DPDK

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DPDK DATA PLANE DEVELOPMENT KIT

THE LINUX FOUNDATION

Towards Low Latency Interrupt Mode DPDK

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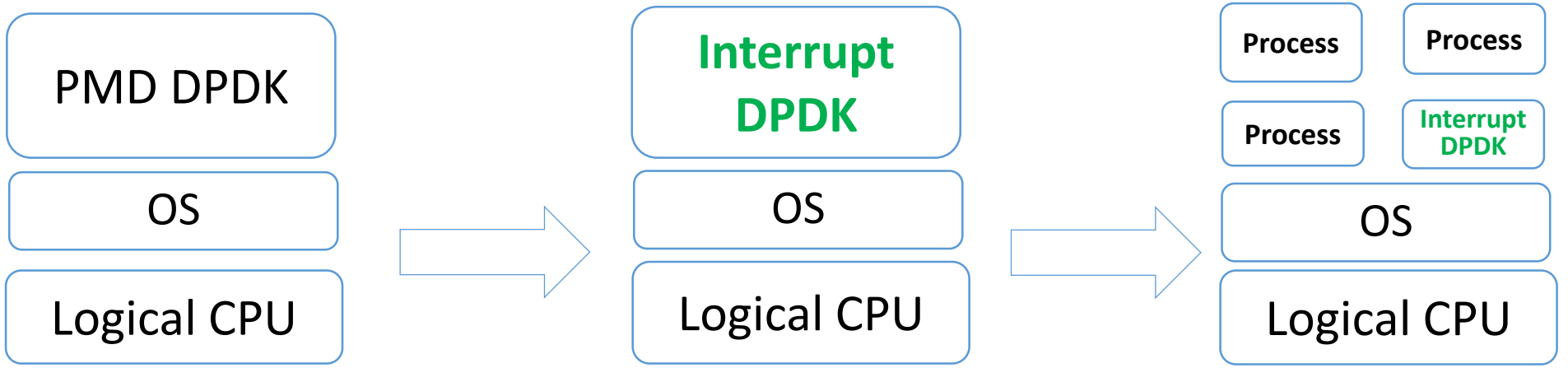
Agenda

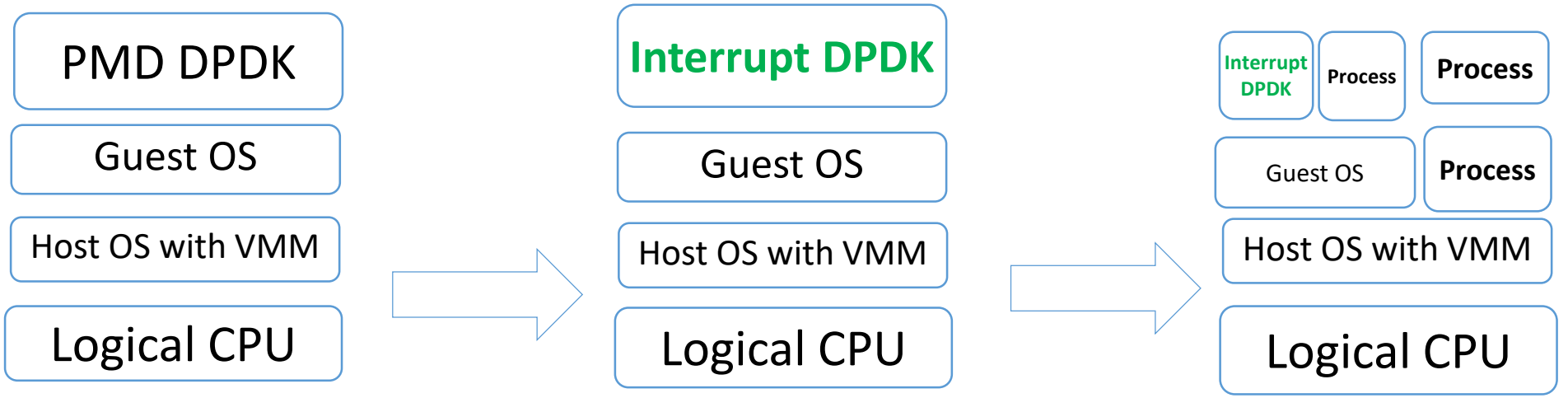
- DPDK Working Mode Transition
- Problems and Optimizations
- Performance Evaluation
- Next Step Plan

