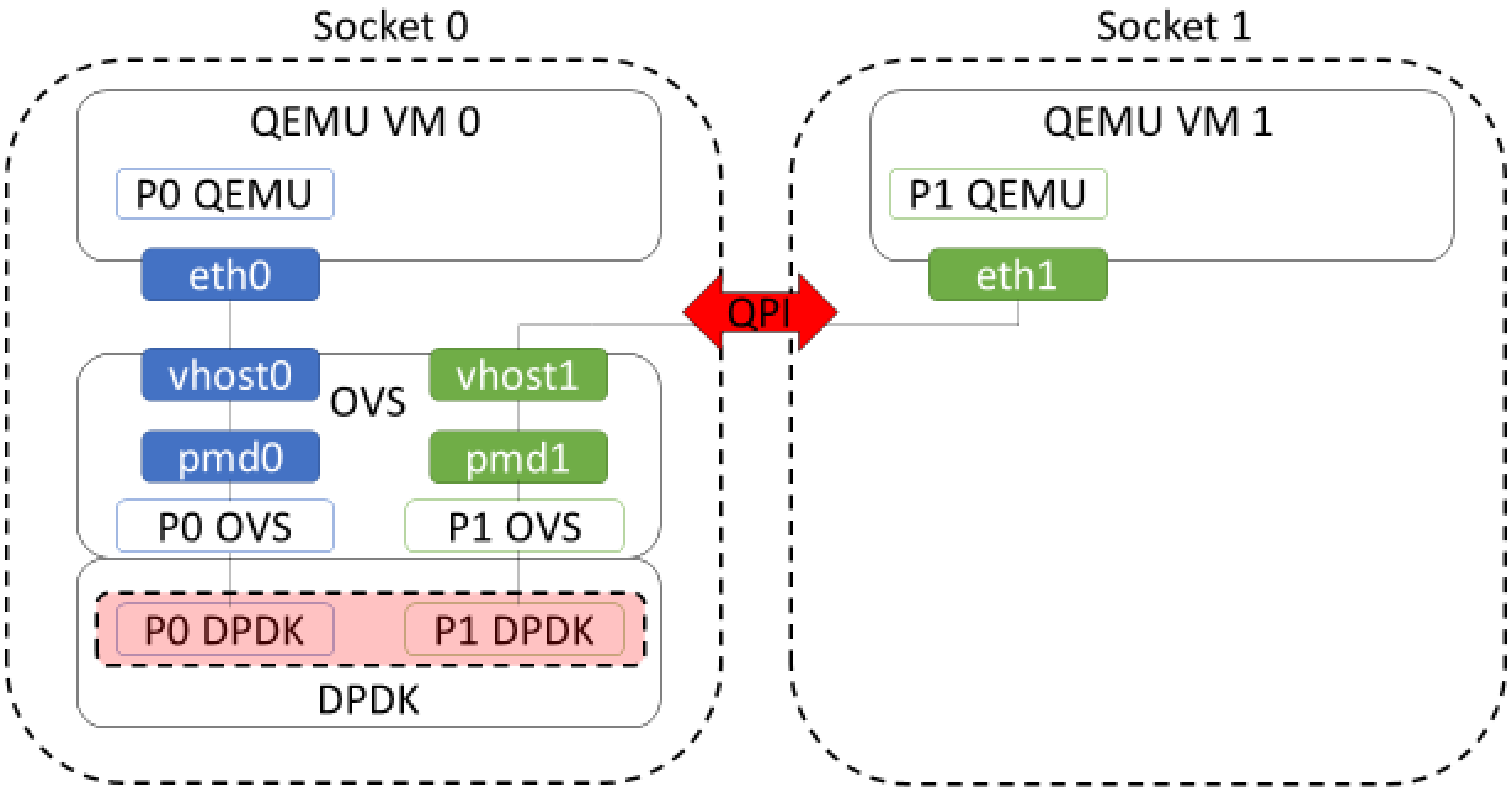

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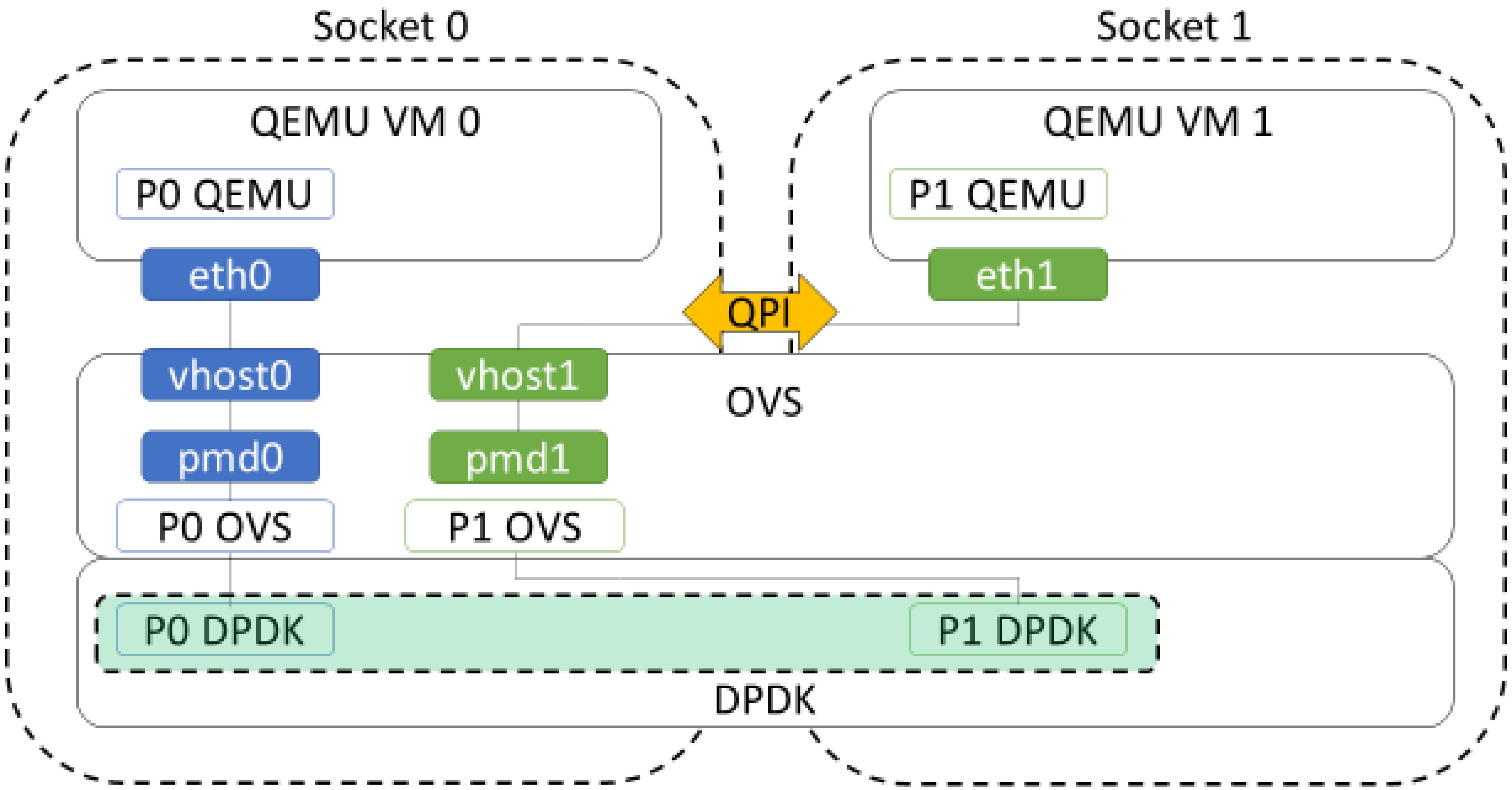
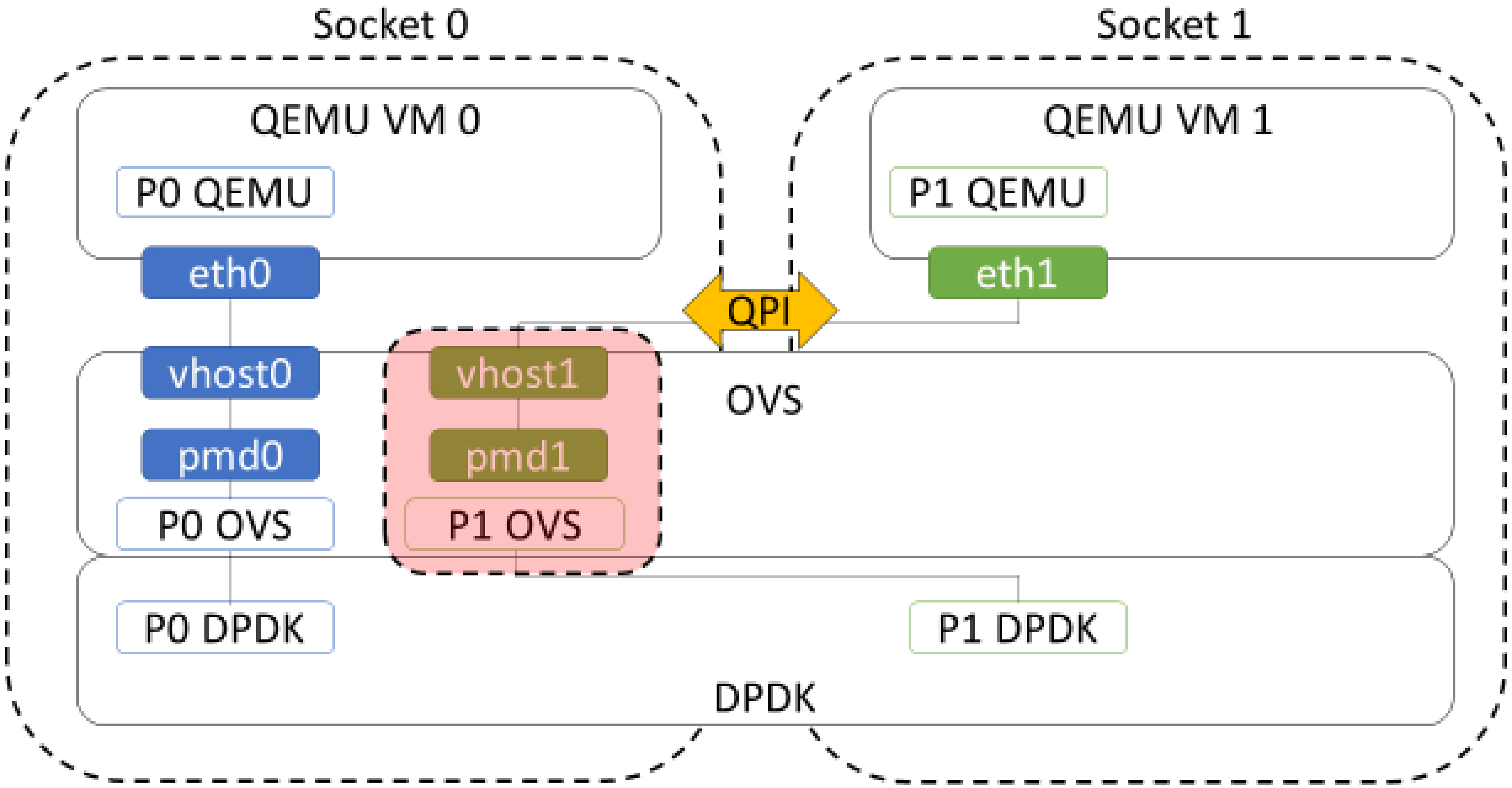


Solution:

DPDK vHost memory relocated to correct NUMA node on VM boot.

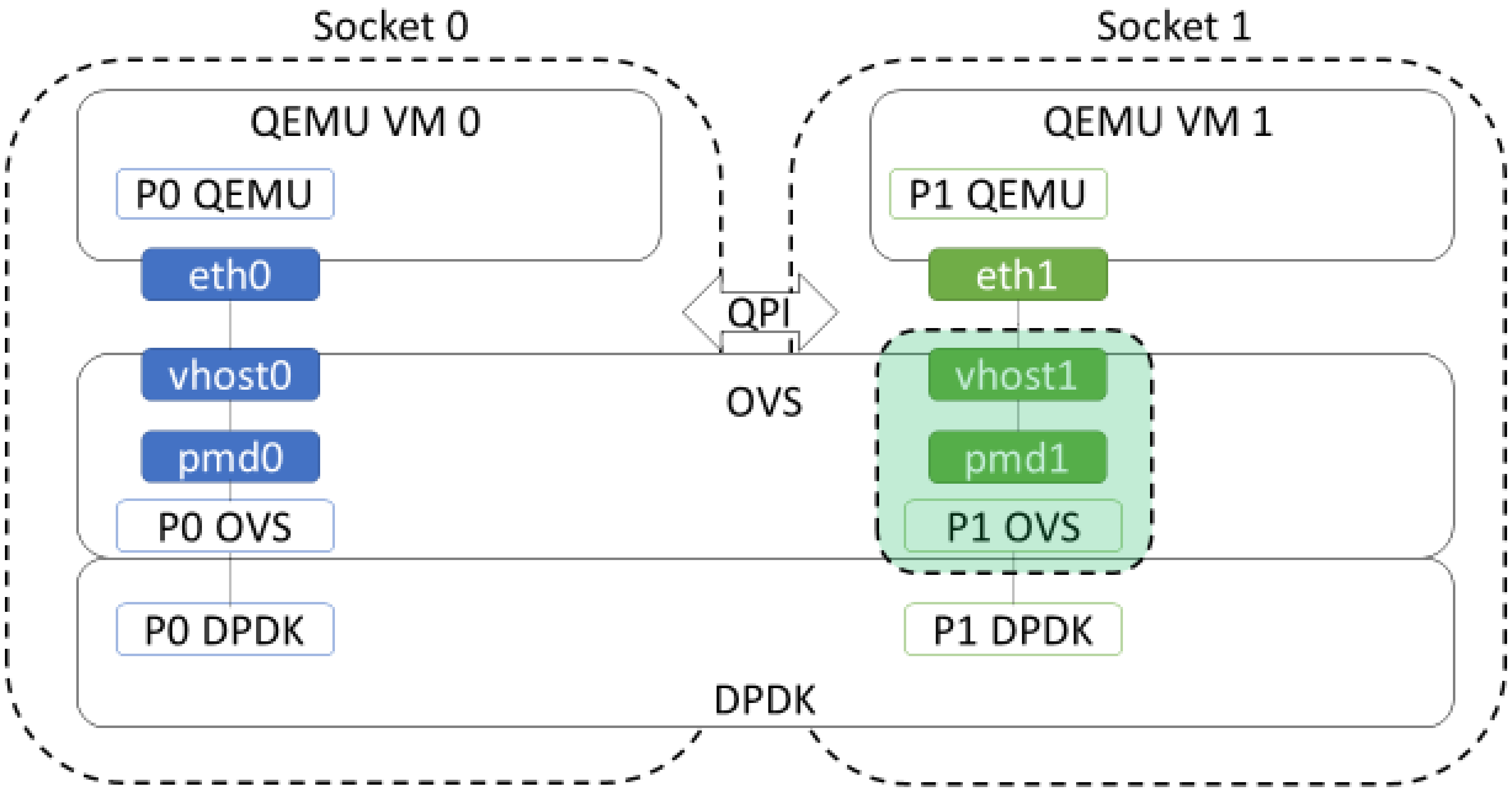
NUMA Awareness



Previous limitation:

All PMDs servicing vHost ports must come from the same NUMA node.

