Cloud Networking
Host Virtualization

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- Spin-up a virtual machine in seconds

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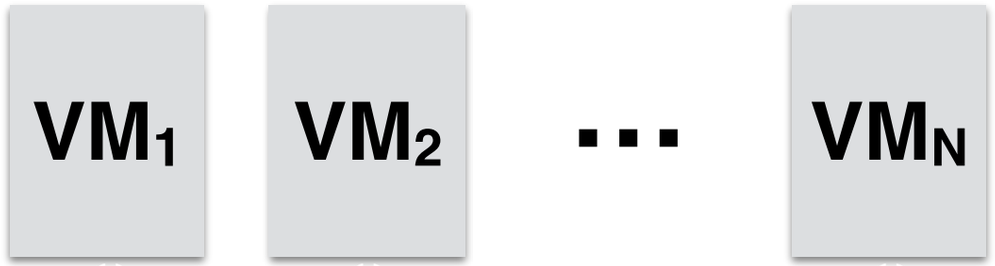
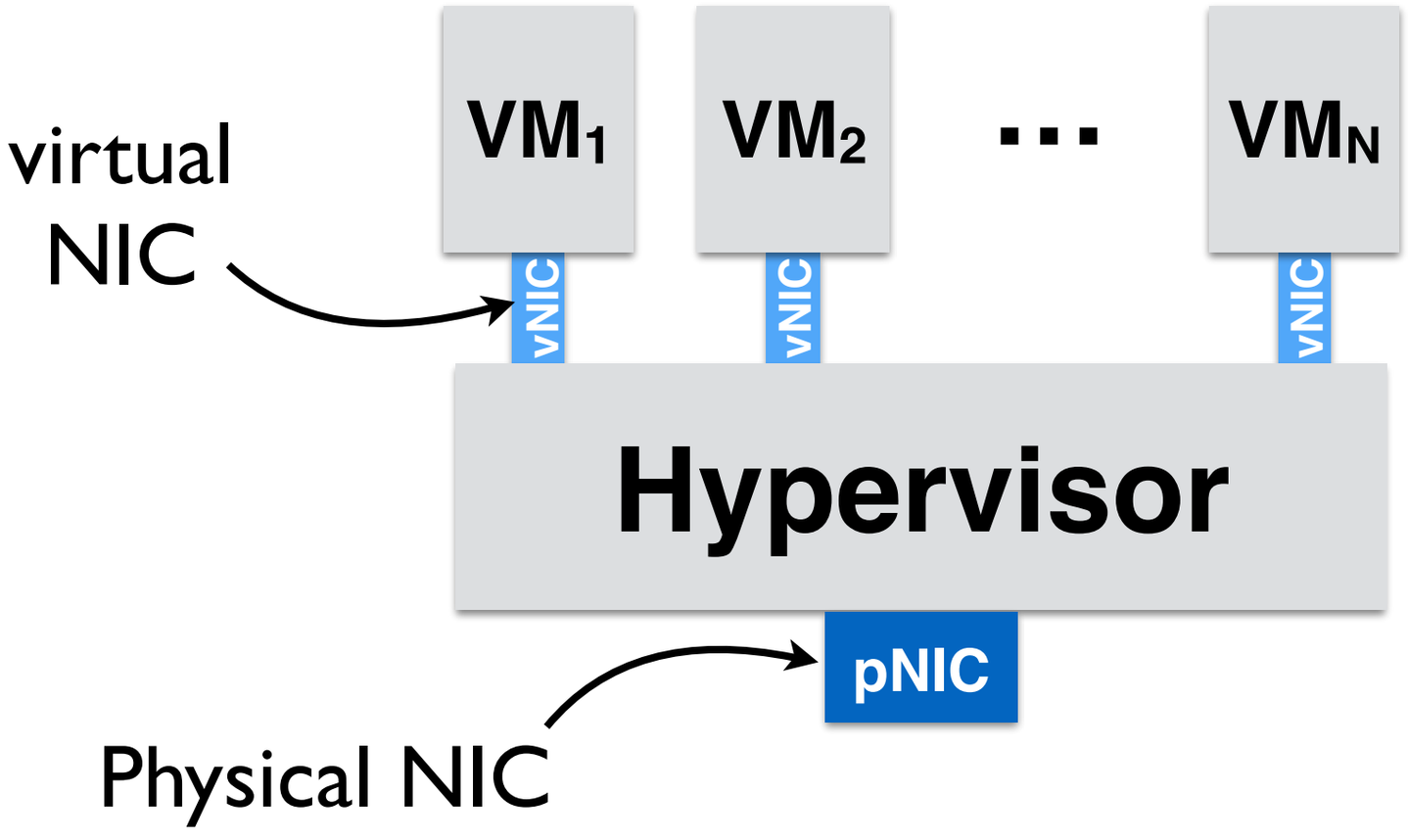
- Sharing of physical infrastructure
- Spin-up a virtual machine in seconds
- Live VM migration