Working Model Transition



- Polling mode:
  - 100% CPU usage even without inbound packets
- Interrupt mode DPDK on a dedicated CPU:
  - Enter CPU idle state when no packet is received
- Interrupt mode DPDK sharing a CPU with other processes:
  - Run with the highest priority
  - Yield the CPU to other processes when no packet is received

Working Model Transition with Virtualization



- Polling mode:
  - 100% CPU usage even without inbound packets

- Interrupt mode DPDK inside a VM on a dedicated CPU:
  - Enter CPU idle state when no inbound packets

- Interrupt mode DPDK inside a VM sharing a CPU with other processes:
  - Run with the highest priority
  - Yield the CPU to other processes on the Host OS when no inbound packets
  - Possible to share the CPU with processes inside the VM, but not encouraged currently.

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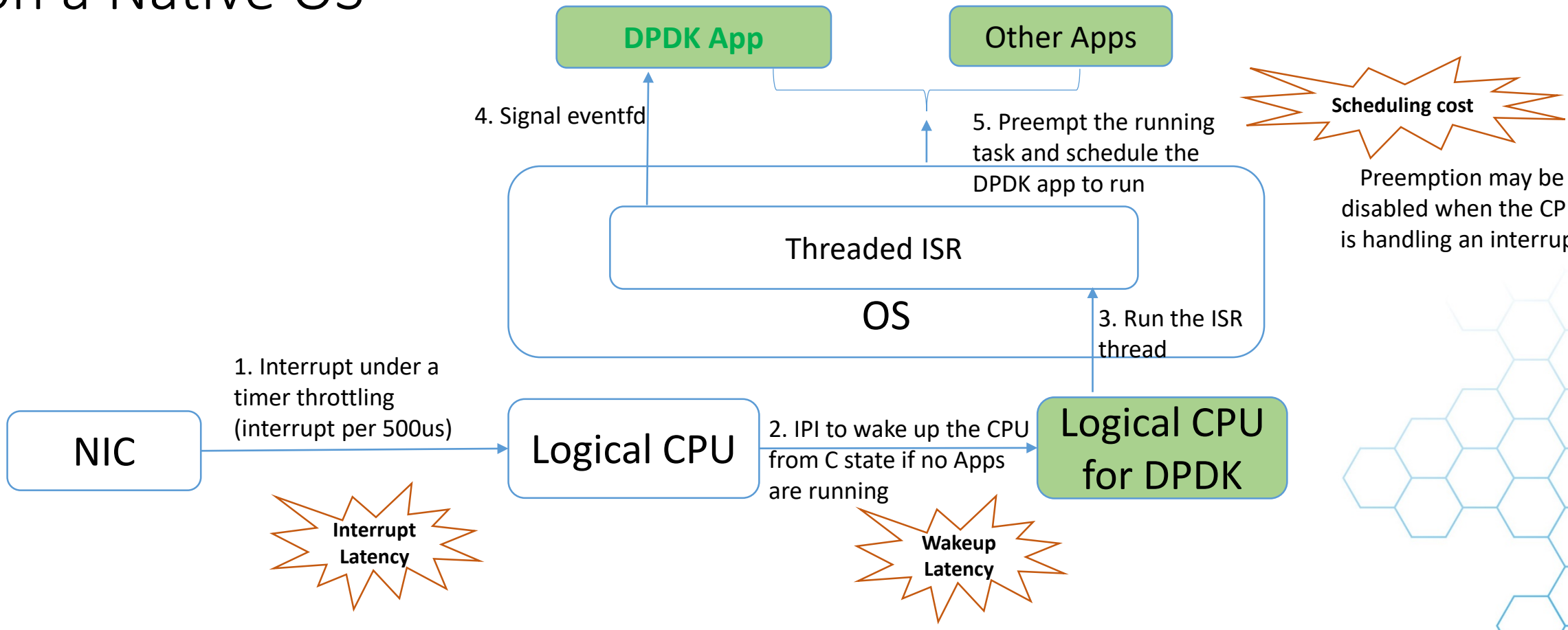
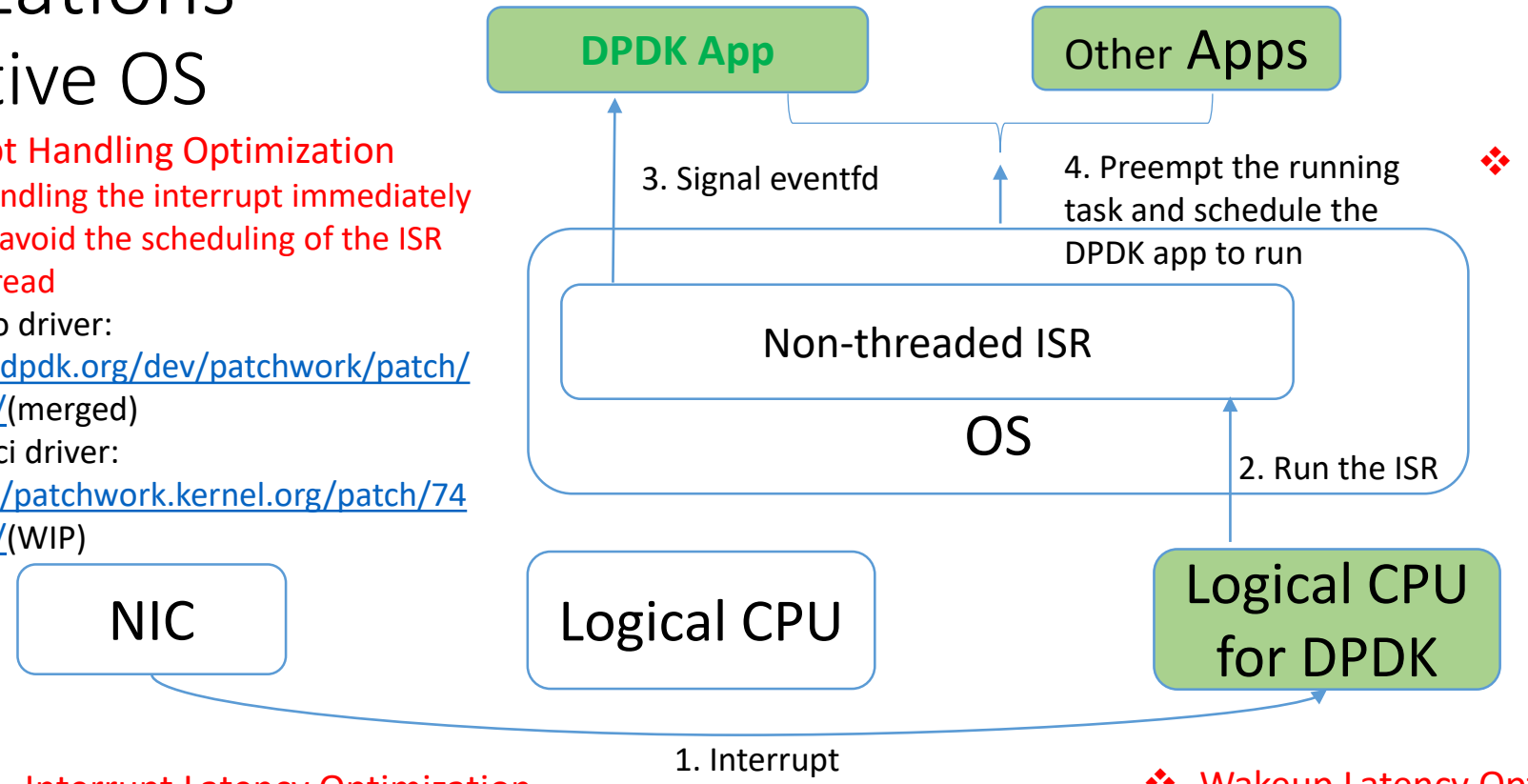
Performance Issues on a Native OS