NUMA Awareness



Solution:

mbufs and servicing PMD in OVS are moved to correct NUMA during DPDK callback.

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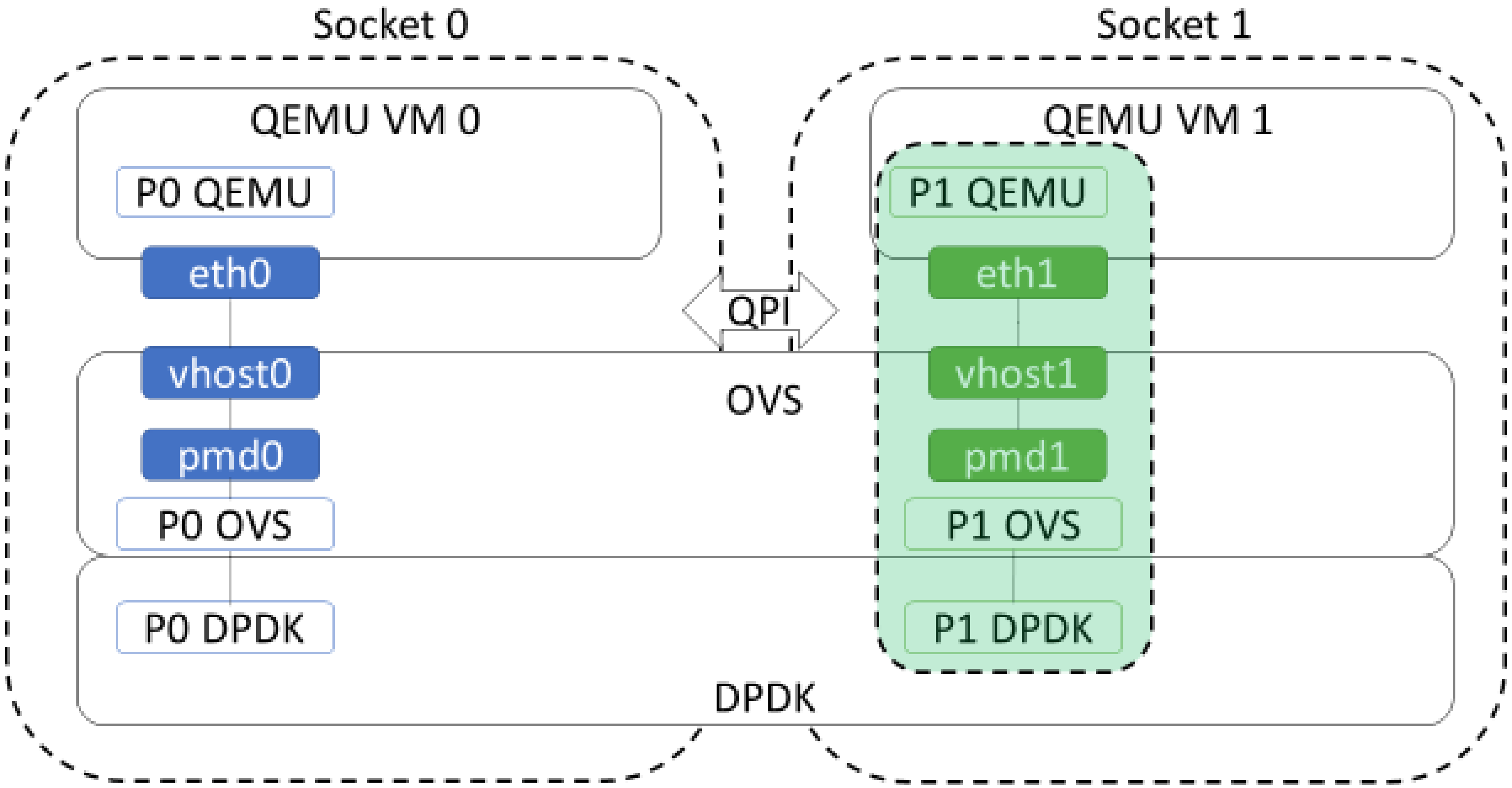

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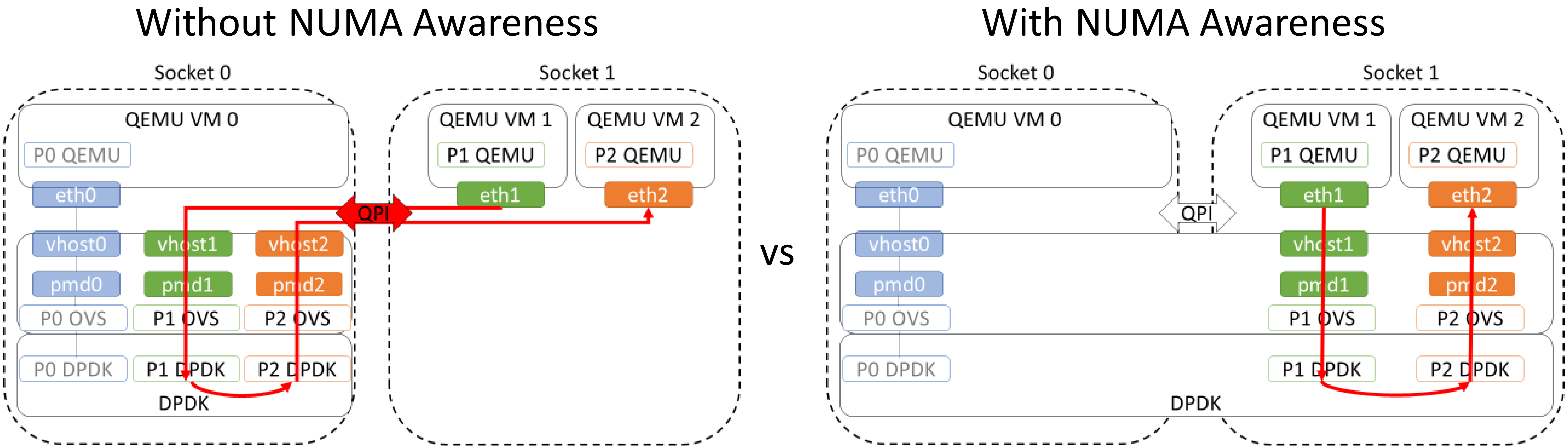

Can achieve >50% improvement in second socket VM2VM performance*

* Platform Configuration and Test Result in Backup

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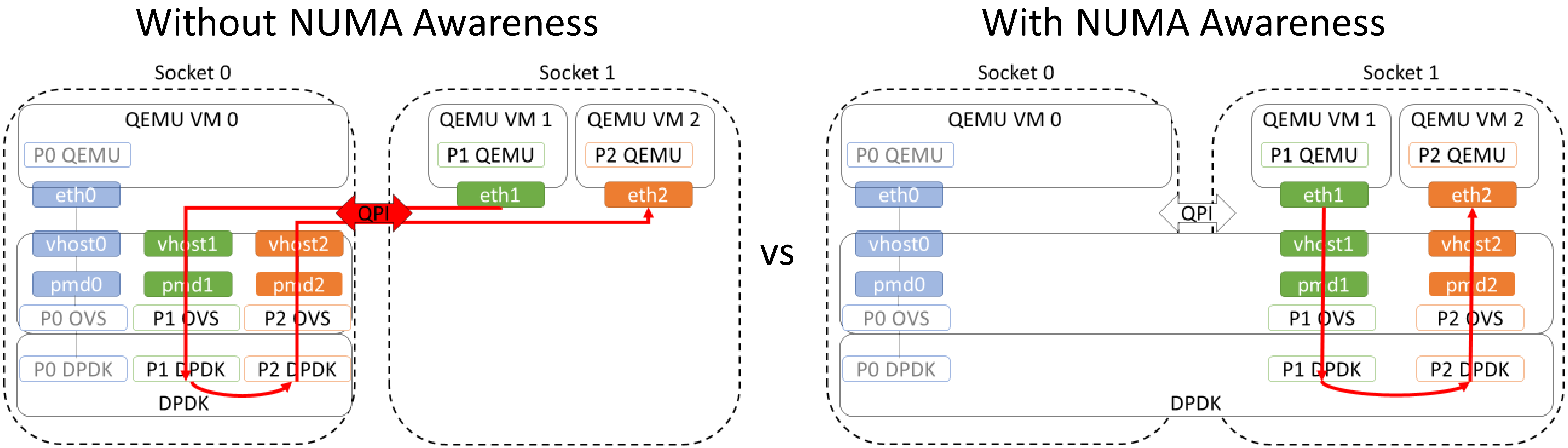

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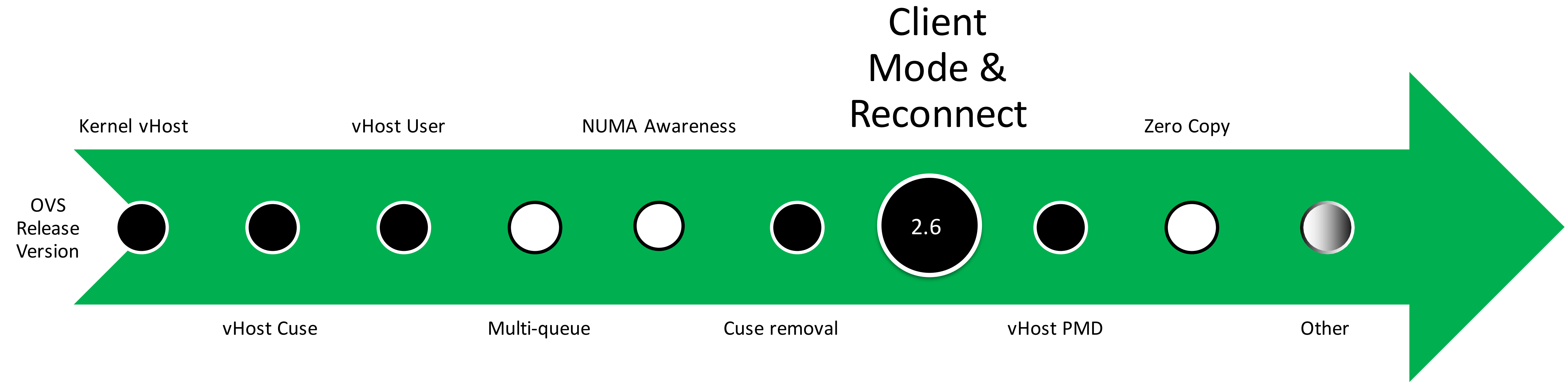
https://software.intel.com/en-us/articles/vhost-user-numa-awareness-in-open-vswitch-with-dpdk

Client Mode & Reconnect



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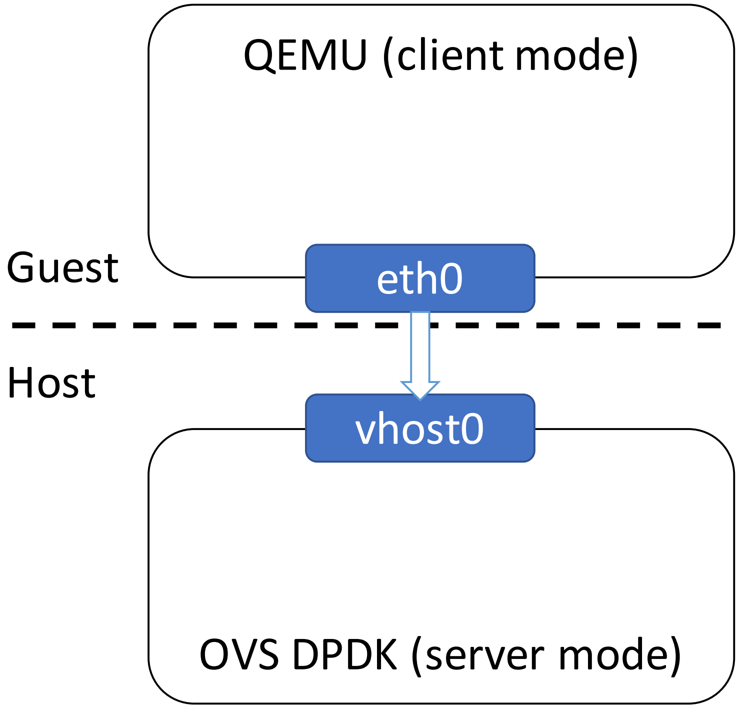
Default Mode (Server)

Previous Limitation:

VMs cannot easily regain connectivity if OVS DPDK crashes or is reset



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OVS by default acts as the socket server

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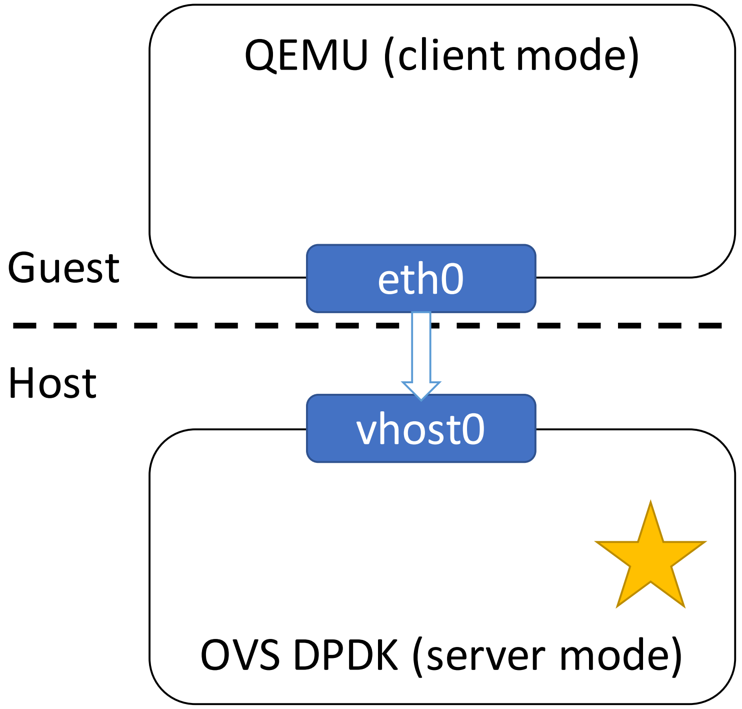