Server virtualization

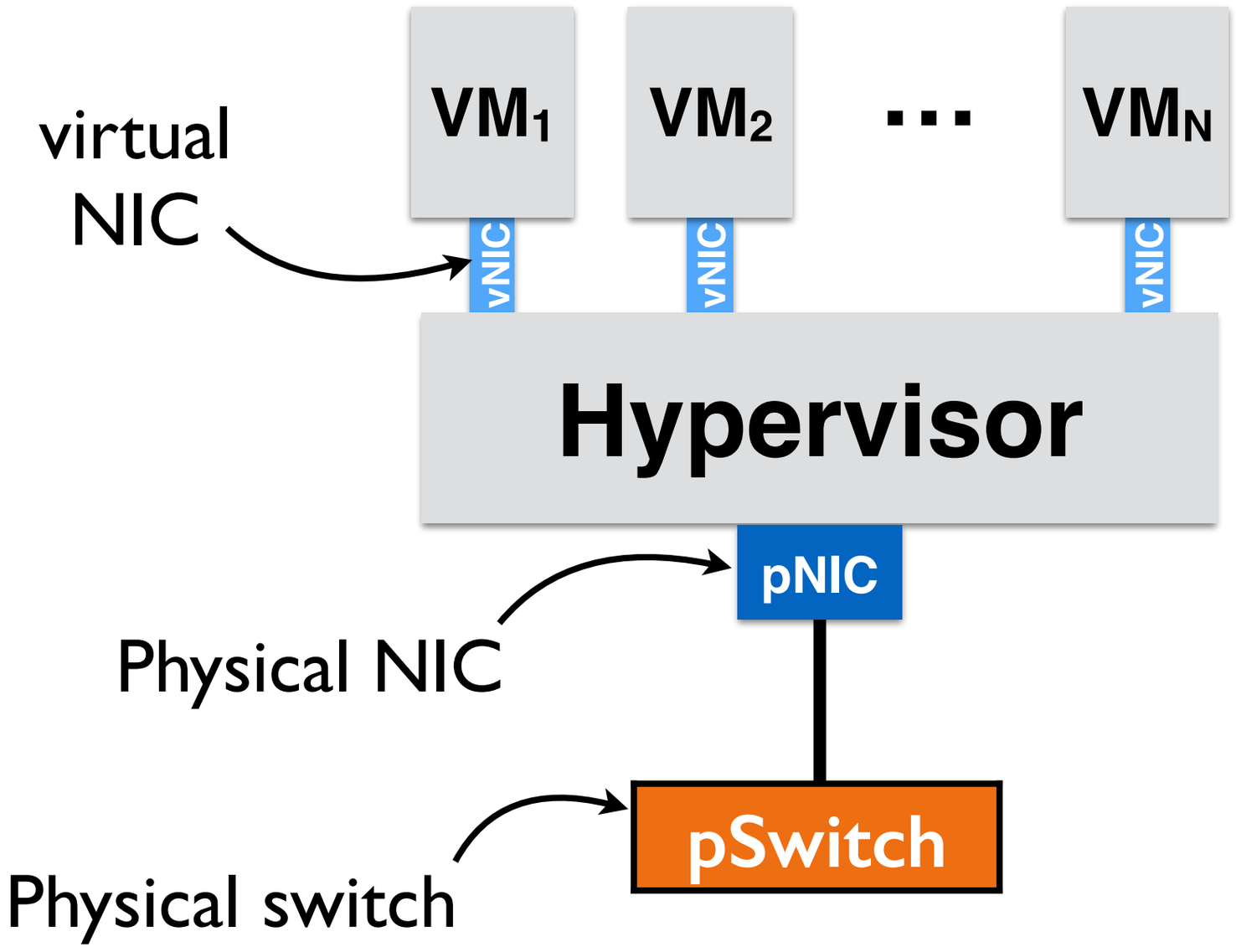


Hypervisor

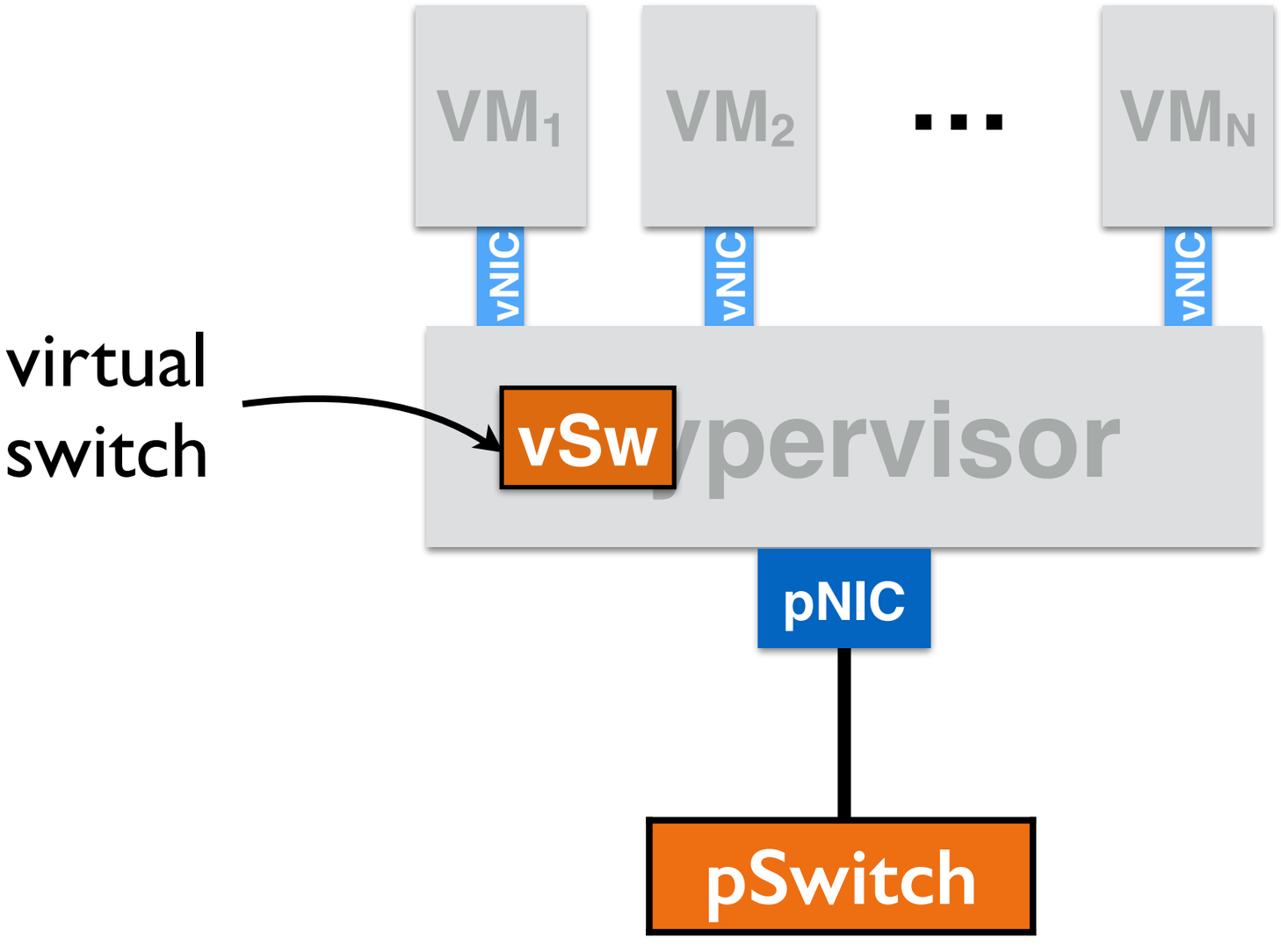
Server virtualization



Server virtualization

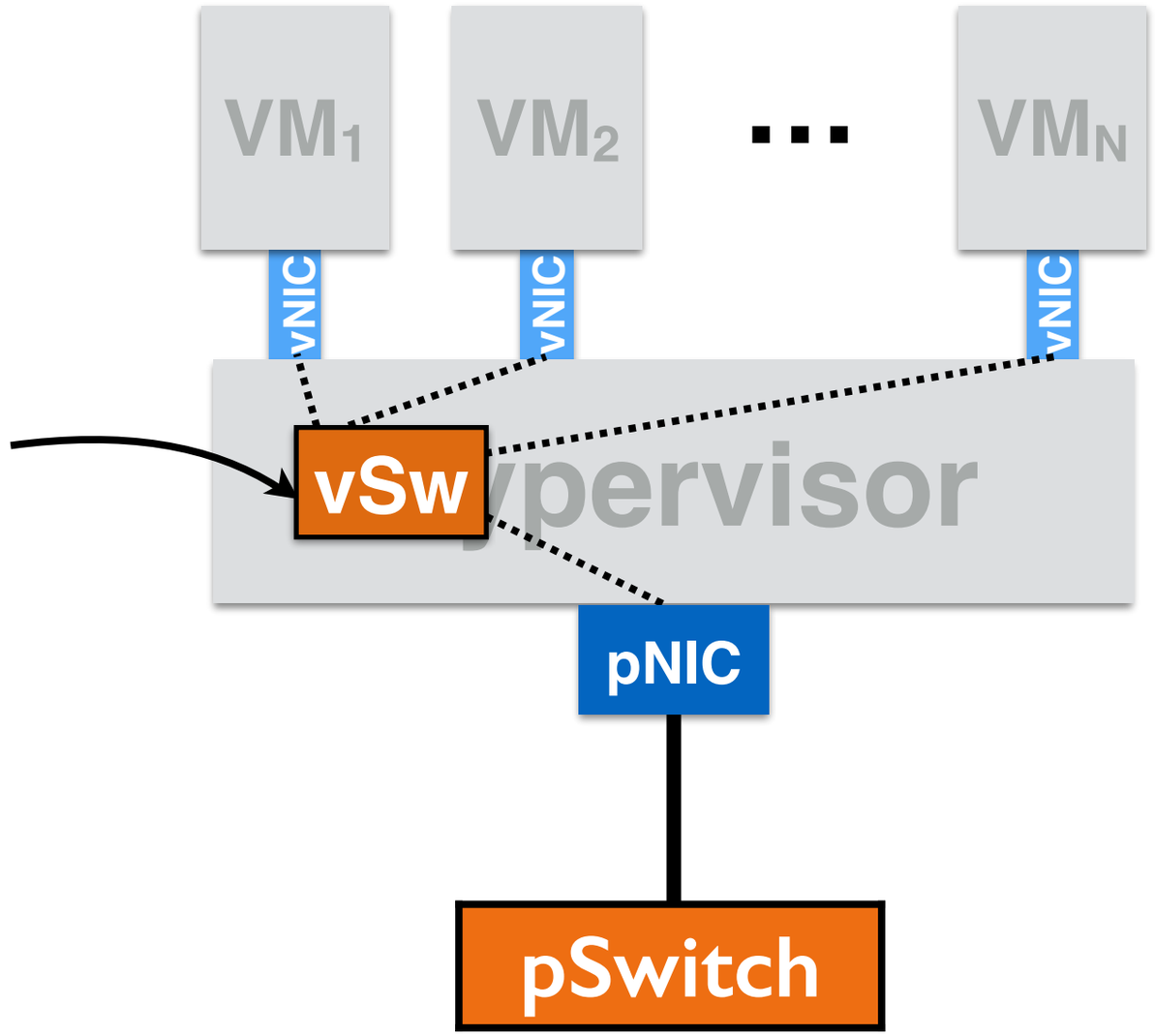


Networking VMs

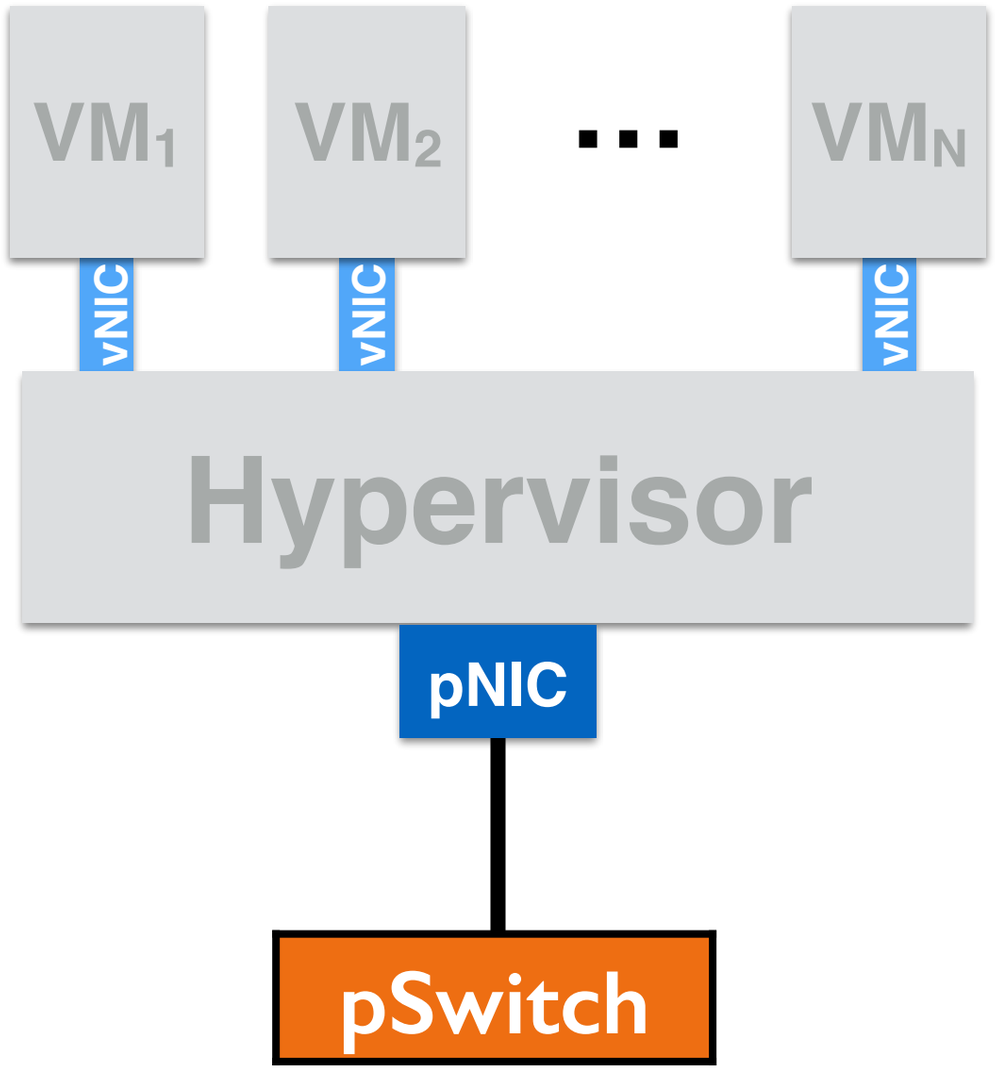


Networking VMs

virtual switch



Sidenote: Docker



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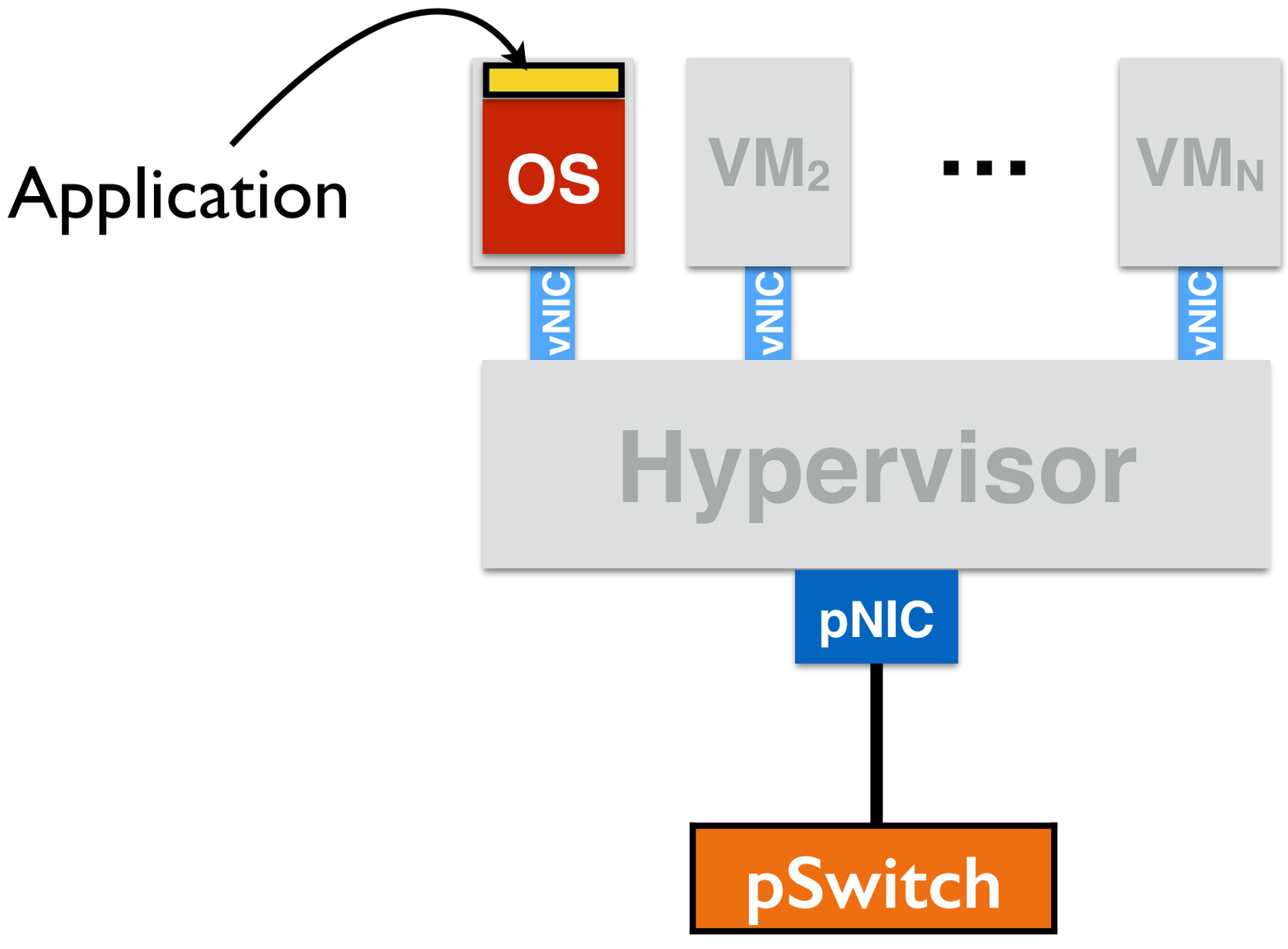