Optimizations on a Native OS

- Interrupt Handling Optimization
  - Handling the interrupt immediately to avoid the scheduling of the ISR thread

igb_uio driver: http://dpdk.org/dev/patchwork/patch/19855/(merged)
vfio_pci driver: https://patchwork.kernel.org/patch/7493081/(WIP)



- Scheduling Optimization
  - RT Linux is helpful to reduce the scheduling delay

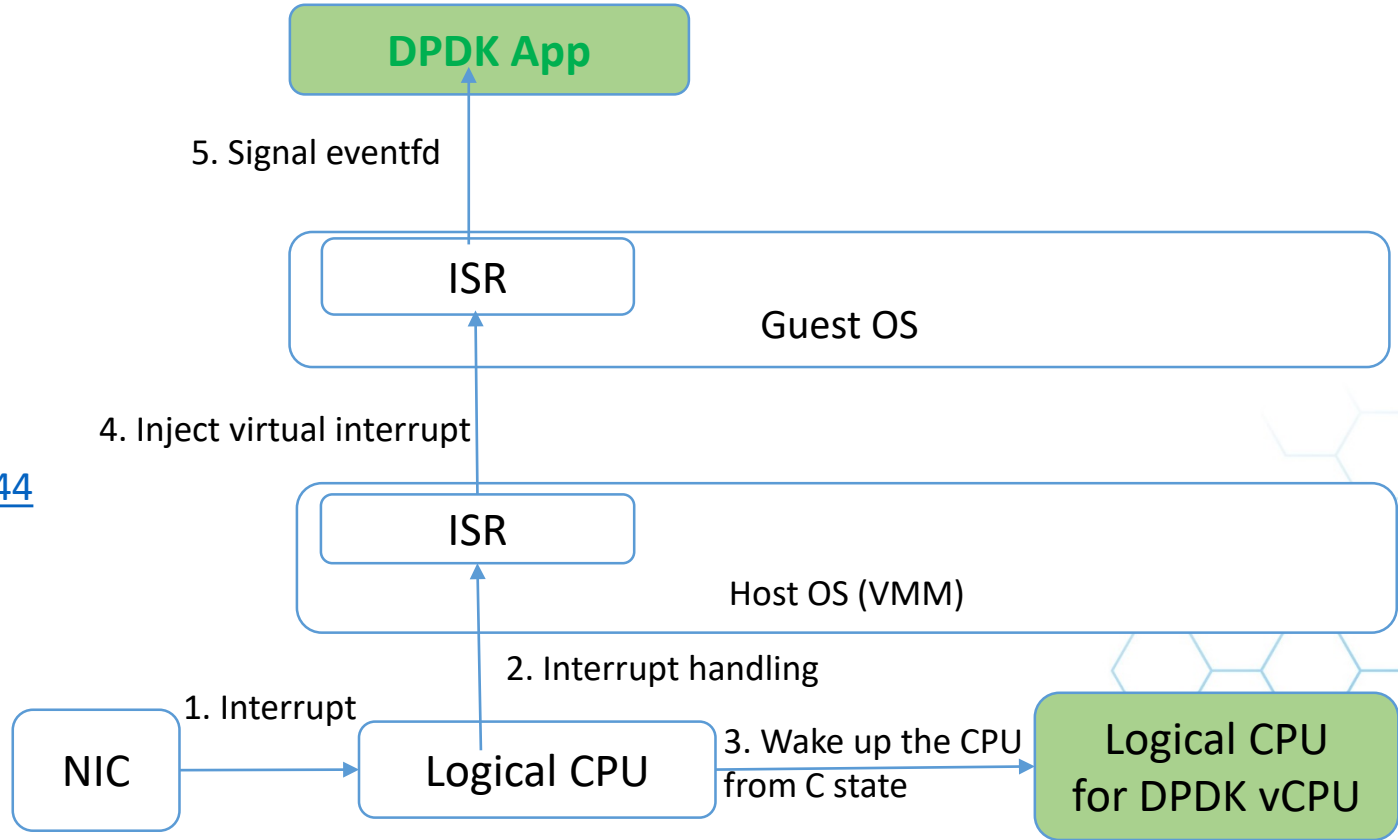
- Interrupt Latency Optimization
  - Interrupt affinity setup to avoid one IPI. It will be good if the affinity can be set in the DPDK library.
  - Remove the timer throttling to get interrupts in time. http://dpdk.org/dev/patchwork/patch/19856/ (WIP)

- Wakeup Latency Optimization
  - Limit the maximum C state via the kernel booting parameter

Performance Issues on a VM

- Latency as described for the native environment, plus the extra latency from the virtualization layer
  - The ISR on the guest kernel
  - Host/Guest context switch for interrupt injection
- Potential bugs on the VMM layer may cause longer latency
  - https://www.spinics.net/lists/kvm/msg144469.html