★ = creates/manages/destroys sockets

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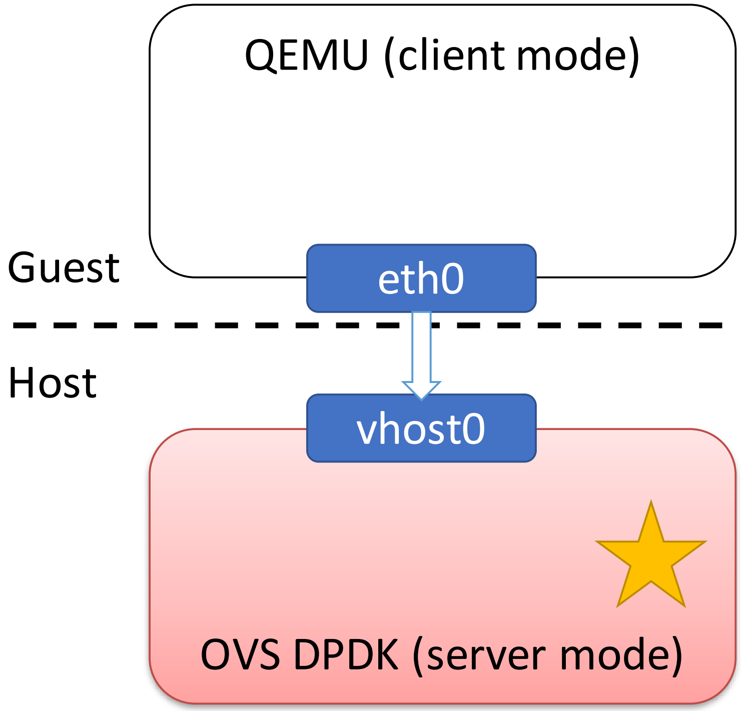

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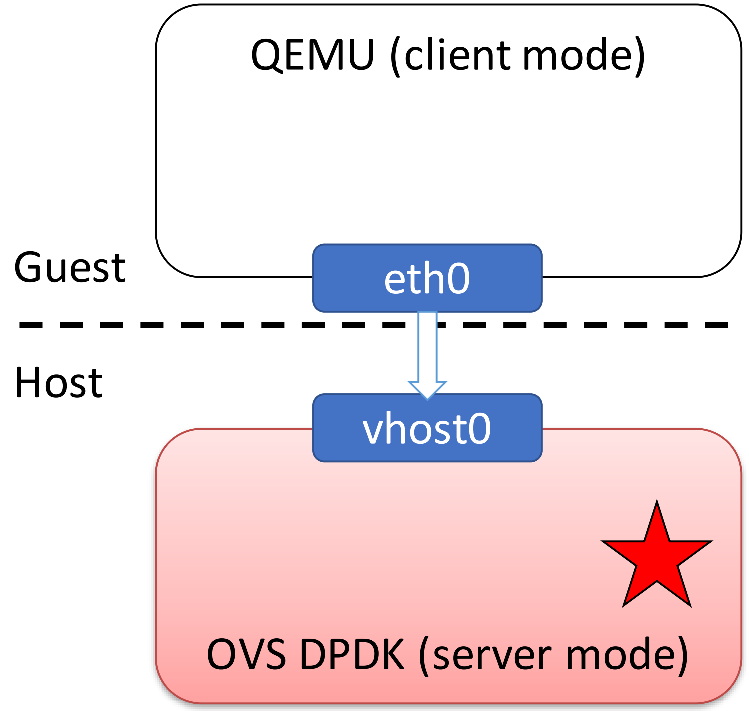

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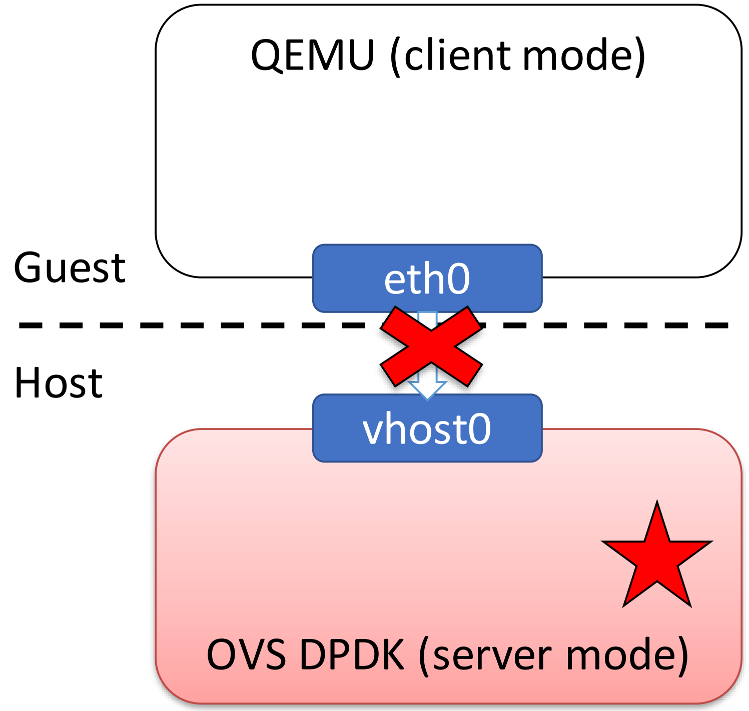

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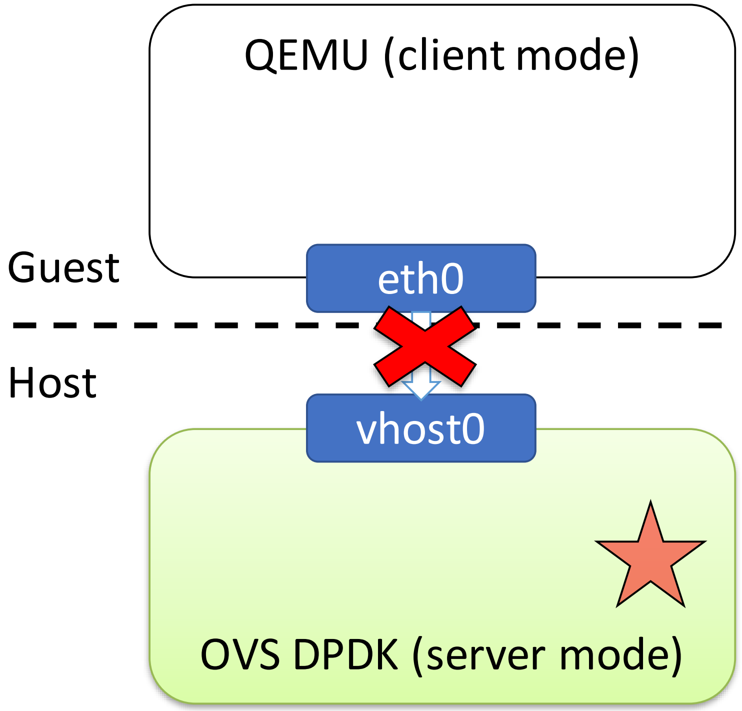

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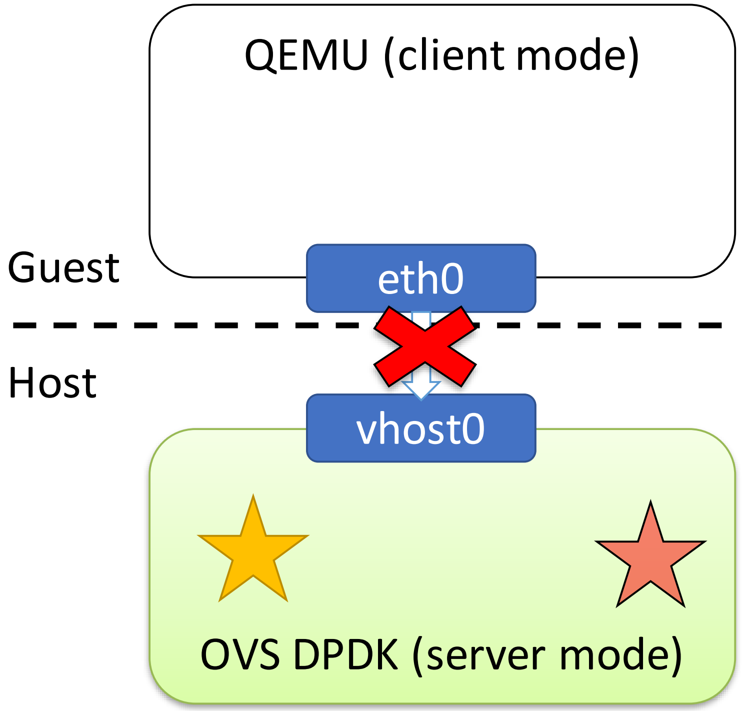

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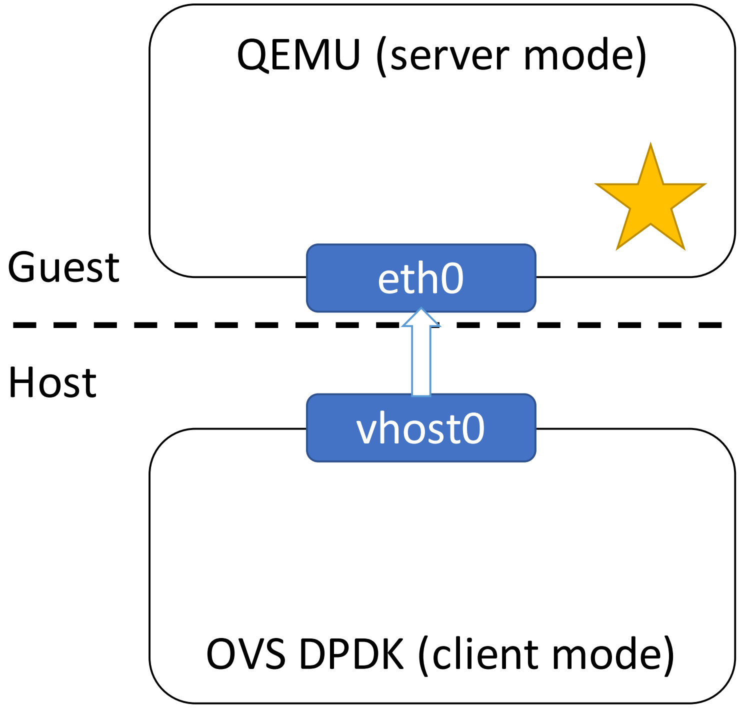
New Mode (Client)

Solution:

QEMU creates the socket and acts as the server instead



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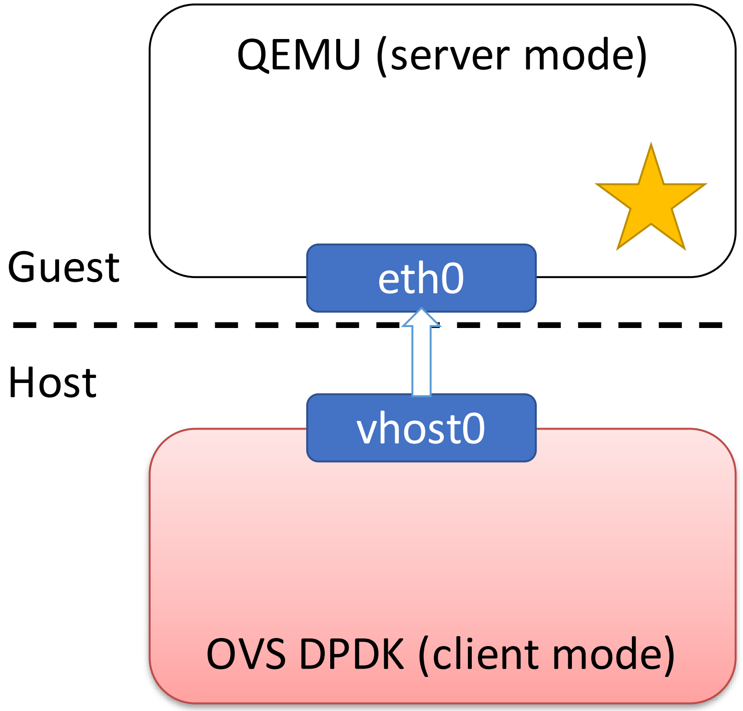

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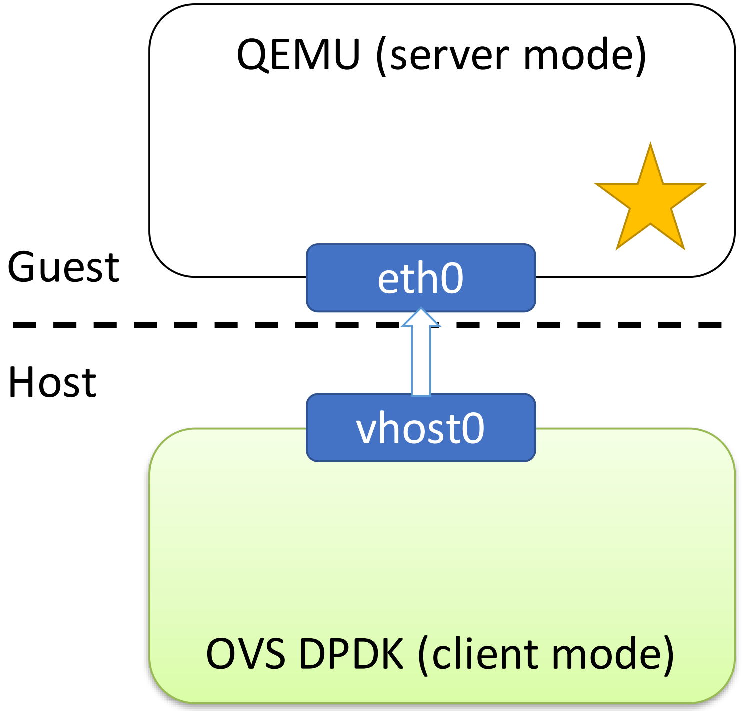

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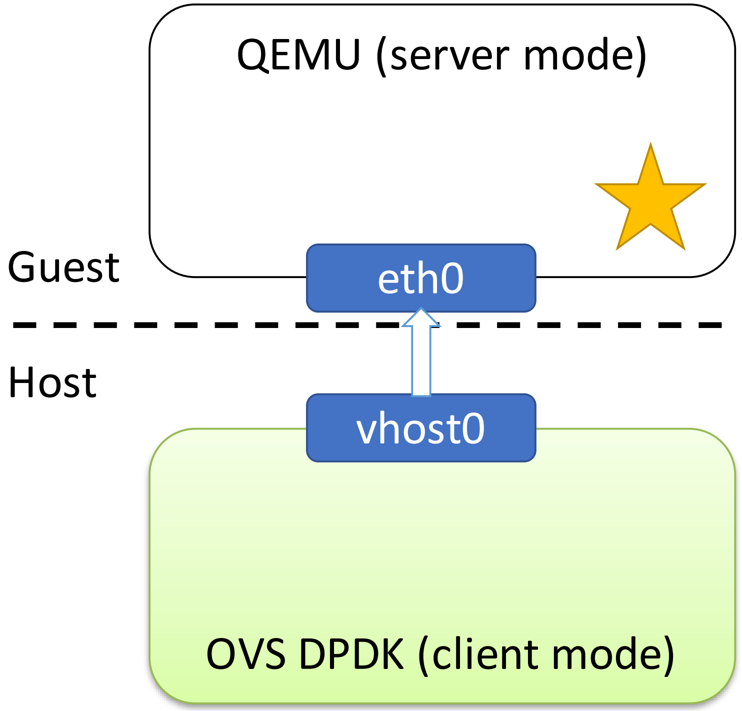