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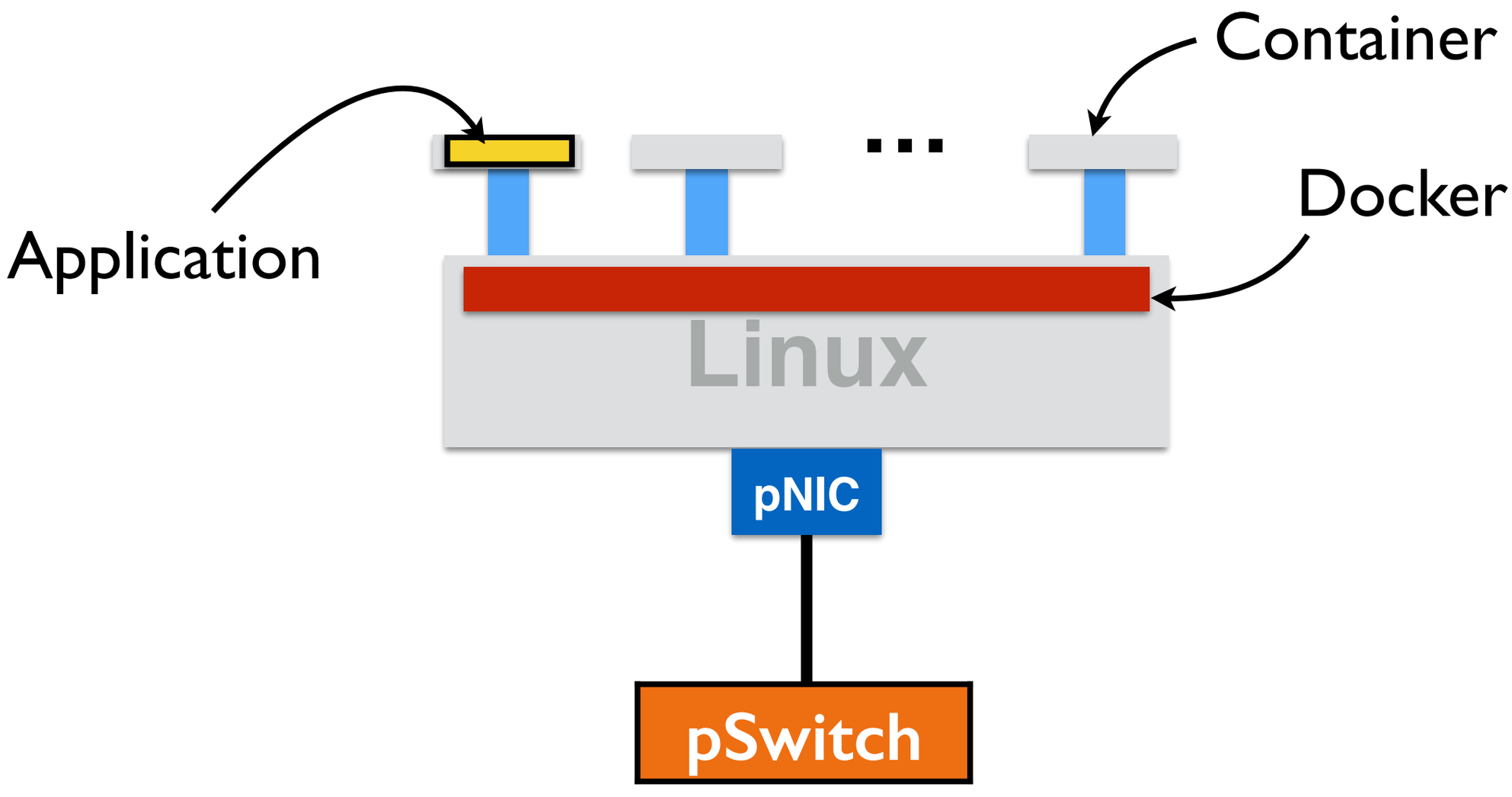
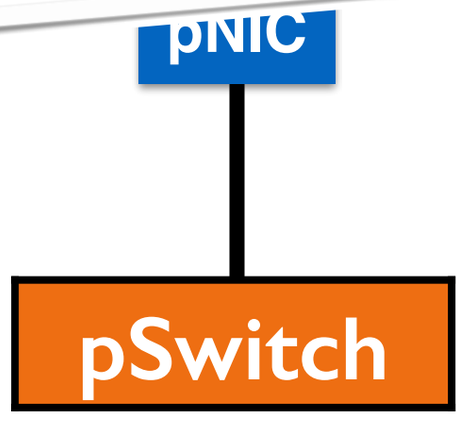


Sidenote: Docker

IBM Research Report, 2014

An Updated Performance Comparison of Virtual Machines and Linux Containers

Wes Felter, Alexandre Ferreira, Ram Rajamony, Juan Rubio
IBM Research, Austin, TX



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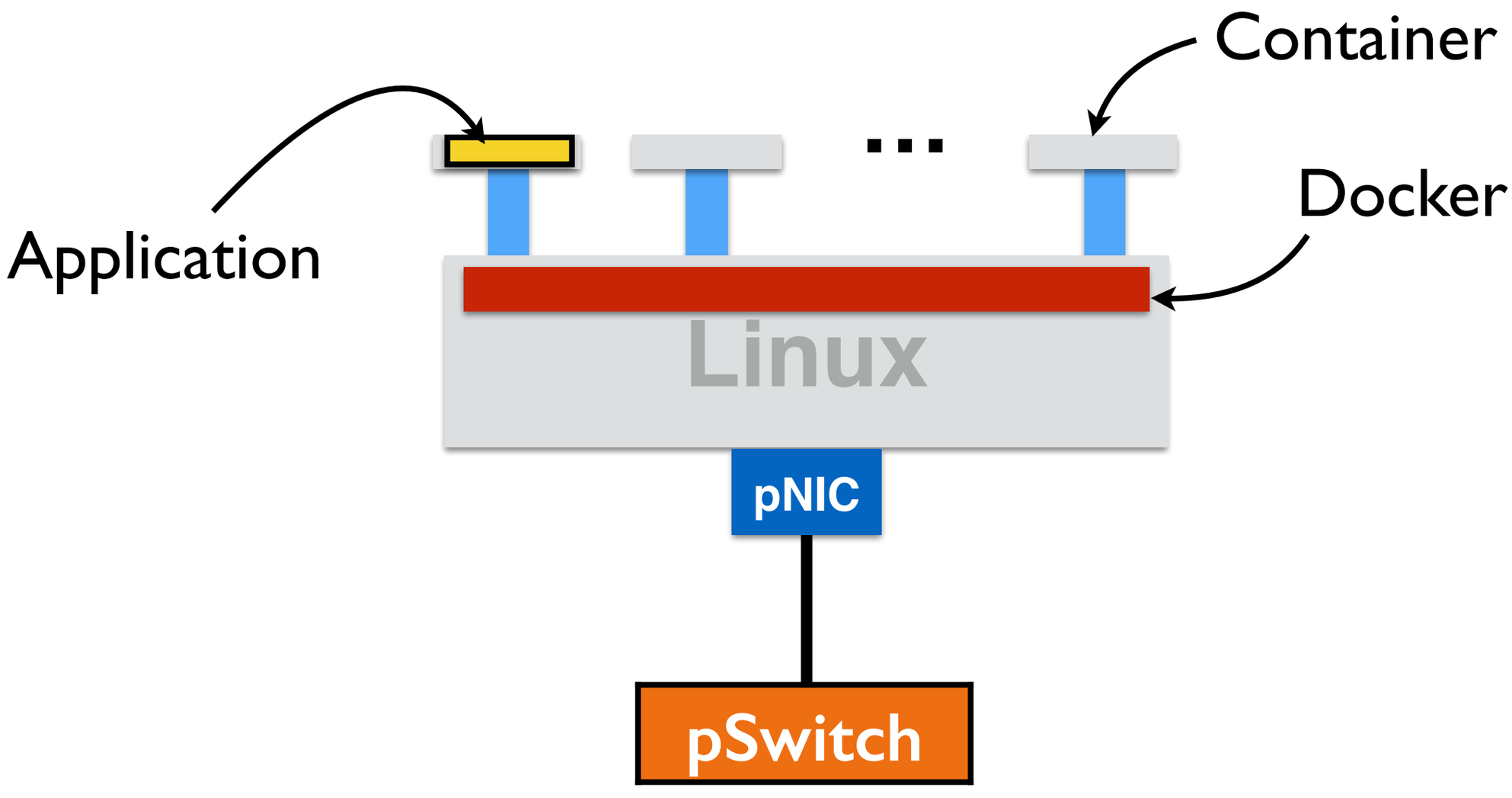
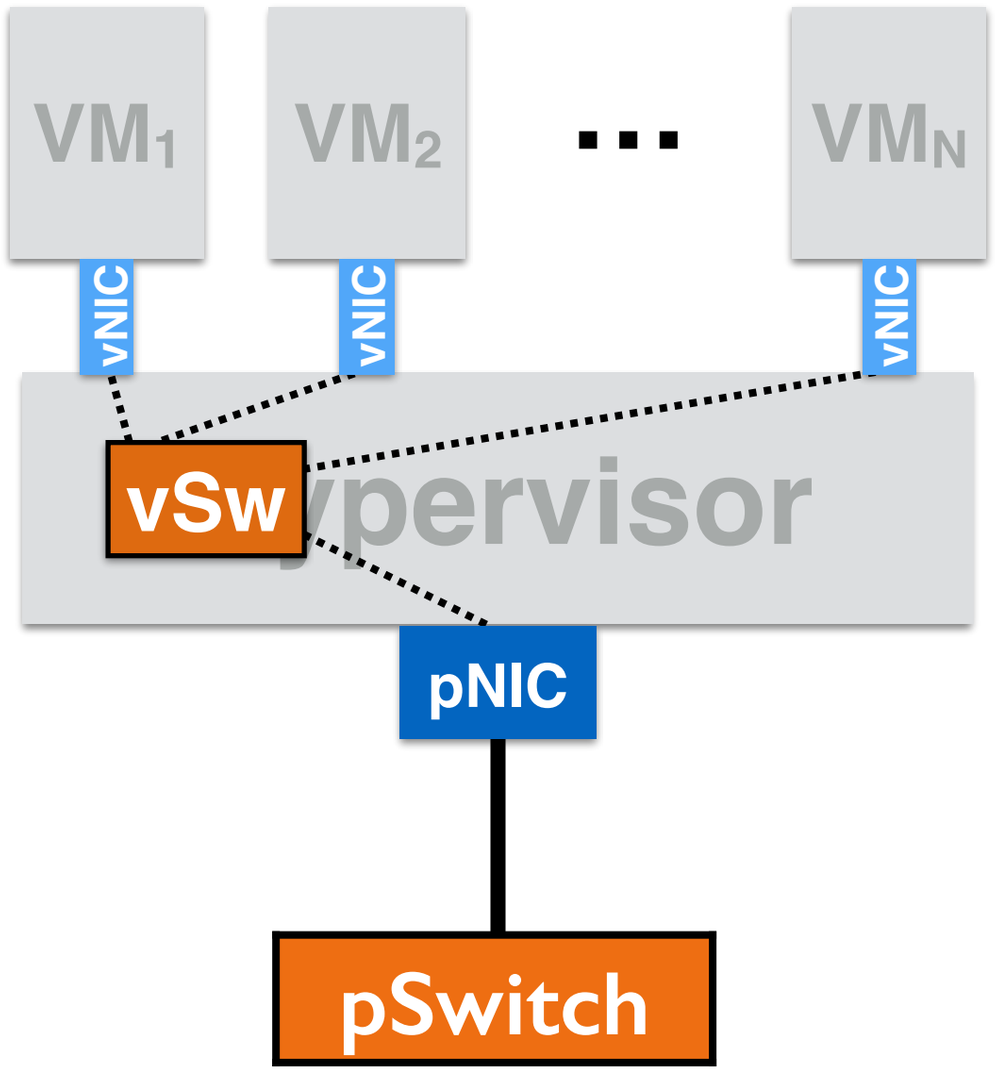
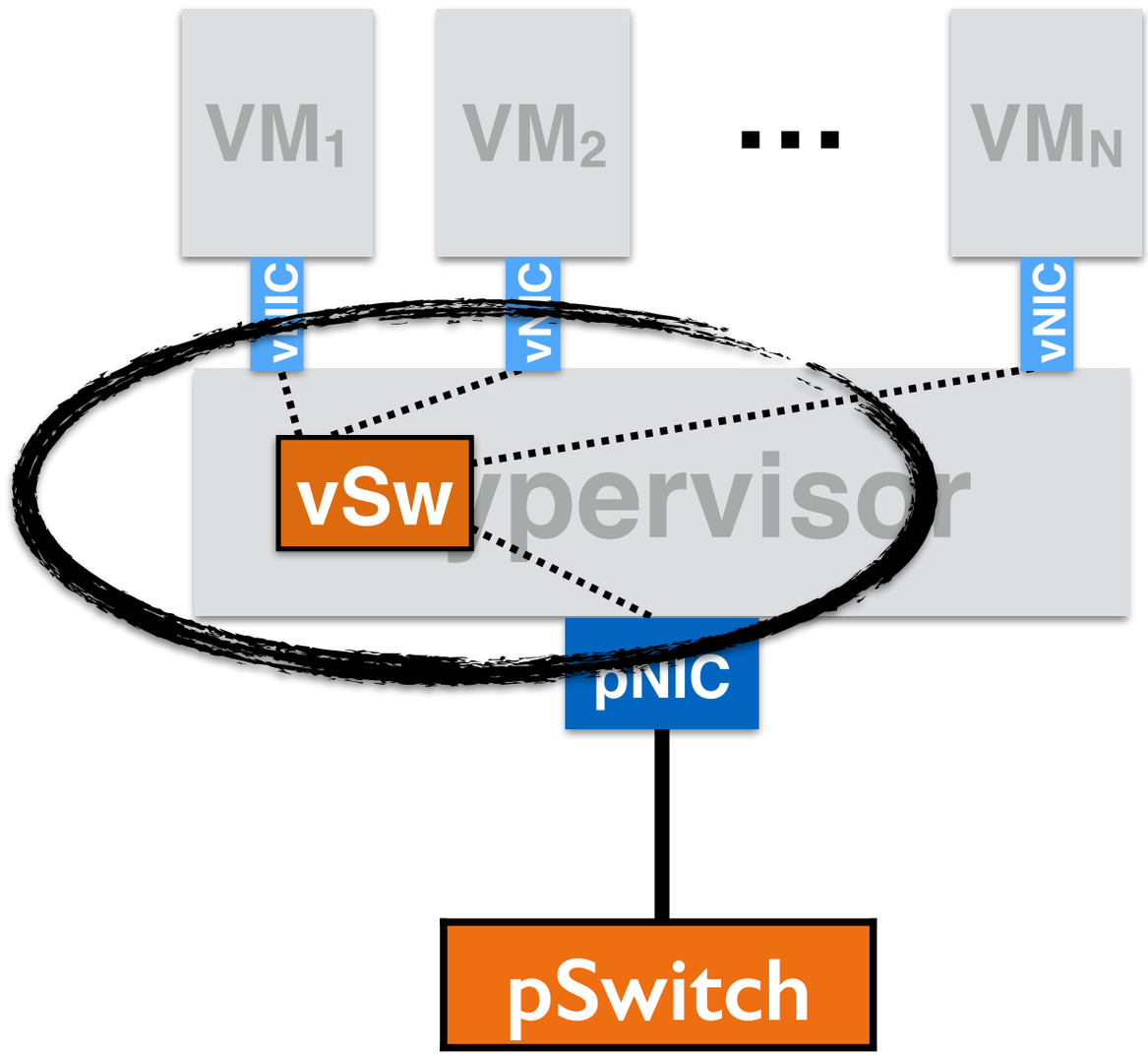