Further optimizations to the VMM layer are in our next step plan



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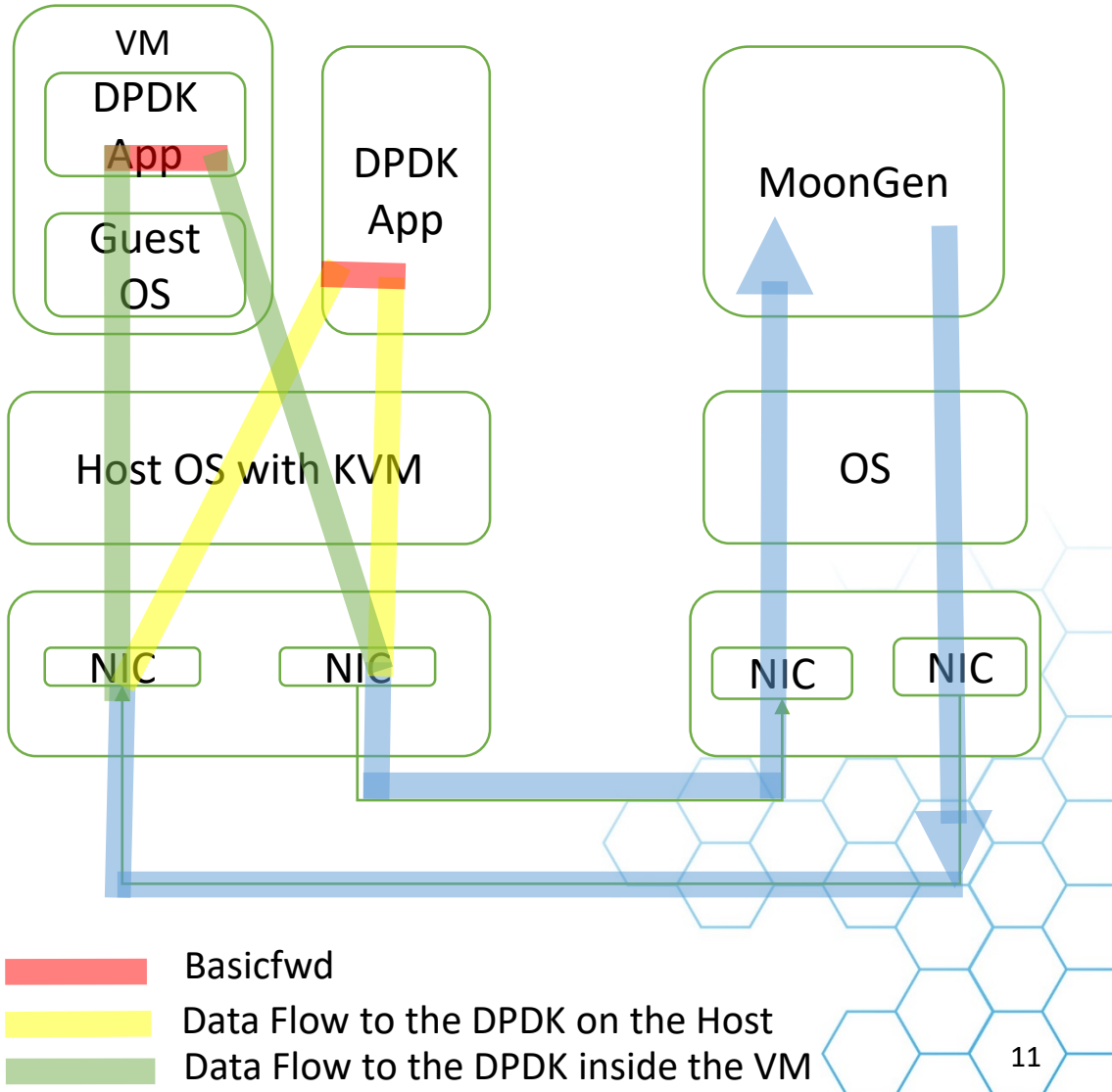
Test Environment

- Host
  - CPU: Intel XeonE5-2699 v3 @ 2.30GHz
  - OS: KVM4NFV D release (RT Kernel 4.4)
  - NIC: Intel Ethernet Controller X540-AT2, 10Gbs
- Guest
  - vCPUs bound to isolated pCPUs
  - OS: same as host
- Test applications
  - DPDK basicfwd
    - Modified based on DPDK l3fwd-power example
    - Sleep if no packets for more than 300 us
- Packet generator (MoonGen)
  - 1 packet every 350 us



CPU Idle Optimization –Current Situation

Max Cstate	C0	C1	C3	C6
Interrupt mode Basicfwd Latency (us)	14	14.9	60.9	87.7
C State Exit Latency *	0	2	33	133

* Output from “cpupower idle-info” on Intel XeonE5-2699 v3 @ 2.30GHz

Latency Improvement

Latency	Minimum (µs)	Average (µs)	Maximum (µs)
Interrupt mode Basicfwd (Host, before optimization)	19	105	418
Interrupt mode Basicfwd (Host, after optimization)	9	14	21
Interrupt mode Basicfwd (in-VM, before optimization)	9	112	7210
Interrupt mode Basicfwd (in-VM, after optimization)	9	20	35