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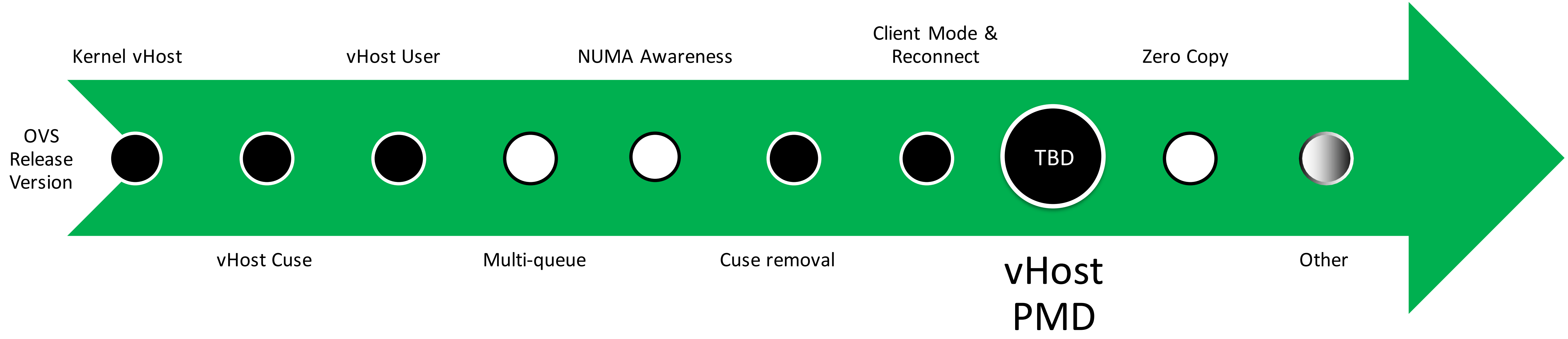
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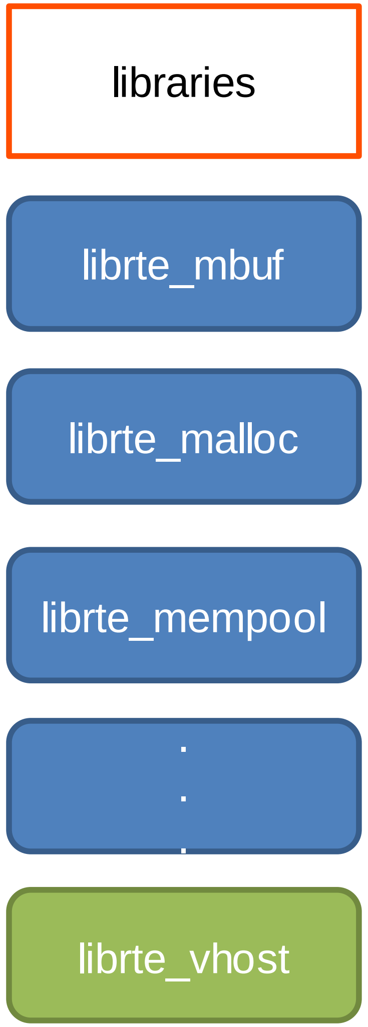

libraries

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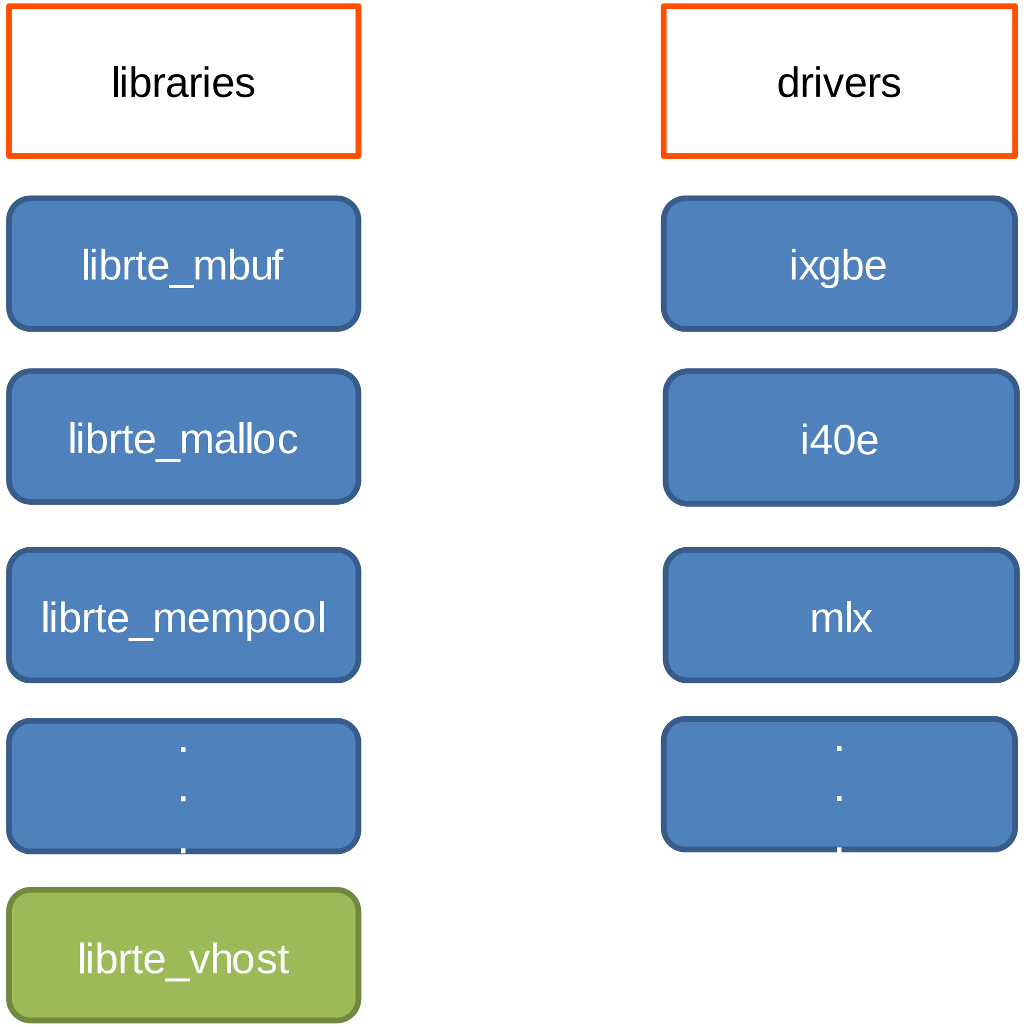

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⋮	⋮
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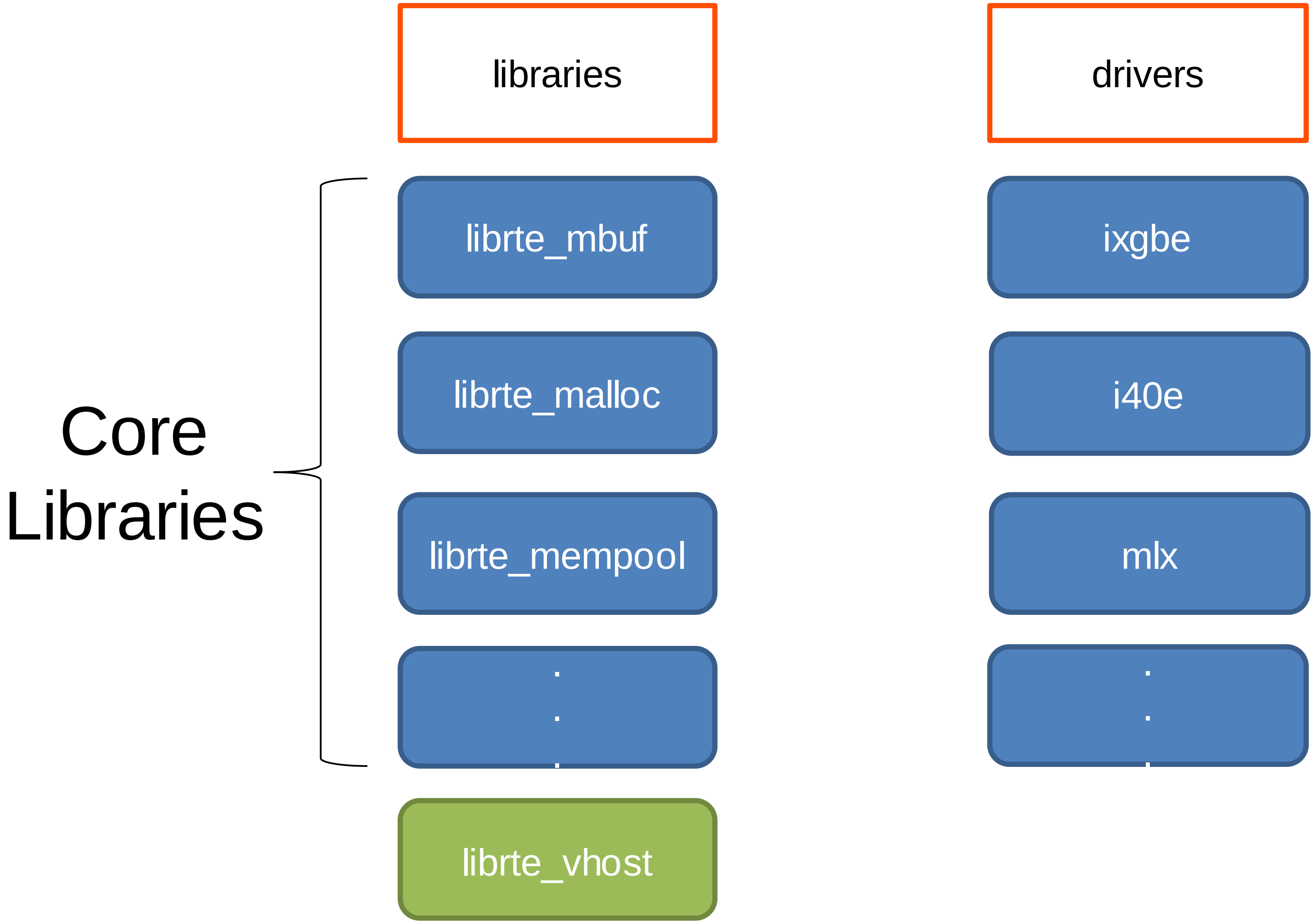

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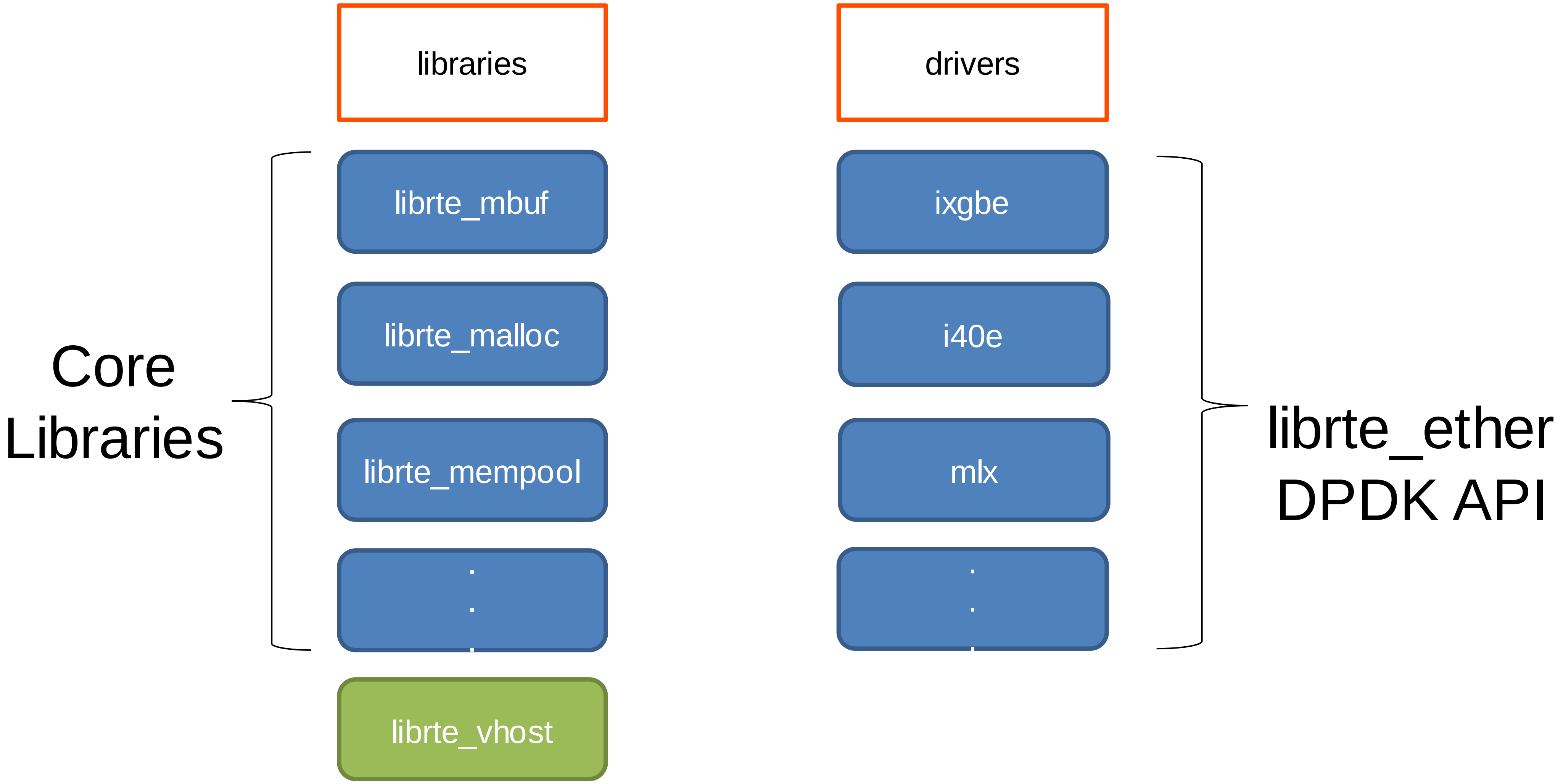