Improving networking performance



Improving networking performance

CPU does the work!



Packet processing on CPUs

Flexible

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Flexible **slow, CPU-expensive**

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10Gbps, 84 Byte packets ⇒ 67ns time budget

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10Gbps, 84 Byte packets ⇒ 67ns time budget

Context: CPU-memory takes tens of ns

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- Packet I/O

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- Userspace overheads

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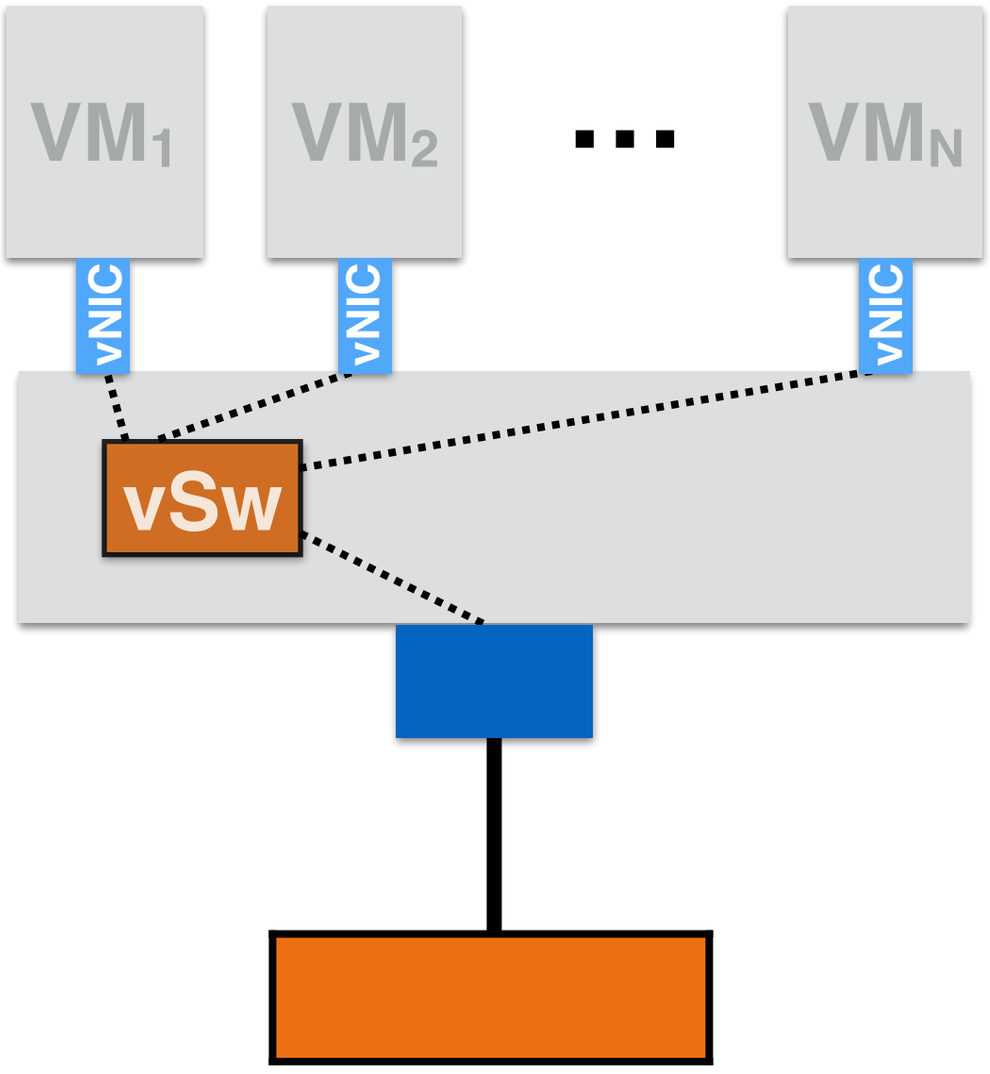
Progress is being made!

SR-IOV: Single-root I/O Virtualization



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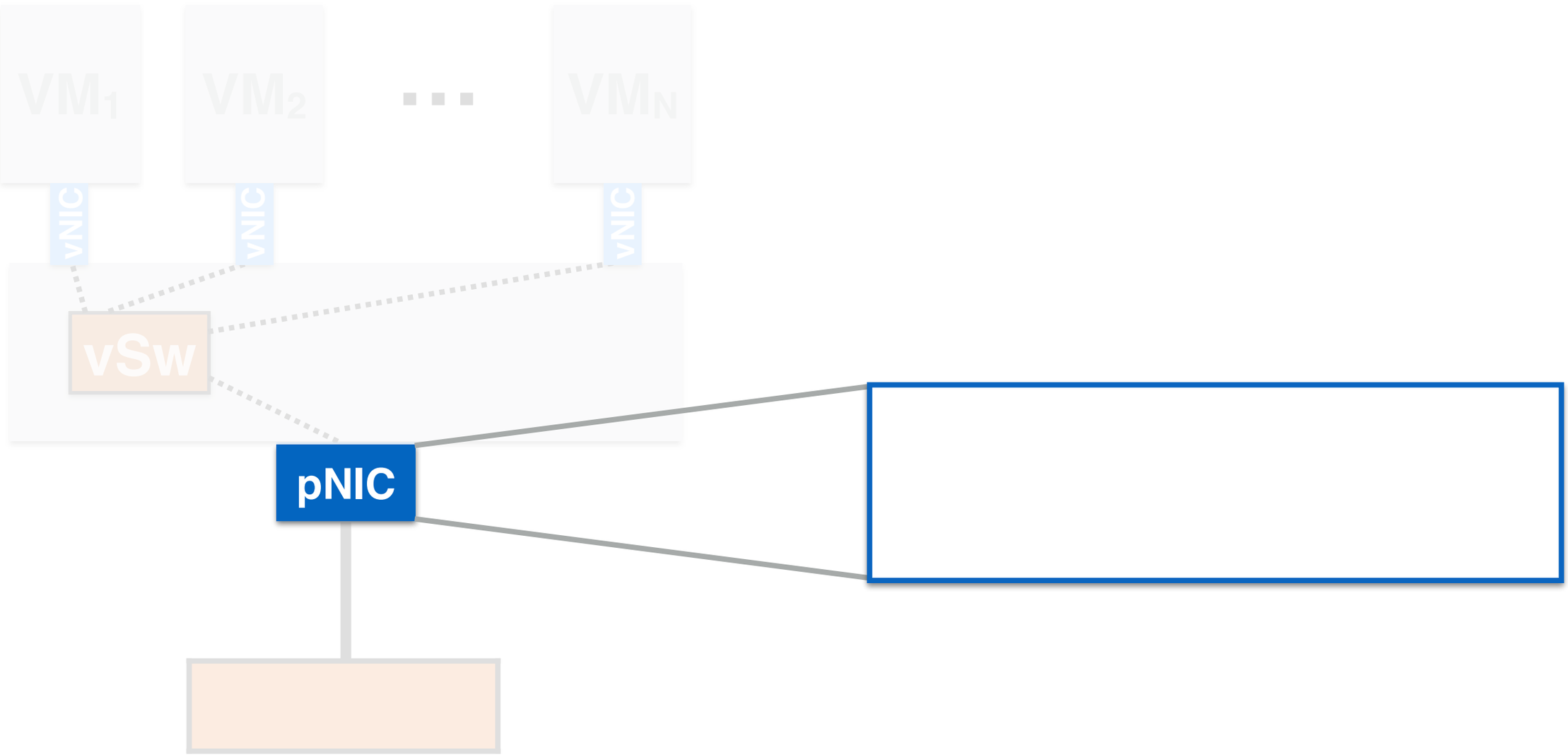