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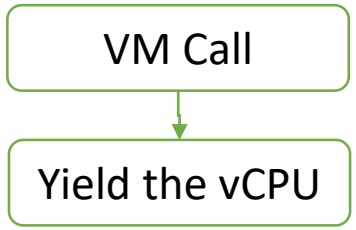
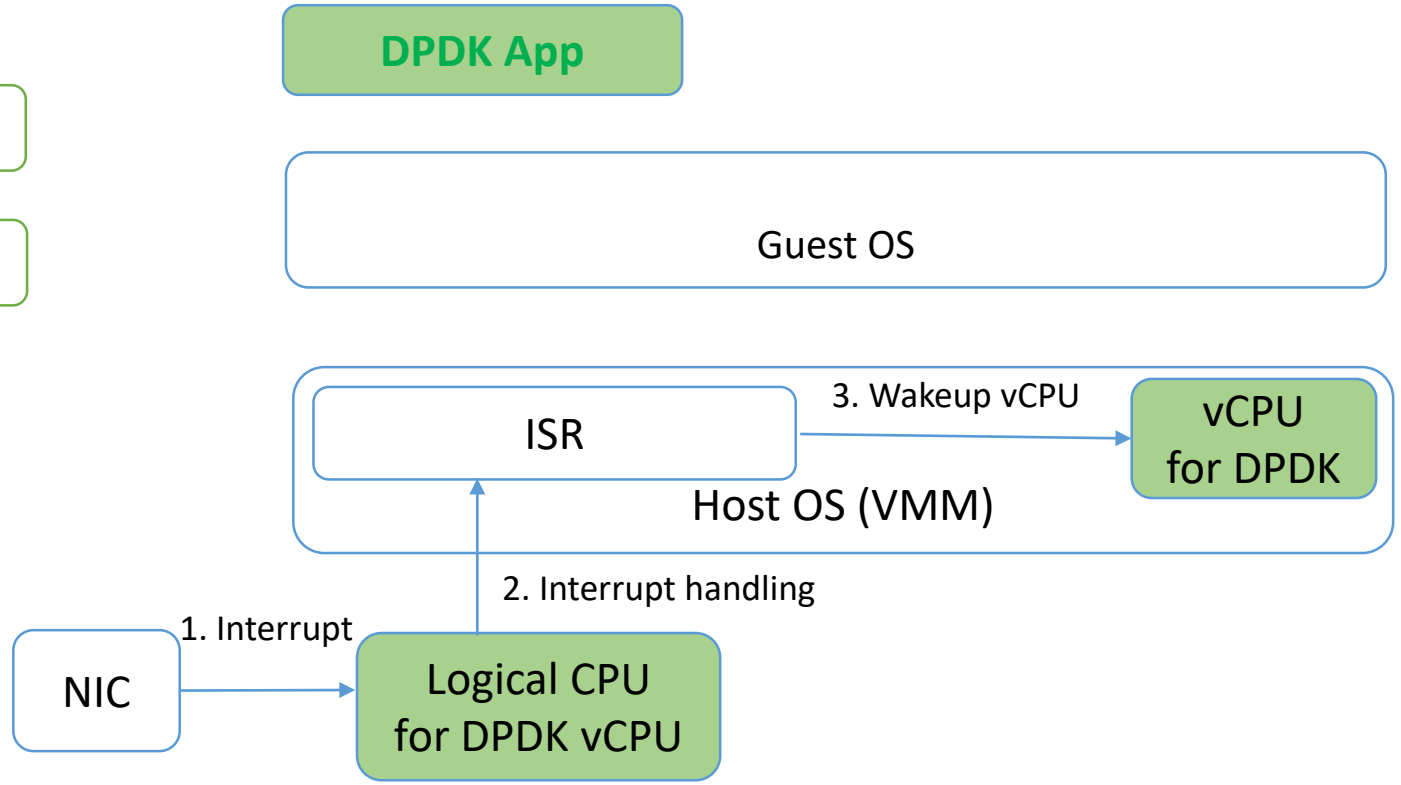
Optimizations to DPDK inside the VM

When no packets come:



When packets come:



- DPDK App starts to run once the vCPU is woken up by the Host ISR
- No need to inject virtual interrupts
- No need to signal eventfd inside the VM

End of Presentation

Thank you!