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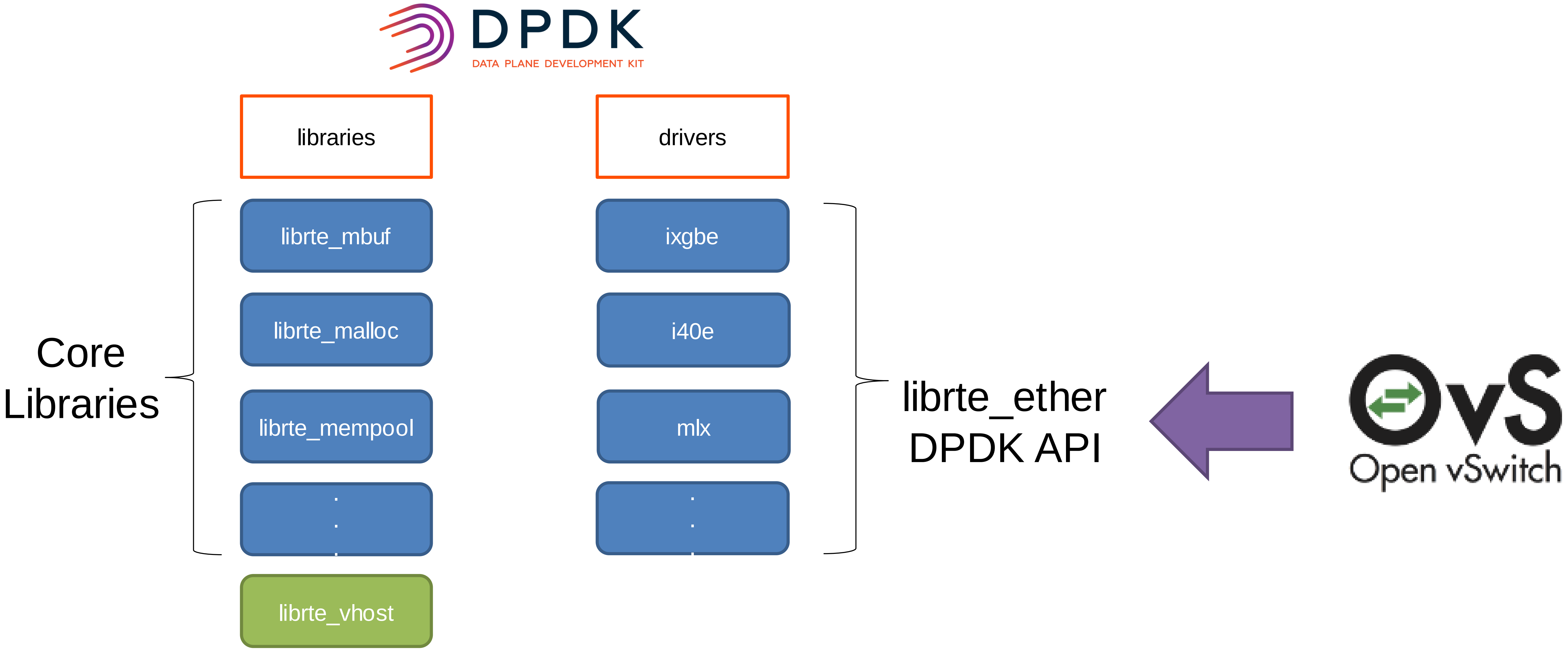

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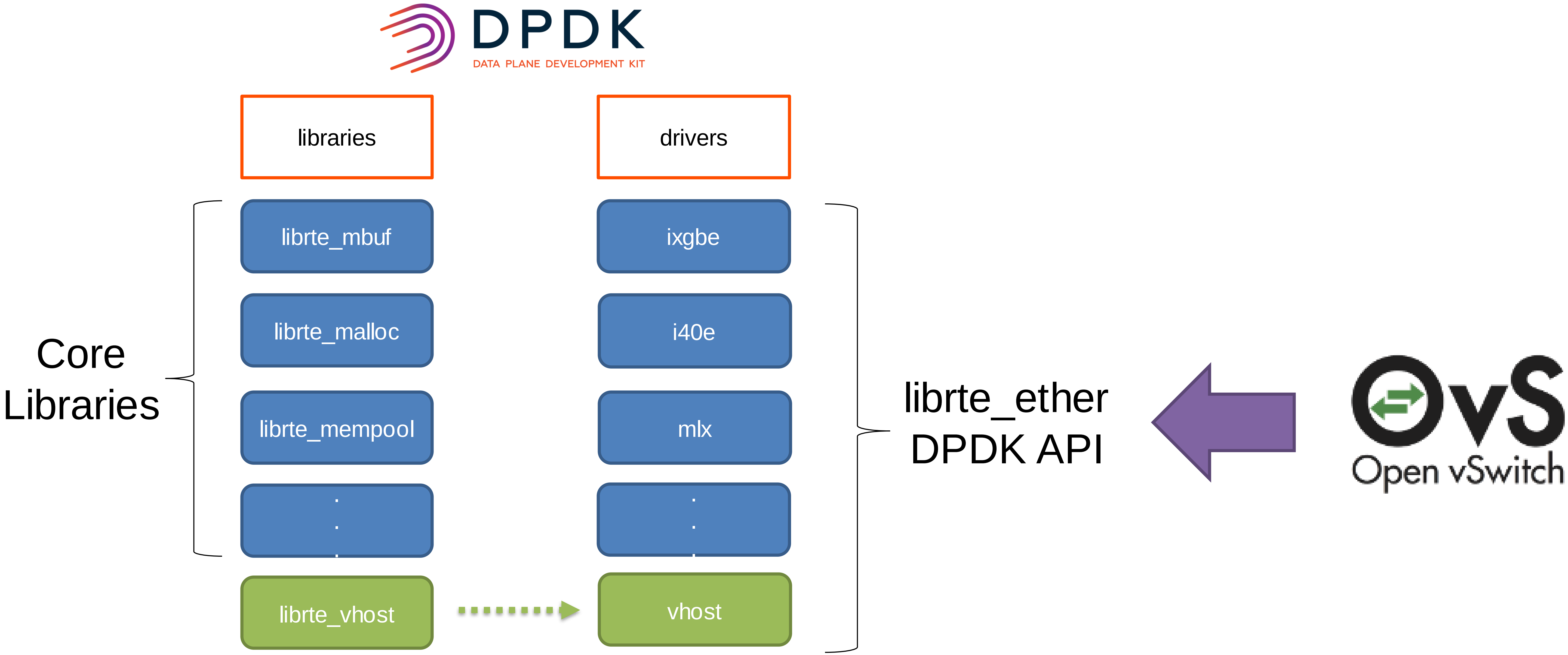

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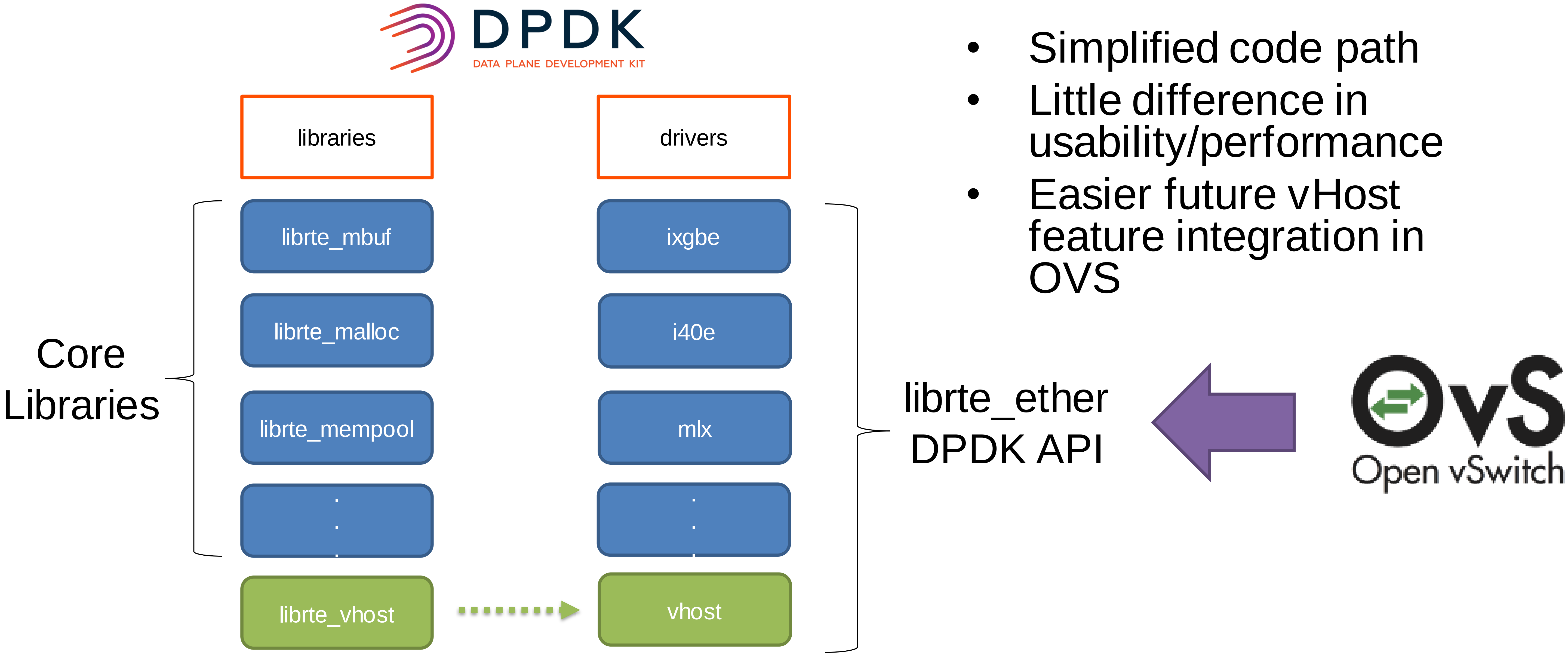
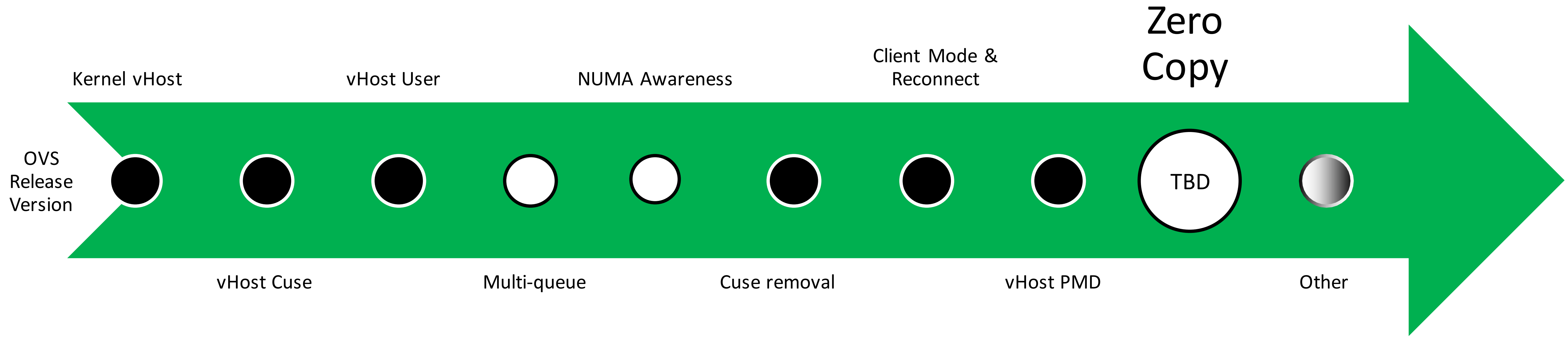
librte_malloc
librte_mempool
. . .
ixgbe
i40e
mlx
. . .
librte_vhost
vhost
librte_ether
DPDK API
Open vSwitch

vHost PMD



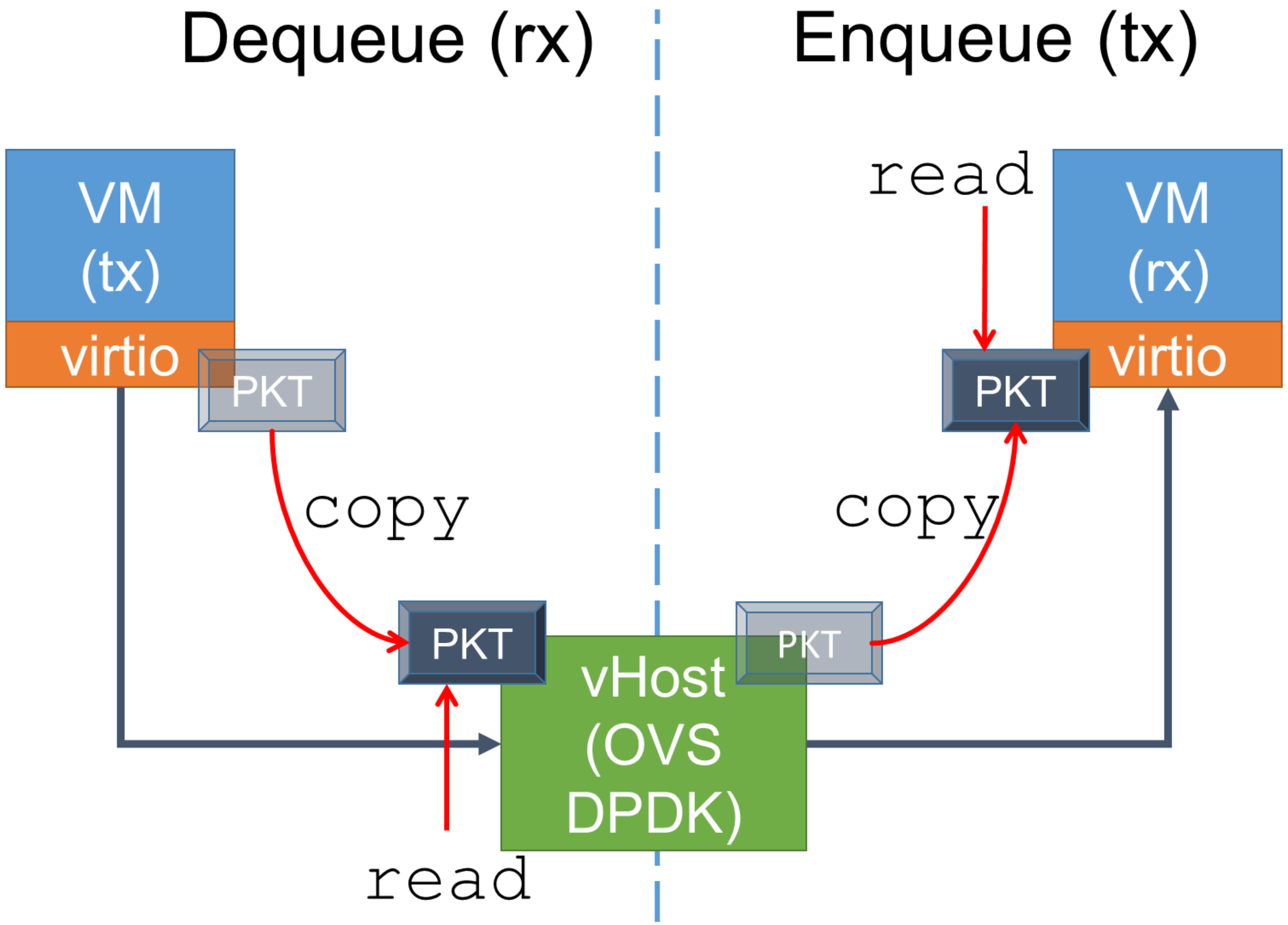
- Simplified code path
- Little difference in usability/performance
- Easier future vHost feature integration in OVS