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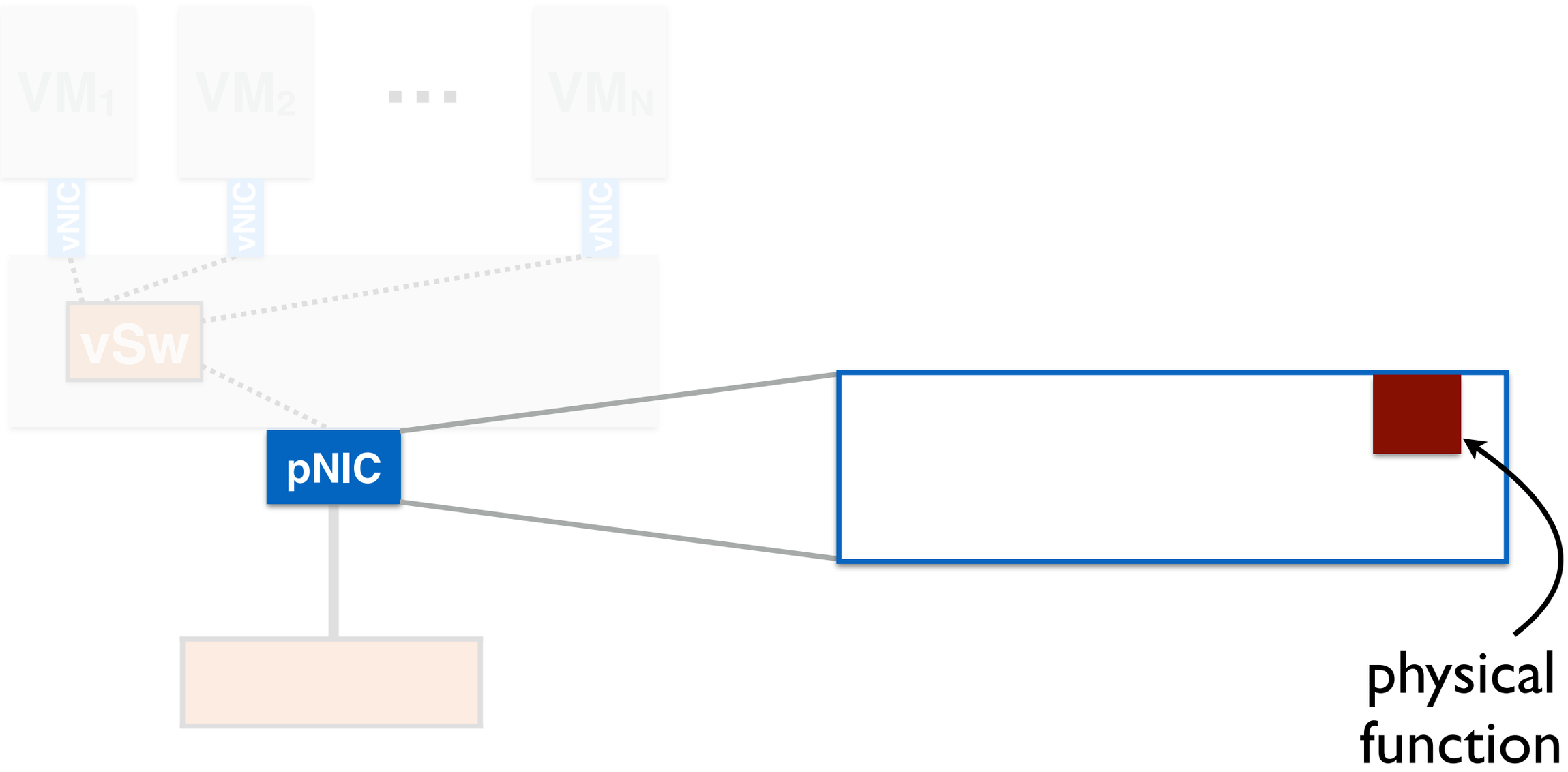

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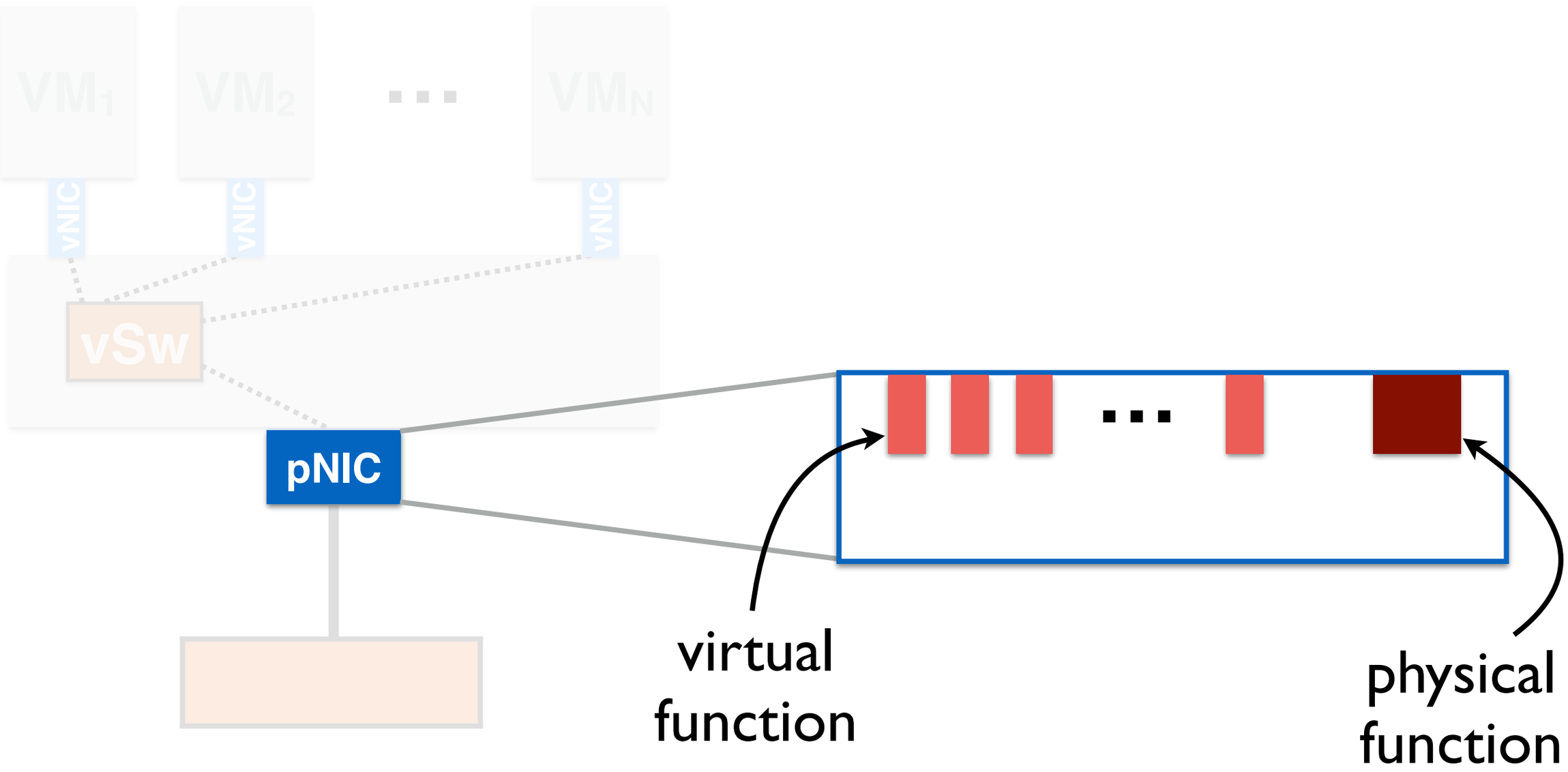

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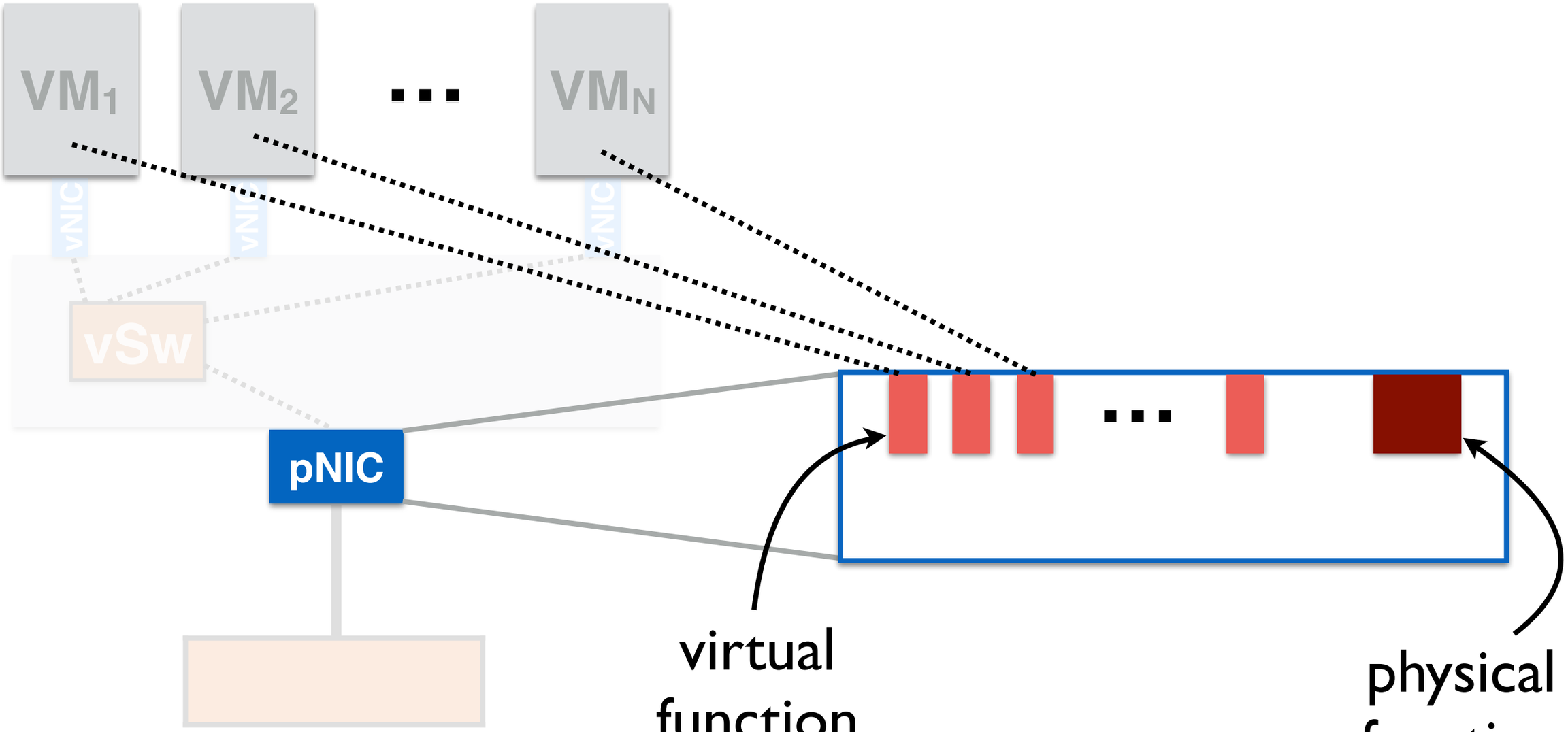

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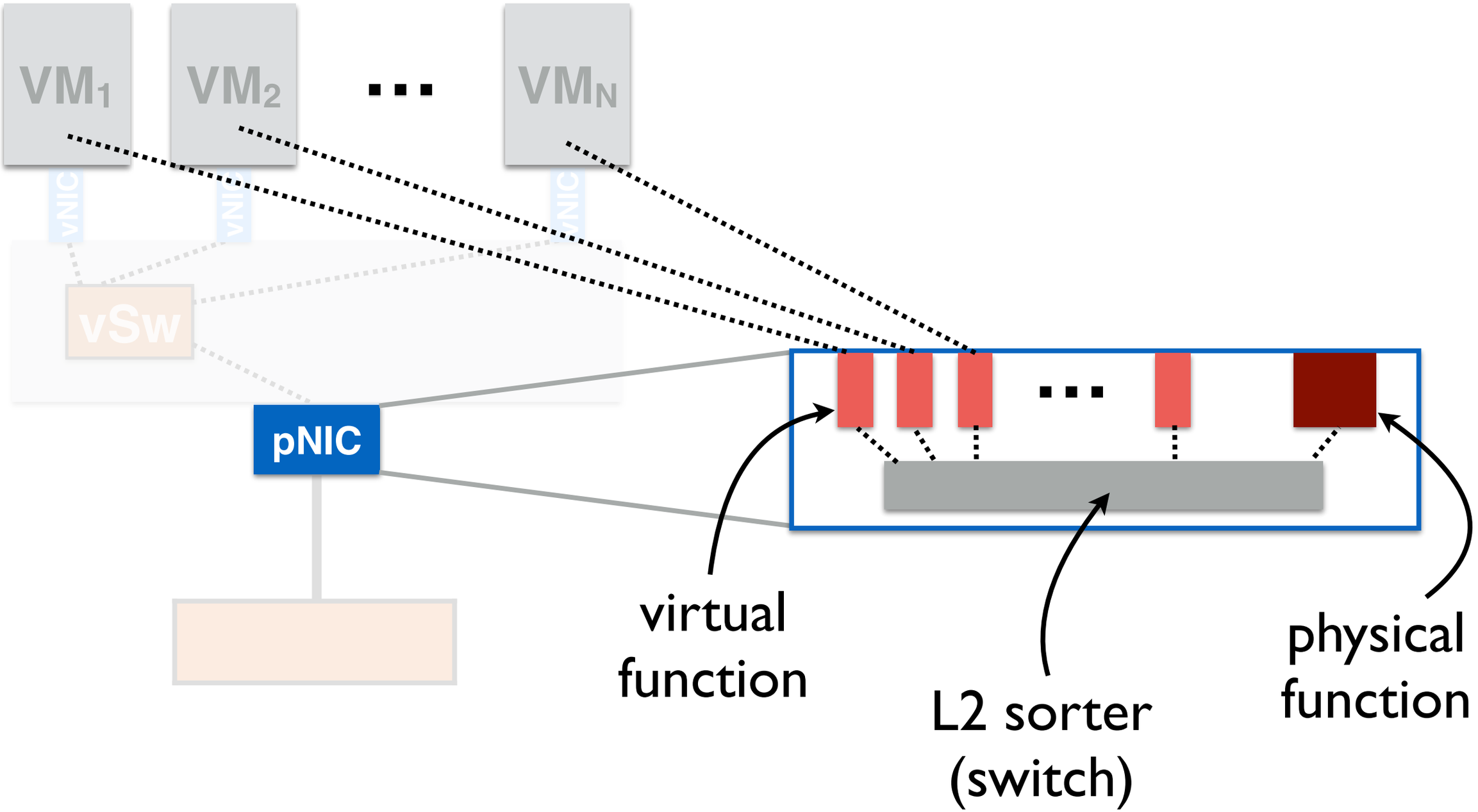

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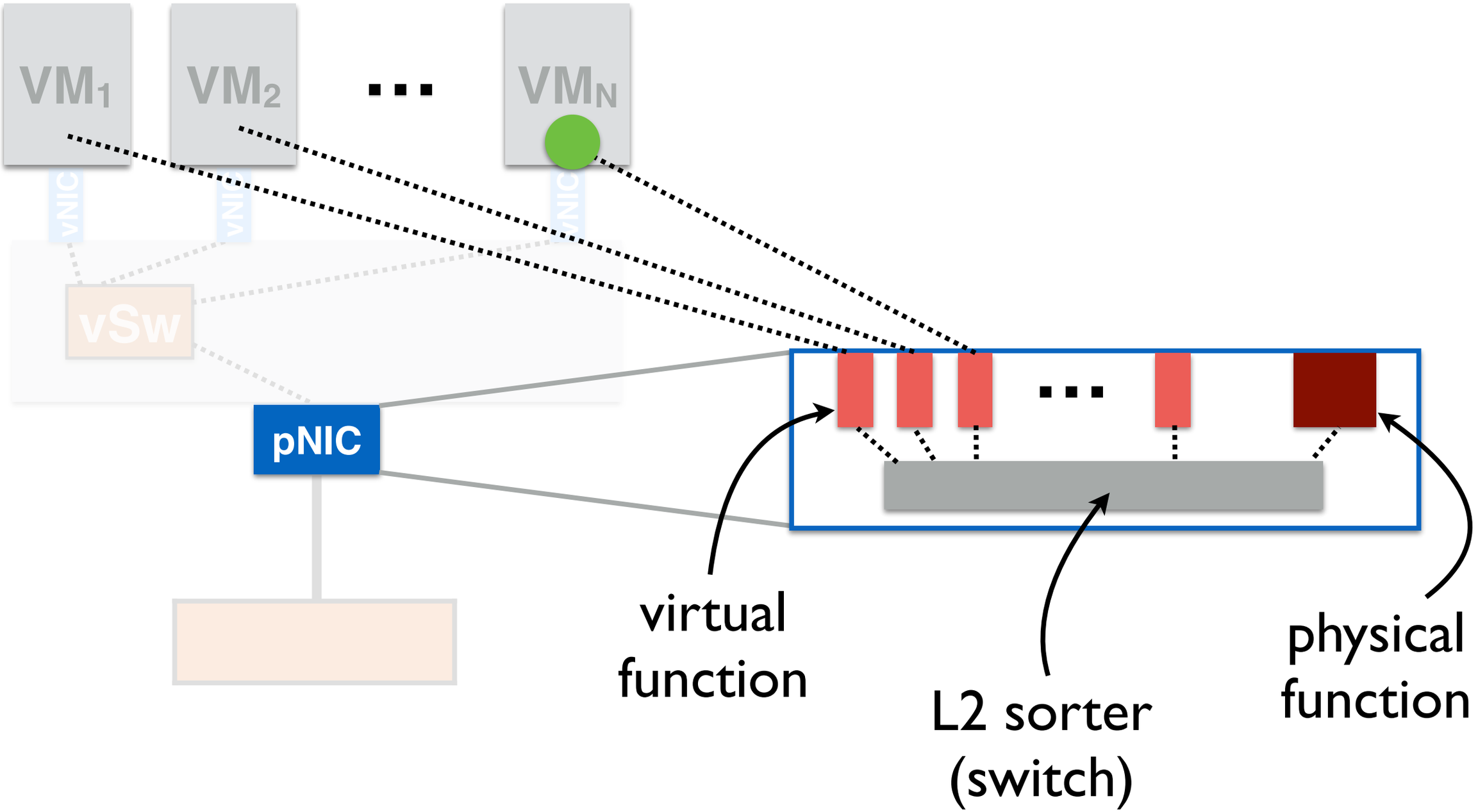

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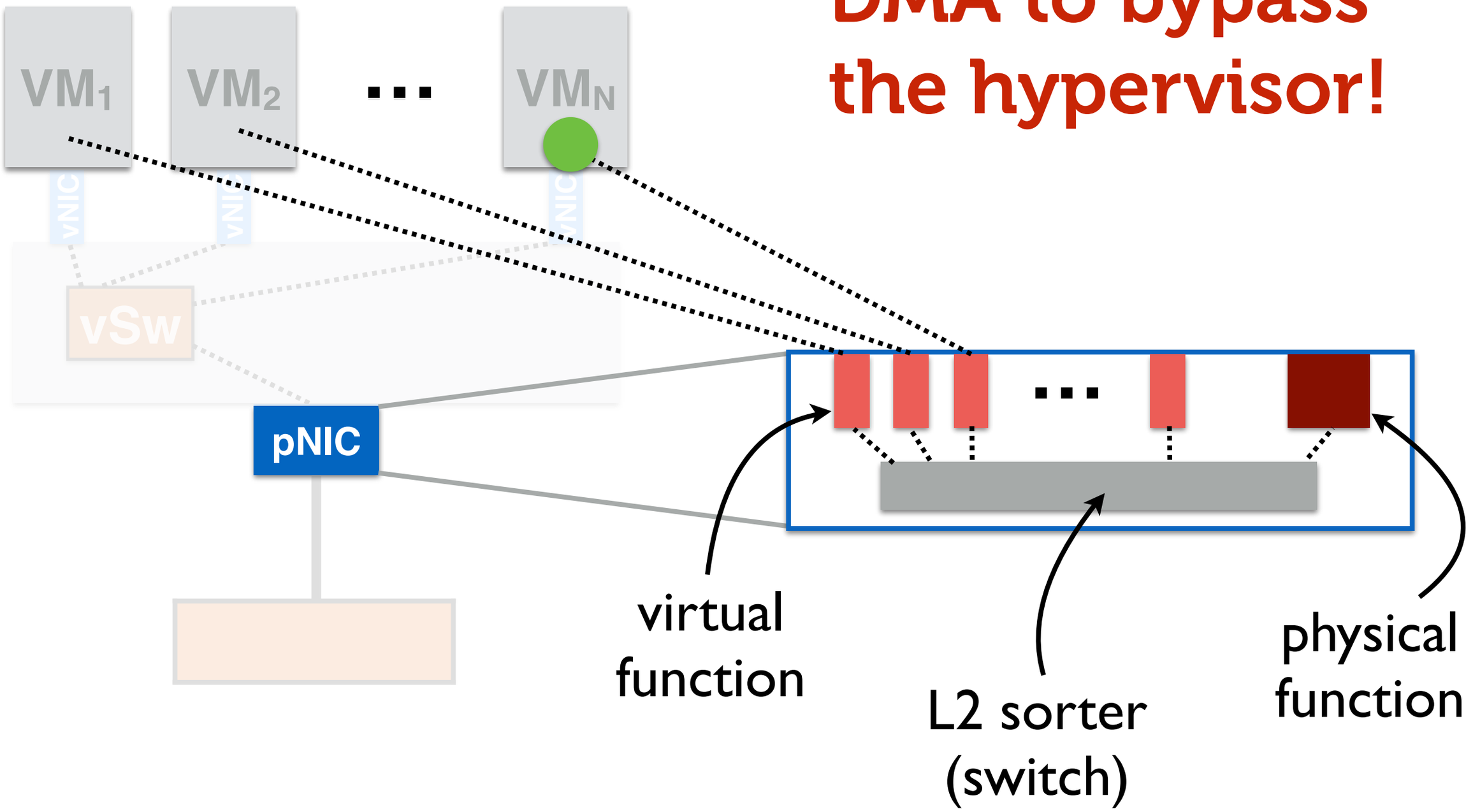


DMA to bypass the hypervisor!