Zero Copy


Kernel vHost
vHost User
NUMA Awareness
Client Mode & Reconnect
Zero Copy
OVS Release Version
TBD
vHost Cuse
Multi-queue
Cuse removal
vHost PMD
Other

Zero Copy

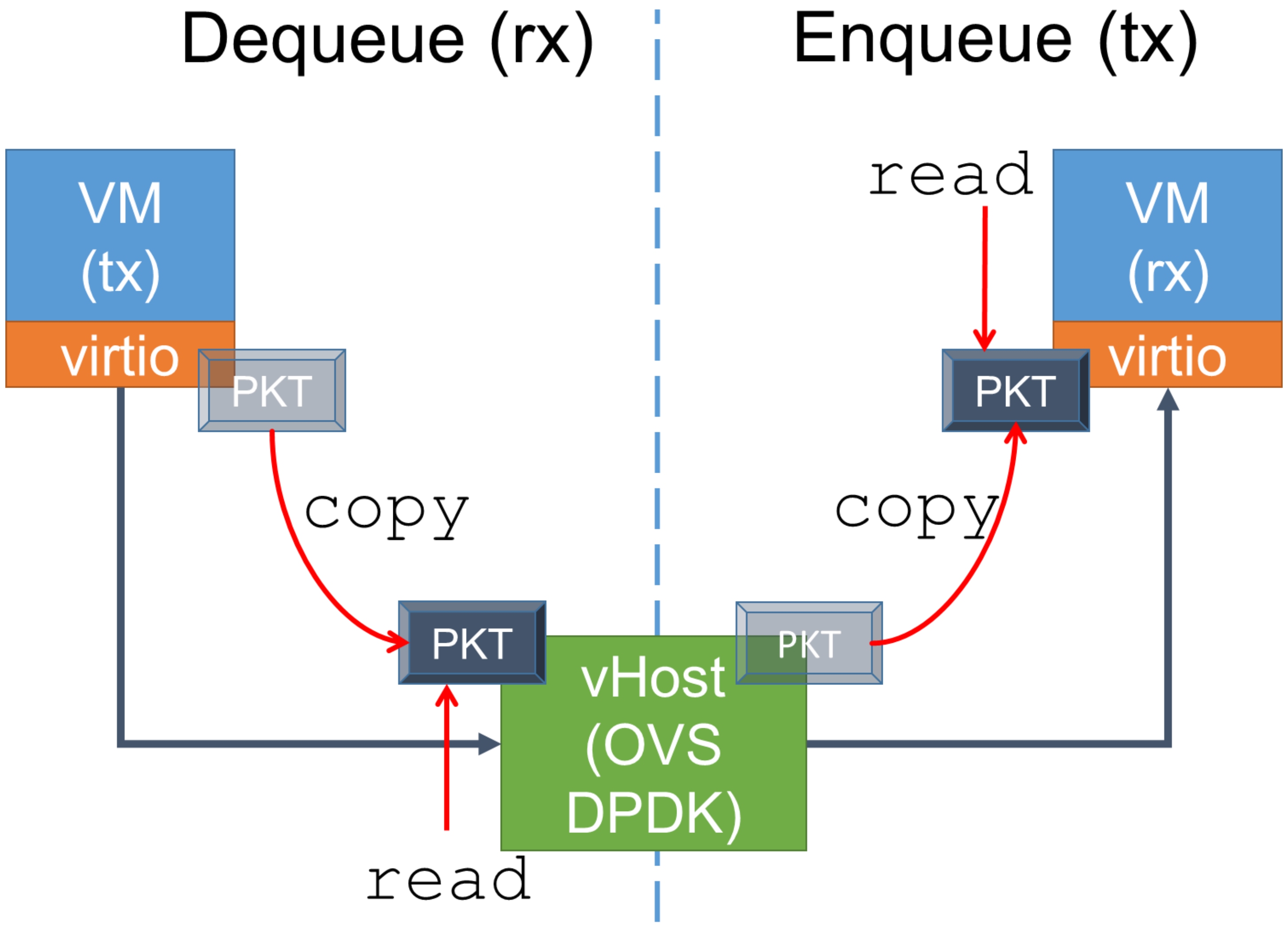
DPDK 16.11 performance improvement



Zero Copy

DPDK 16.11 performance improvement

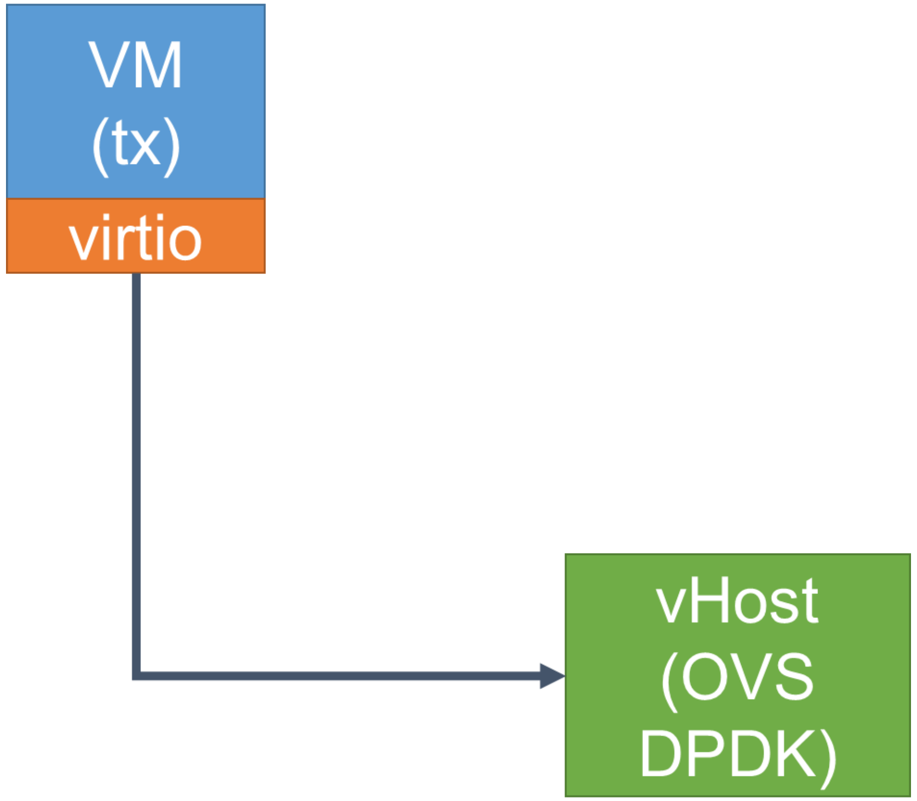
Both dequeue (rx) and enqueue (tx) paths usually incur a copy.



Zero Copy

Dequeue path involves copying a packet from the VM to the host

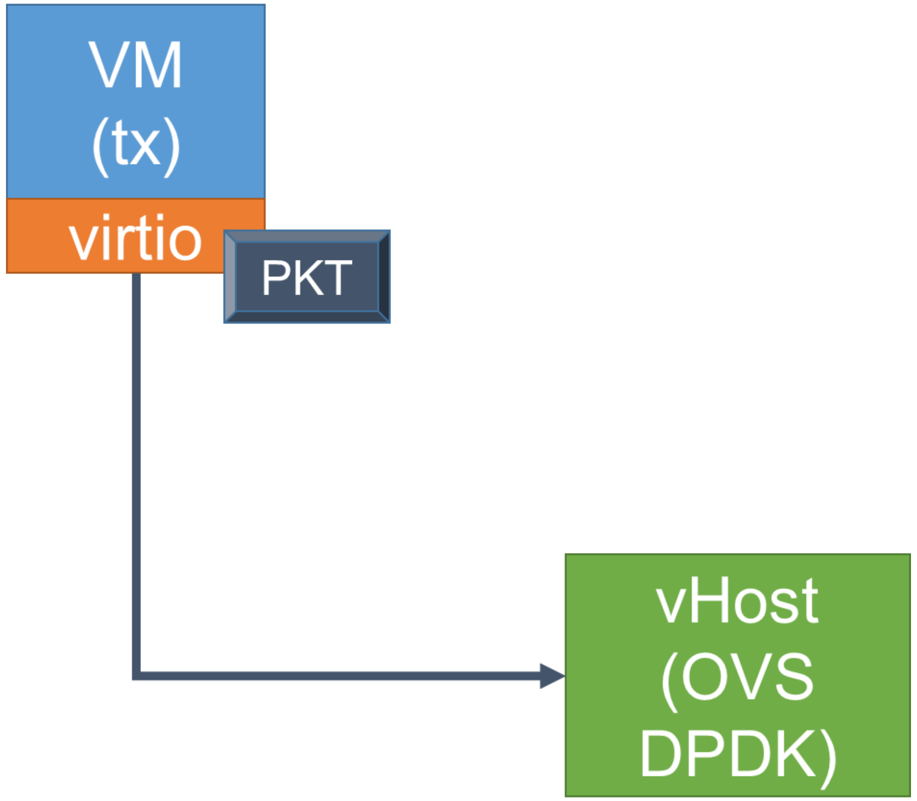
Dequeue (rx)



Zero Copy

Dequeue path involves copying a packet from the VM to the host

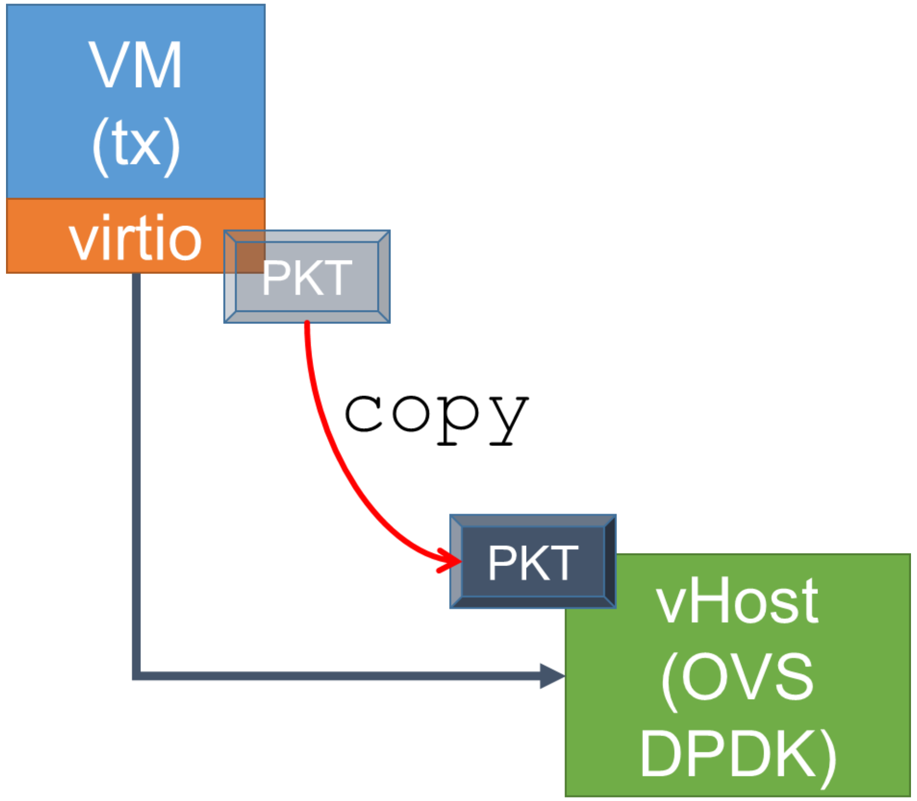
Dequeue (rx)



Zero Copy

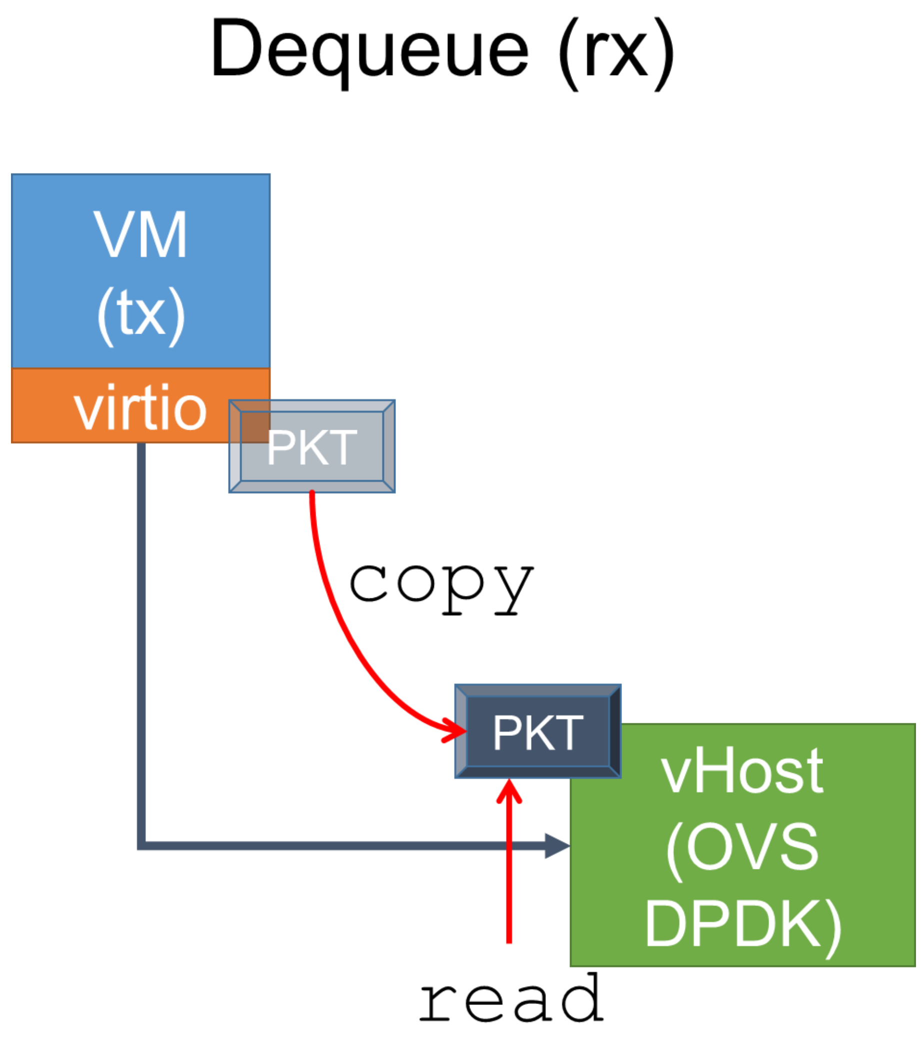
Dequeue path involves copying a packet from the VM to the host