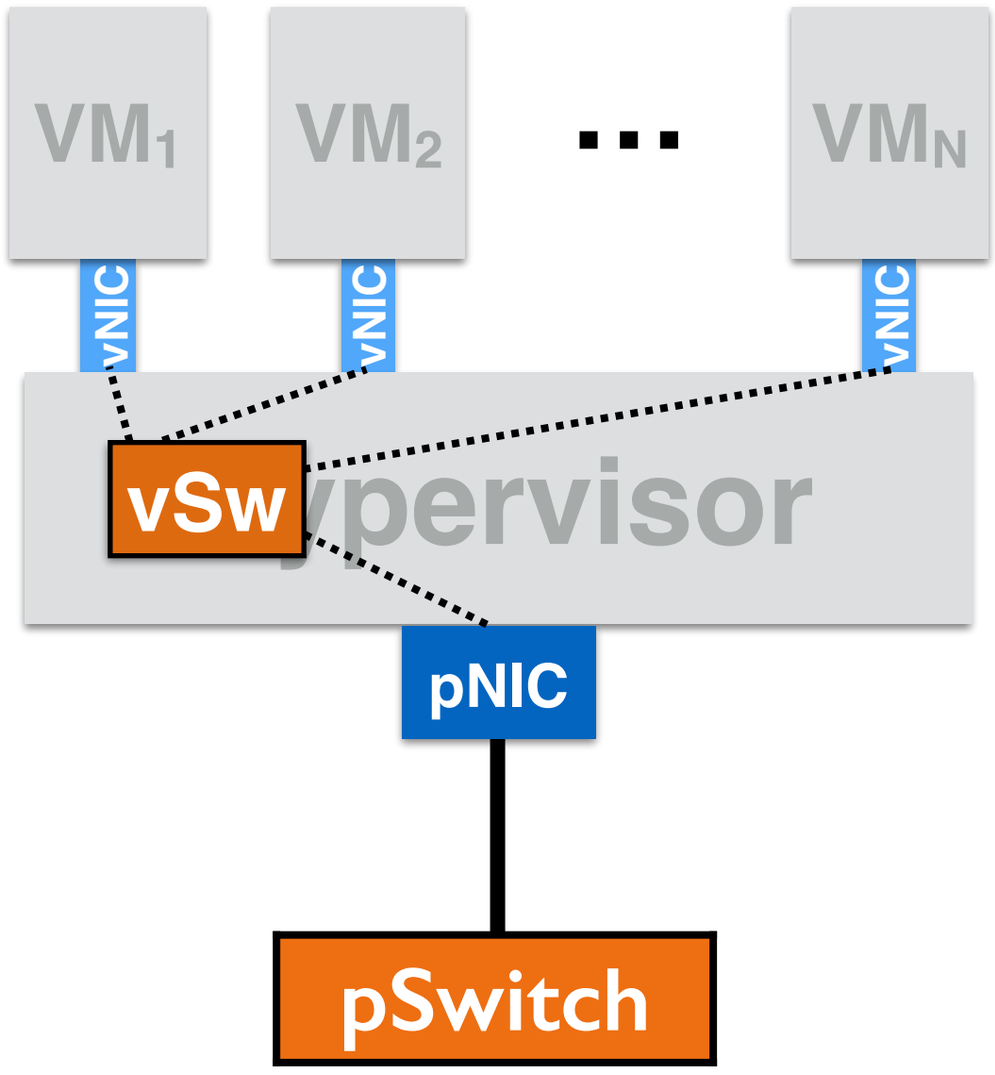
Open vSwitch

USENIX NSDI, 2015

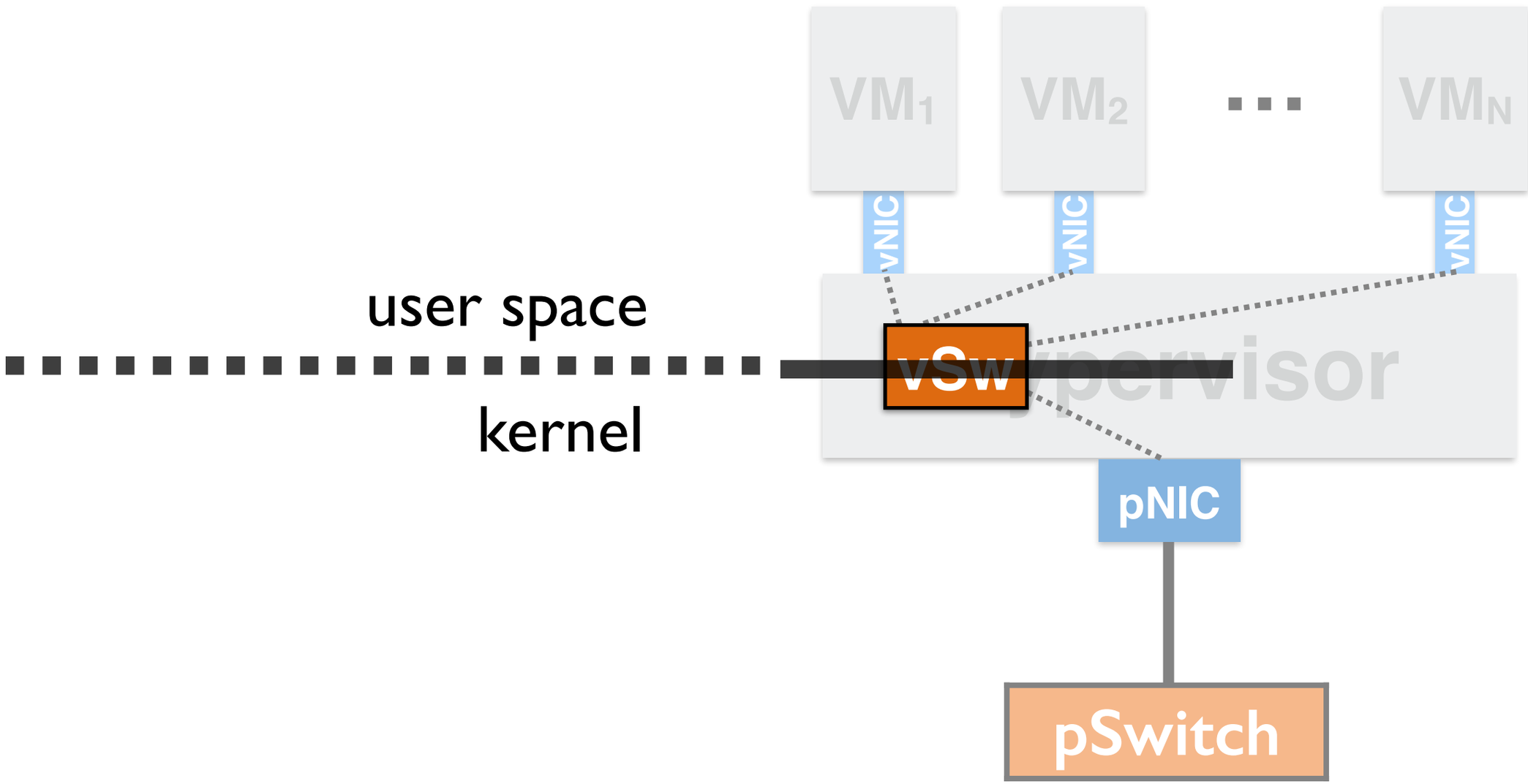
The Design and Implementation of Open vSwitch

*Ben Pfaff**, *Justin Pettit**, *Teemu Koponen**, *Ethan J. Jackson**,
*Andy Zhou**, *Jarno Rajahalme**, *Jesse Gross**, *Alex Wang**,
*Jonathan Stringer**, *Pravin Shelar**, *Keith Amidon*†, *Martín Casado**
*VMware †Awake Networks

Open vSwitch



Open vSwitch

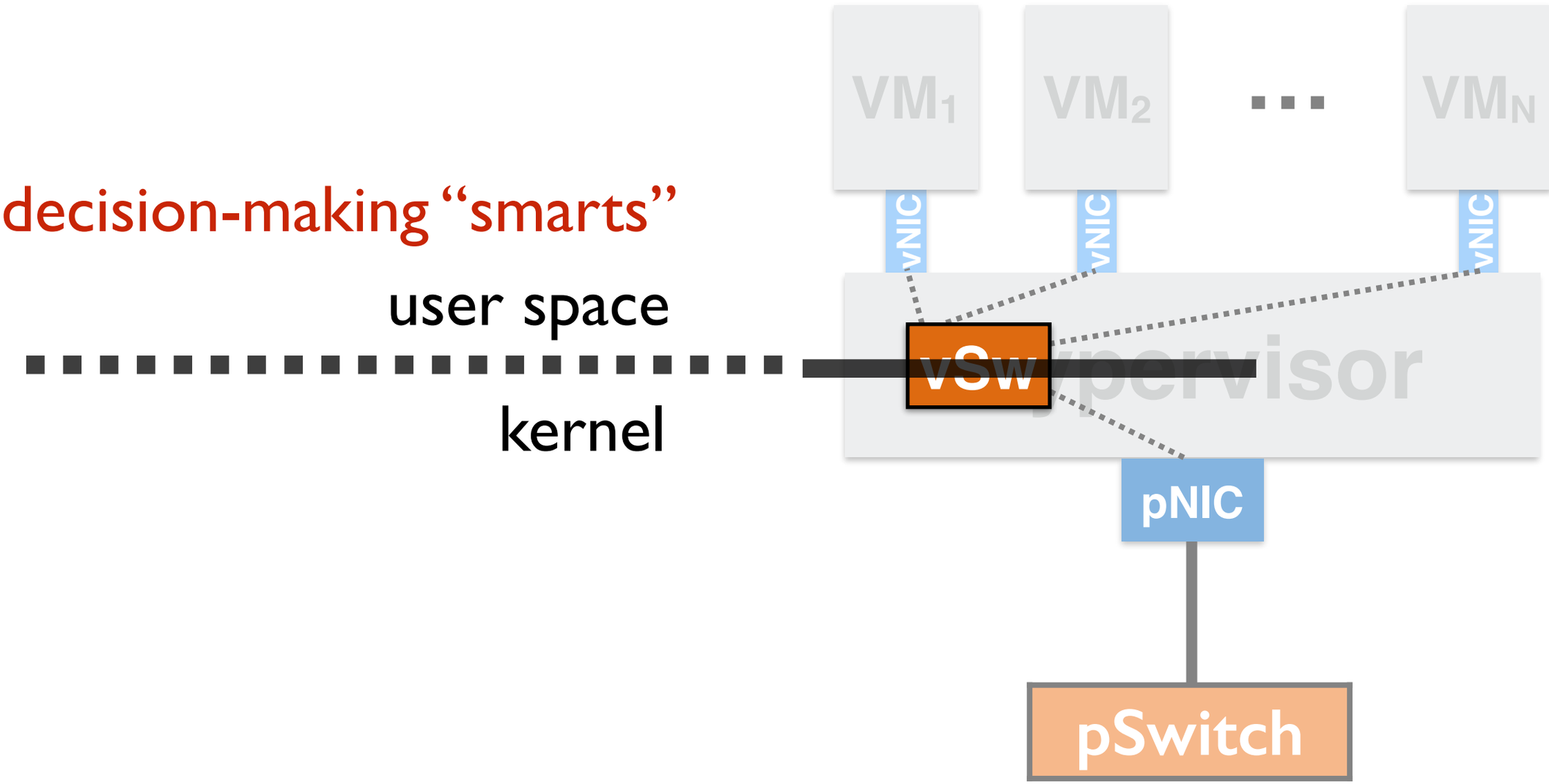


Open vSwitch

decision-making "smarts"