Dequeue (rx)



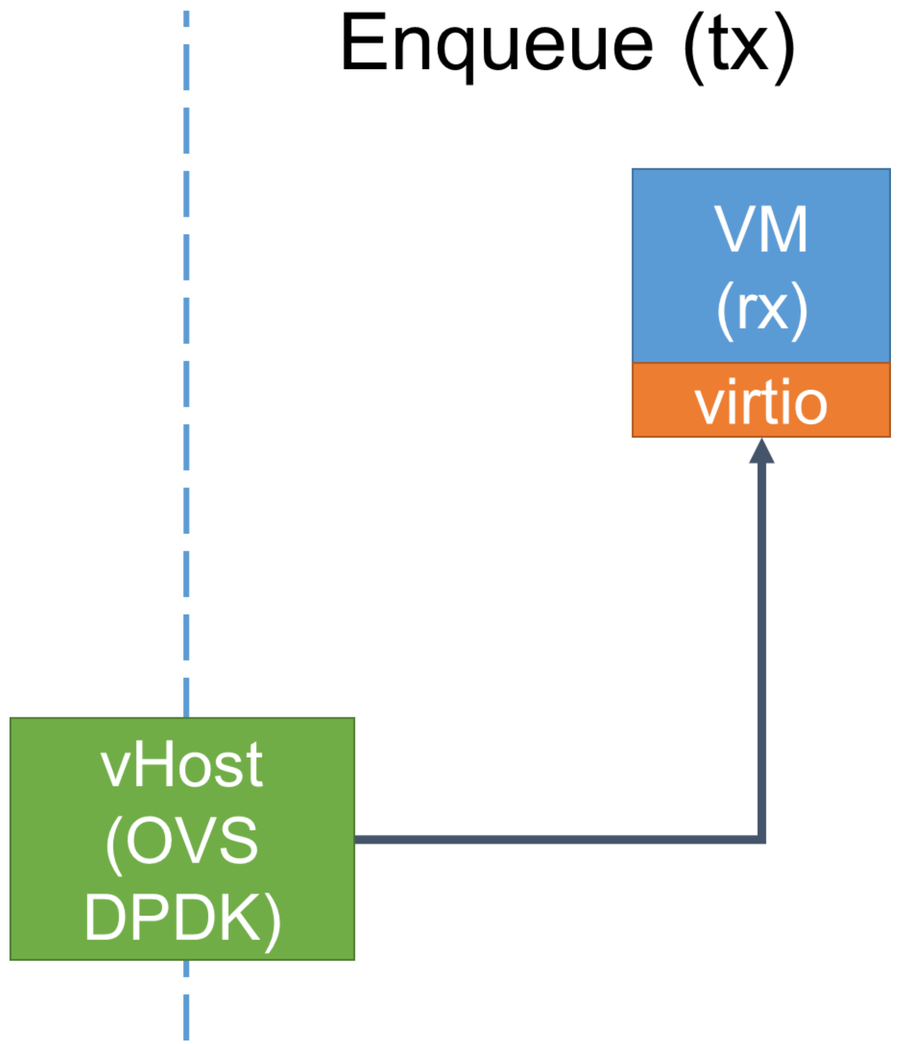
Zero Copy

Dequeue path involves copying a packet from the VM to the host



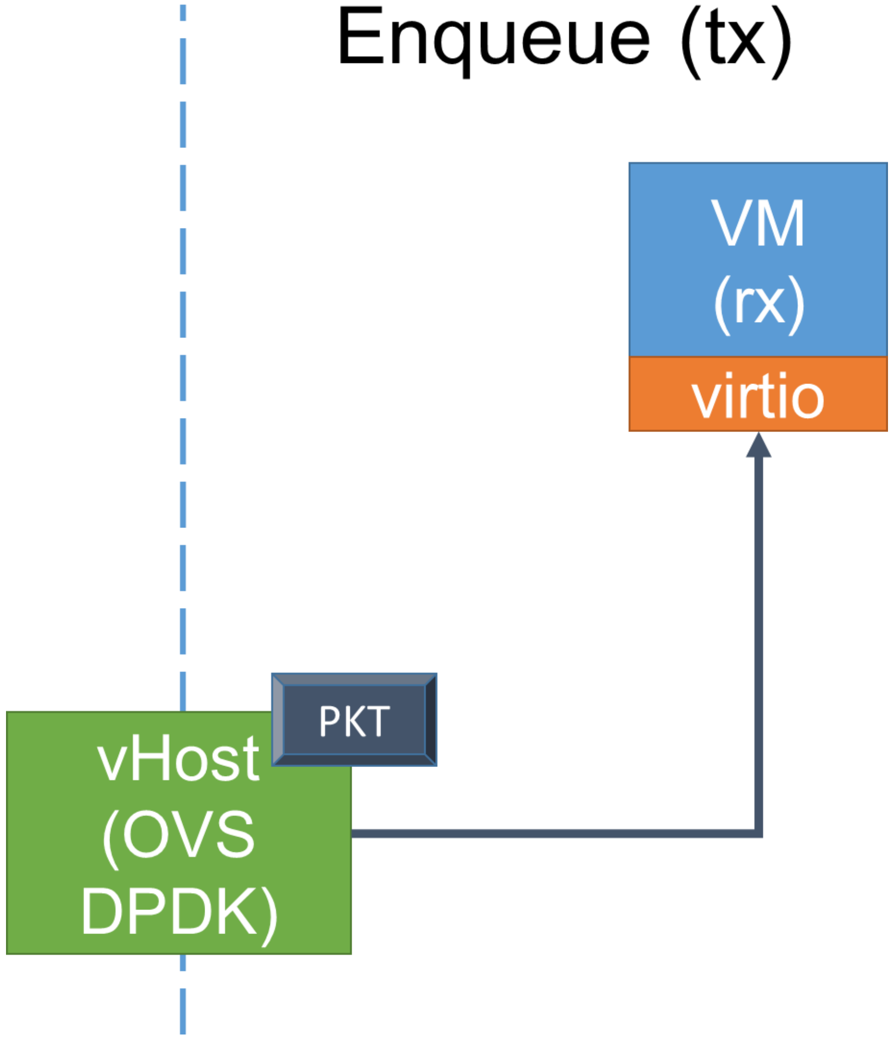
Zero Copy

Enqueue path involves coping a packet from the host to the VM



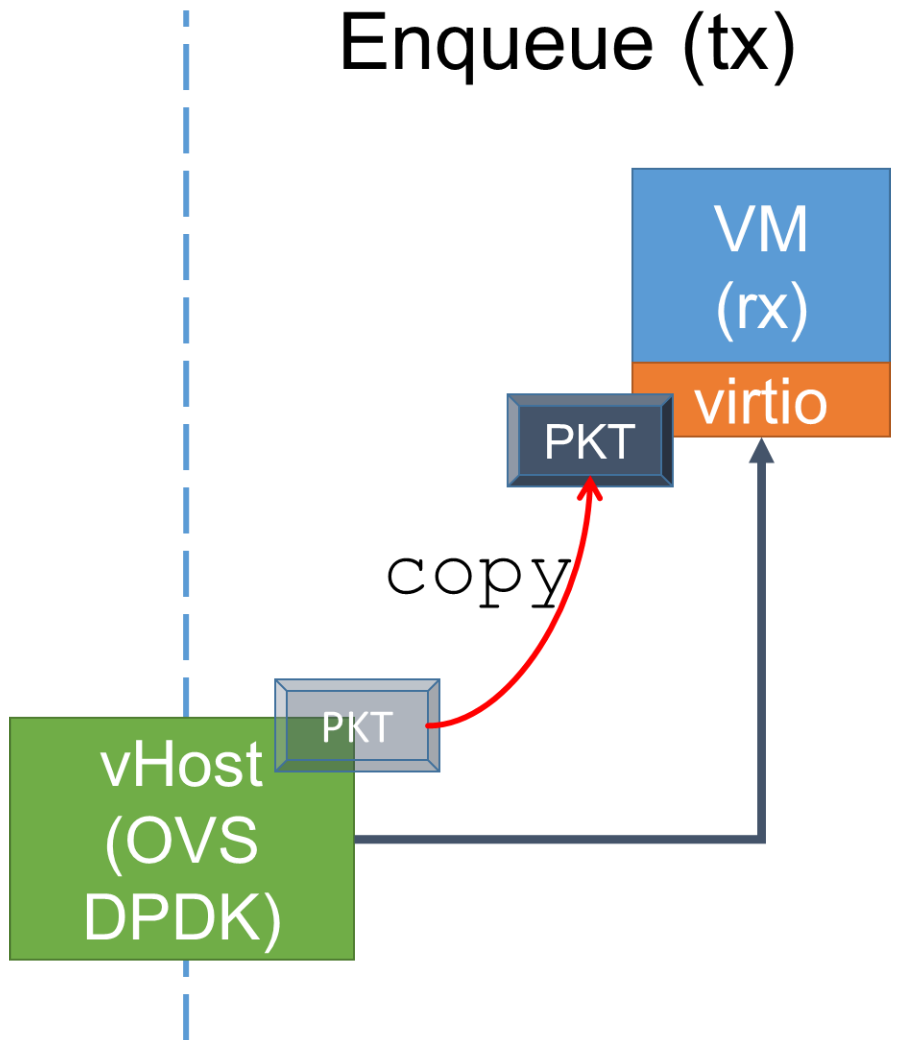
Zero Copy

Enqueue path involves coping a packet from the host to the VM



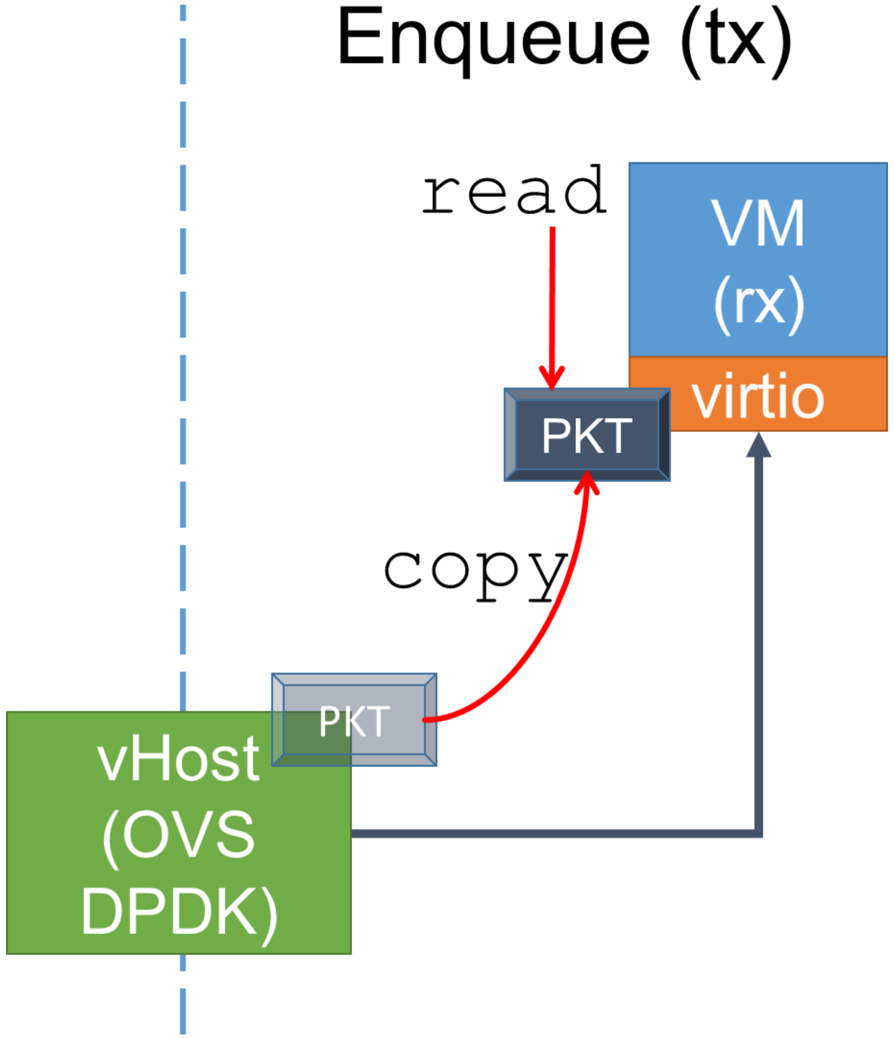
Zero Copy

Enqueue path involves coping a packet from the host to the VM



Zero Copy

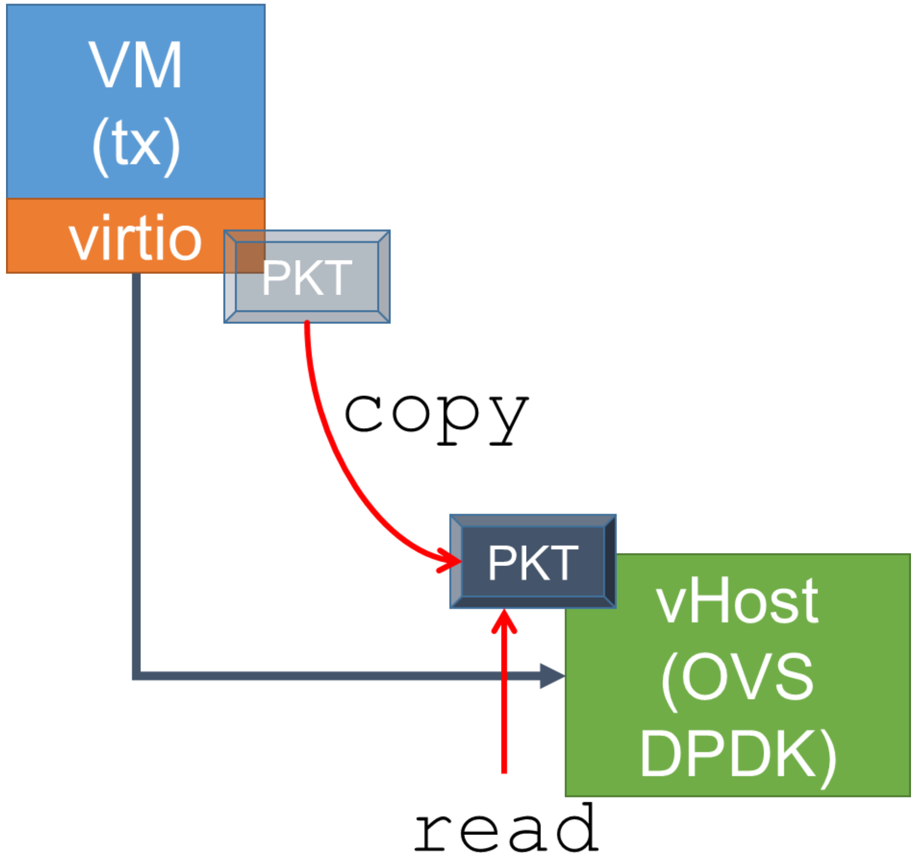
Enqueue path involves coping a packet from the host to the VM



Zero Copy

Zero copy is possible for dequeue if the mbuf references the virtio descriptor buffer **directly**.