user space

kernel



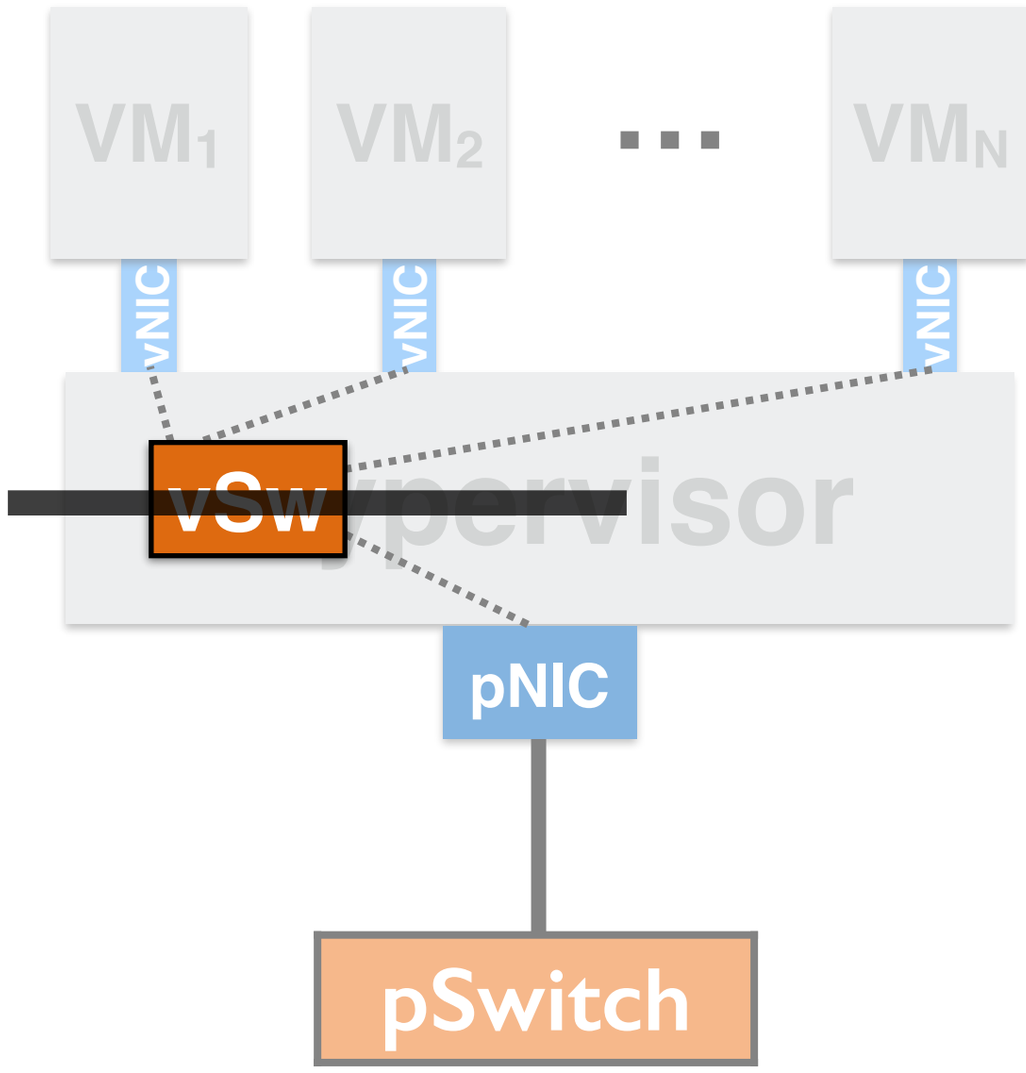
Open vSwitch

decision-making "smarts"

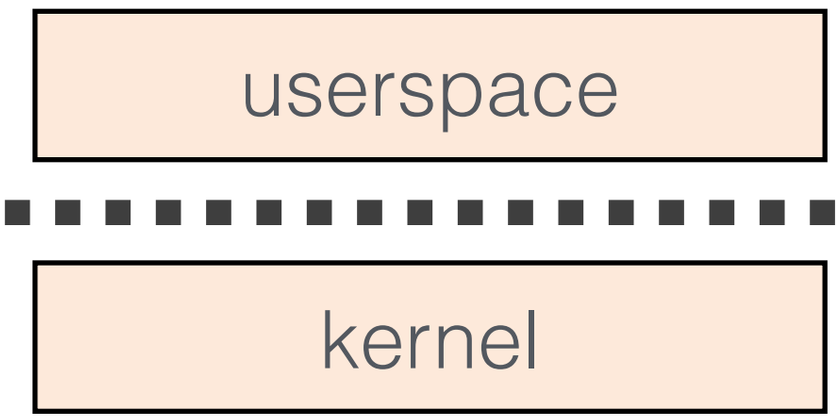
user space

kernel

simple, fast forwarding



Inside Open vSwitch



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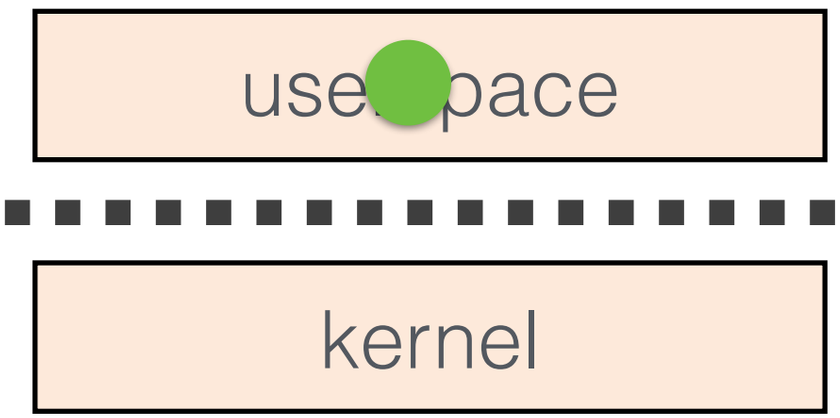
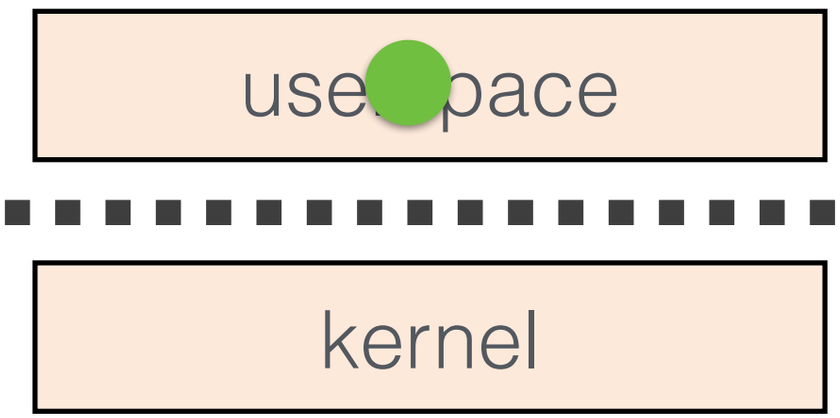


Inside Open vSwitch

srcMAC	dstMAC	action

dstIP	dstTCPPort	action



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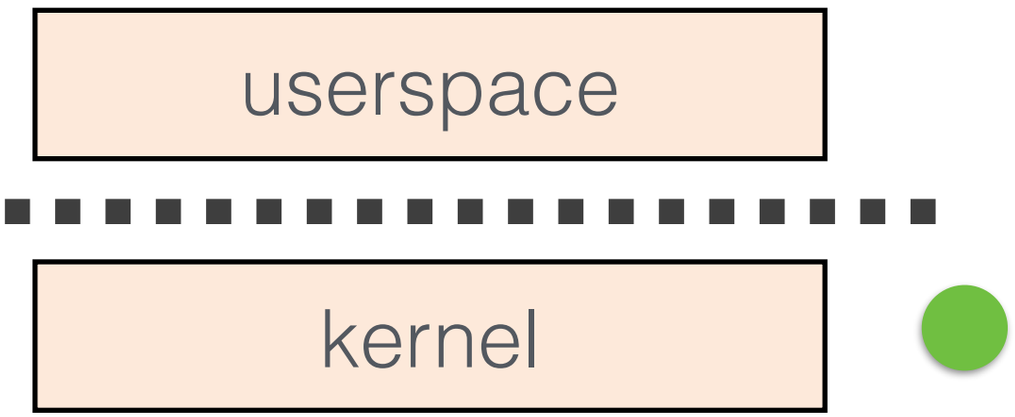


Inside Open vSwitch

srcMAC	dstMAC	action

dstIP	dstTCPPort	action

userspace

kernel

srcMAC	dstMAC	dstIP	dstTCPPort	action

Inside Open vSwitch

srcMAC	dstMAC	action

dstIP	dstTCPPort	action

userspace

kernel

srcMAC	dstMAC	dstIP	dstTCPPort	action

Inside Open vSwitch

srcMAC	dstMAC	action

dstIP	dstTCPPort	action

userspace

kernel

srcMAC	dstMAC	dstIP	dstTCPPort	action

Inside Open vSwitch

srcMAC	dstMAC	action

dstIP	dstTCPPort	action

userspace

kernel

cache

hash-key	flow-table-entry

srcMAC	dstMAC	dstIP	dstTCPPort	action

Inside Open vSwitch

srcMAC	dstMAC	action

dstIP	dstTCPPort	action

userspace

kernel

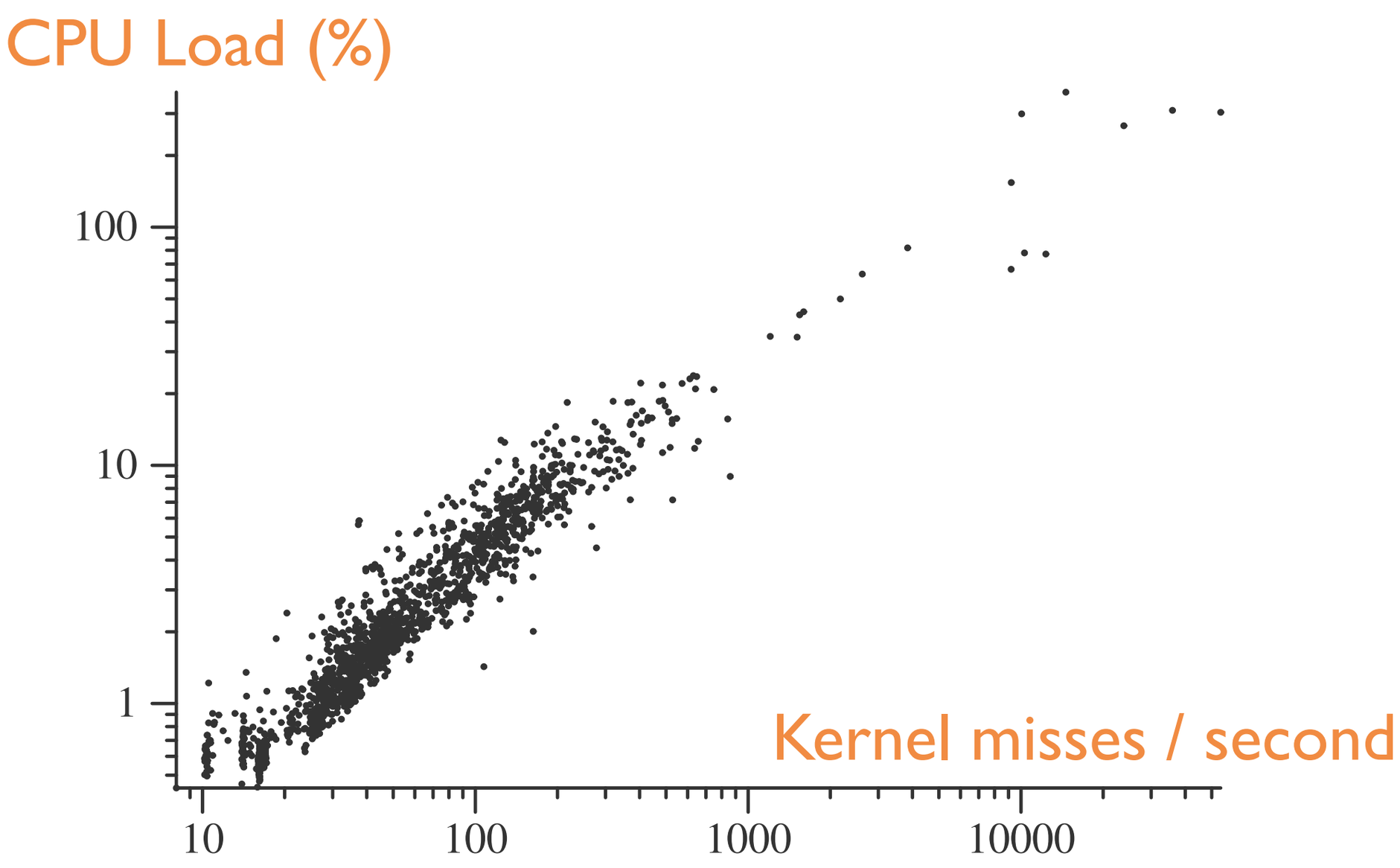
cache

hash-key	flow-table-entry

srcMAC	dstMAC	dstIP	dstTCPPort	action

hash-key = **hash** (srcMAC, dstMAC, dstIP, dstTCPPort)

Inside Open vSwitch



[The Design and Implementation of Open vSwitch. Pfaff et. al, USENIX NSDI 2015]