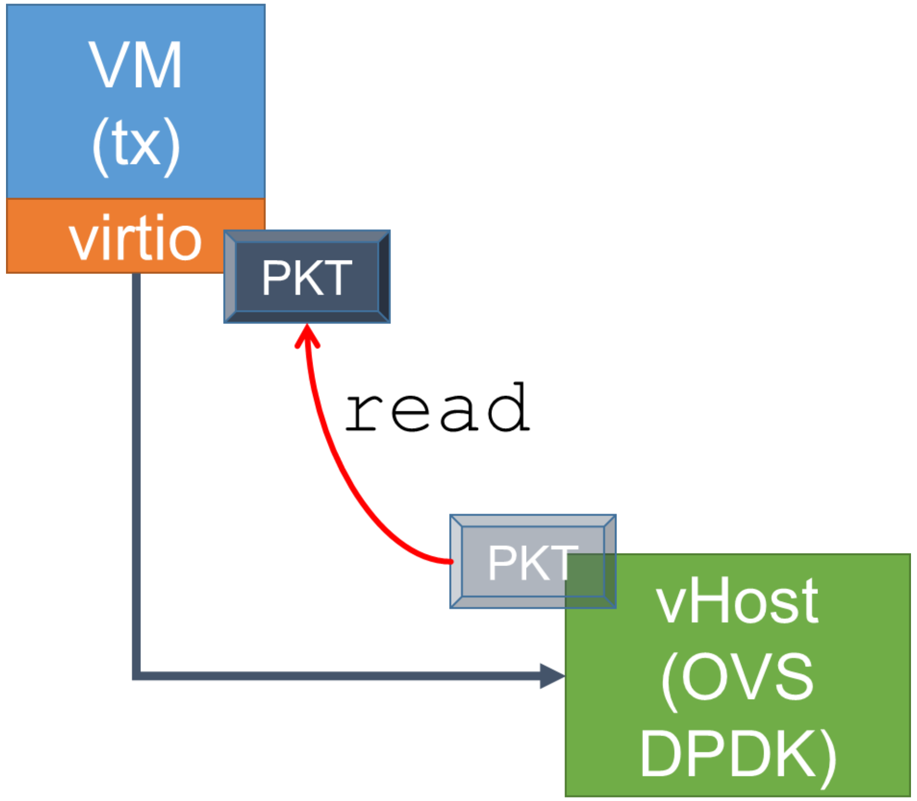
Dequeue (rx)



Zero Copy

Zero copy is possible for dequeue if the mbuf references the virtio descriptor buffer **directly**.

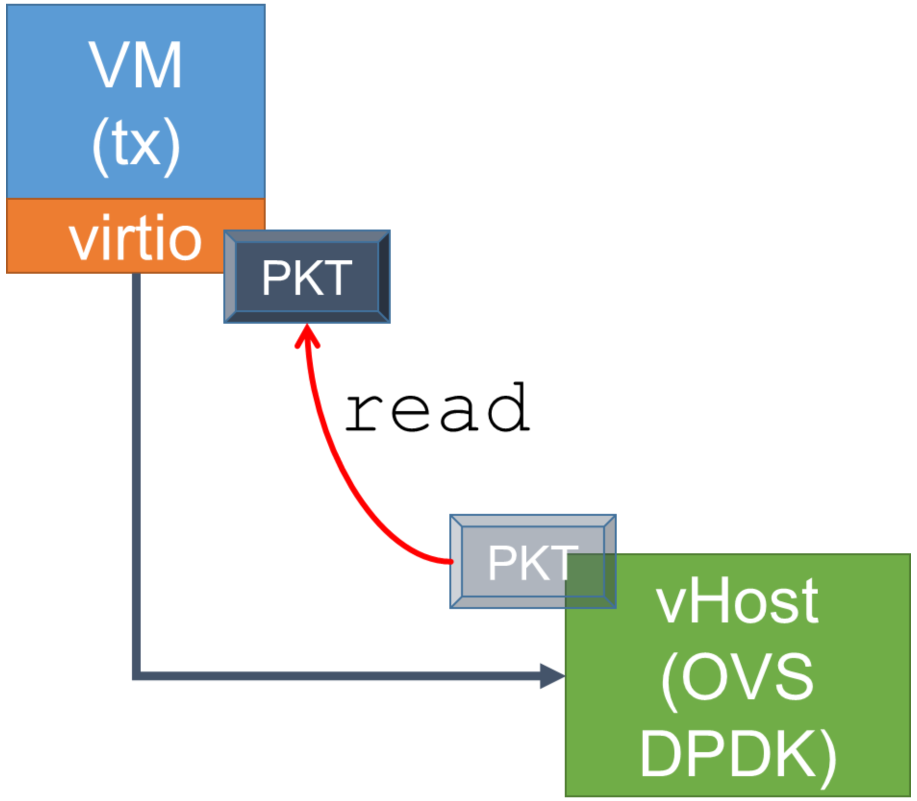
Dequeue (rx)



Zero Copy

Not suitable for small packet sizes (~ < 512B)

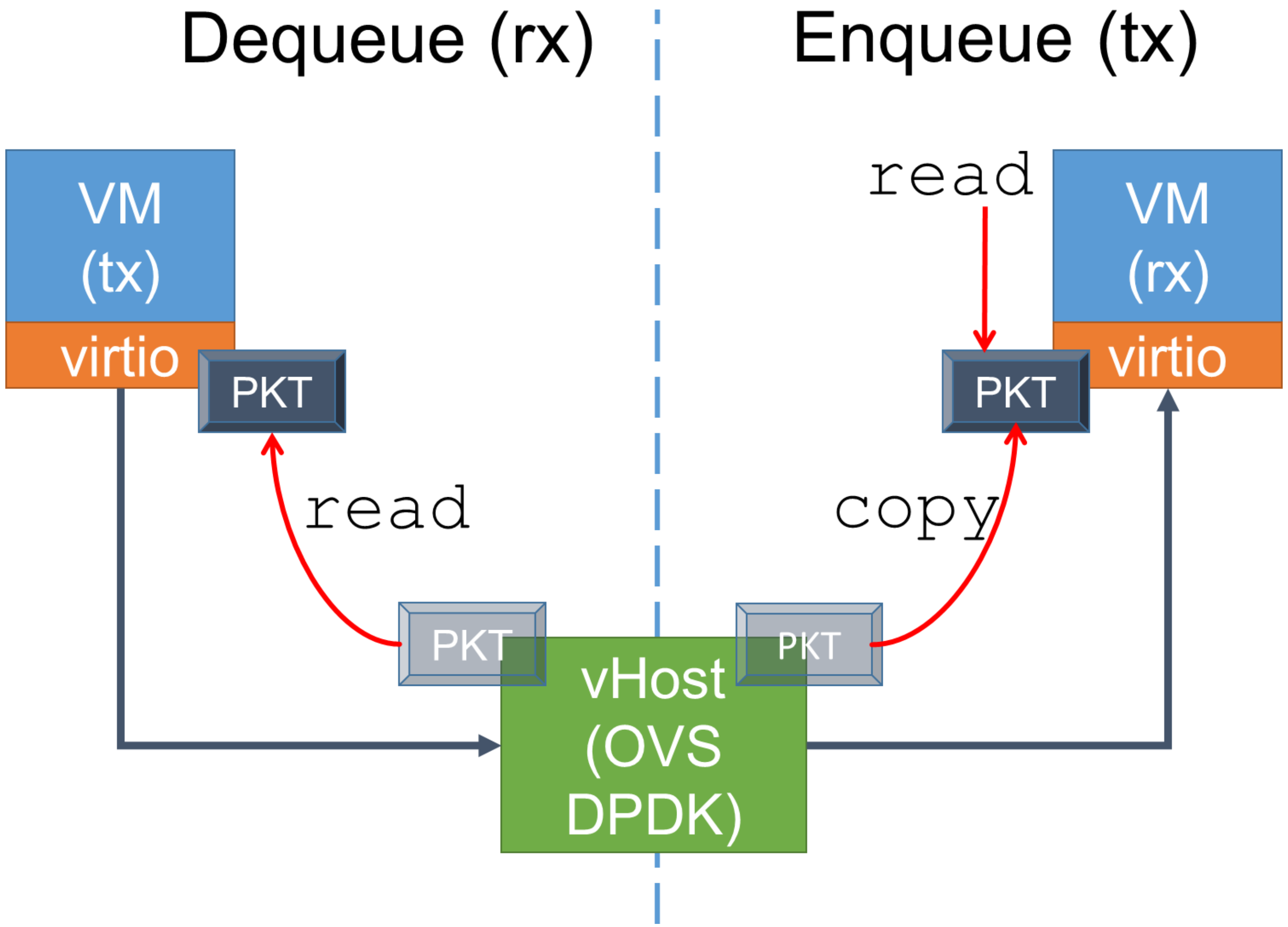
Dequeue (rx)



Zero Copy

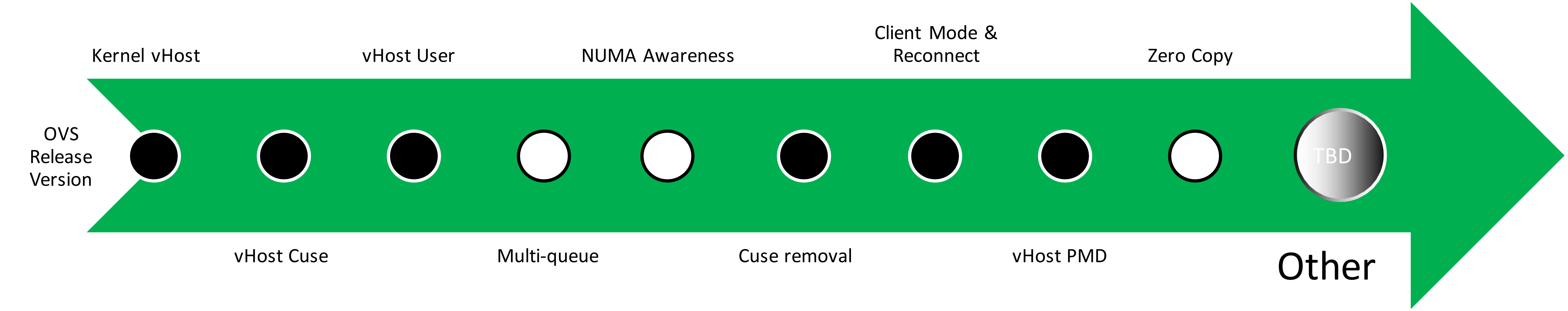
Can achieve >15% increase in throughput for 1518B packets for this use case*

(vHost ⇨ OVS-DPDK ⇨ vHost)



* Platform Configuration and Test Result in Backup

Other Future Improvements



● = Functional Improvement

○ = Performance Improvement

Other Future Improvements

- Virtio User (16.11)
  - New “PMD”
  - Method of using vHost User in containers

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- Virtio User (16.11)
  - New “PMD”
  - Method of using vHost User in containers
- Mergeable buffers path improvement (16.11)
- vHost PCI (POC)
  - VM2VM path performance enhancement
  - vHost vEth pair

Conclusion

- Since it’s introduction to OVS in 2015, many incremental improvements to DPDK vHost User have been added.

- Many more improvements to look forward to.

OvS

Open vSwitch

Questions?

OvS

Open vSwitch

BACKUP

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Platform Configuration & Test Results

Item	Description
Server Platform	Intel® Server Board S2600WTT (Formerly Wildcat Pass) 2 x 1GbE integrated LAN ports Two processors per platform
Chipset	Intel® C610/X99 series chipset (Formerly Wellsburg)
Processor	Intel® Xeon® Processor E5-2695 v3 (Formerly Haswell) Speed and power: 2.30 GHz, 120 W Cache: 35 MB per processor Cores: 14 cores, 28 hyper-threaded cores per processor for 56 total hyper-threaded cores QPI: 9.6 GT/s Memory types: DDR4-1600/1866/2133, Reference: http://ark.intel.com/products/81057/Intel-Xeon-Processor-E5-2695-v3-35M-Cache-2_30-GHz
Memory	Micron 16 GB 1Rx4 PC4-2133MHz, 16 GB per channel, 8 Channels
NICs	2 x Intel® Ethernet CAN X710 Adapter (Total: 4 x 10GbE ports) (Formerly Fortville)
BIOS	Version: SE5C610.86B.01.01.0008.021120151325 Date: 02/11/2015
OS	Fedora 22
Software	DPDK - v2.2.0, OVS – v2.5.0 pre-release (commit 522aca), QEMU – 2.3.0, Linux kernel – 4.0.6-300.fc22.x86_64

Guest Access Method	Packets per Second
virtio-net	51131
vhost-net	406515
vhost-user	3366374

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Server Platform	Intel® Server Board S2600WTT (Formerly Wildcat Pass) 2 x 1GbE integrated LAN ports Two processors per platform
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NICs	2 x Intel® Ethernet CAN X710 Adapter (Total: 4 x 10GbE ports) (Formerly Fortville)
BIOS	Version: SE5C610.86B.01.01.0008.021120151325 Date: 02/11/2015
OS	Fedora 22
Software	DPDK – v16.07, OVS – v2.6.0 (commit 136e425df951), QEMU – 2.7.0, Linux kernel – 4.2.8-200.fc22.x86_64

	Packets per Second
Without NUMA Awareness	2545945
With NUMA Awareness	3831019

Platform Configuration & Test Results

Item	Description
Server Platform	Intel® Server Board S2600WTT (Formerly Wildcat Pass) 2 x 1GbE integrated LAN ports Two processors per platform
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BIOS	Version: SE5C610.86B.01.01.0008.021120151325 Date: 02/11/2015
OS	Fedora 22
Software	DPDK – v16.11-rc2, OVS – v2.6.0 (commit 136e425df951, patched to enable feature), QEMU – 2.7.0, Linux kernel – 4.2.8-200.fc22.x86_64

	Packets per Second
Without zero copy	2094554
With zero copy	2415784