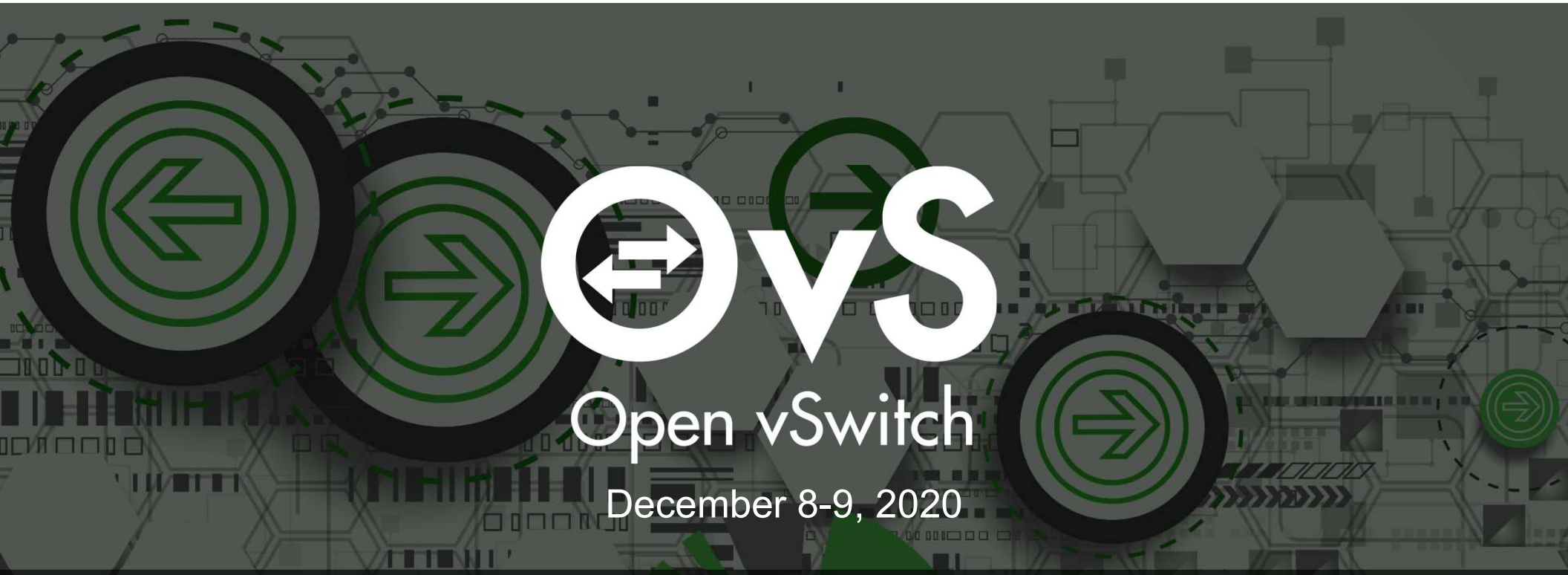

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OvS Offload Layer Design Challenges

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Agenda

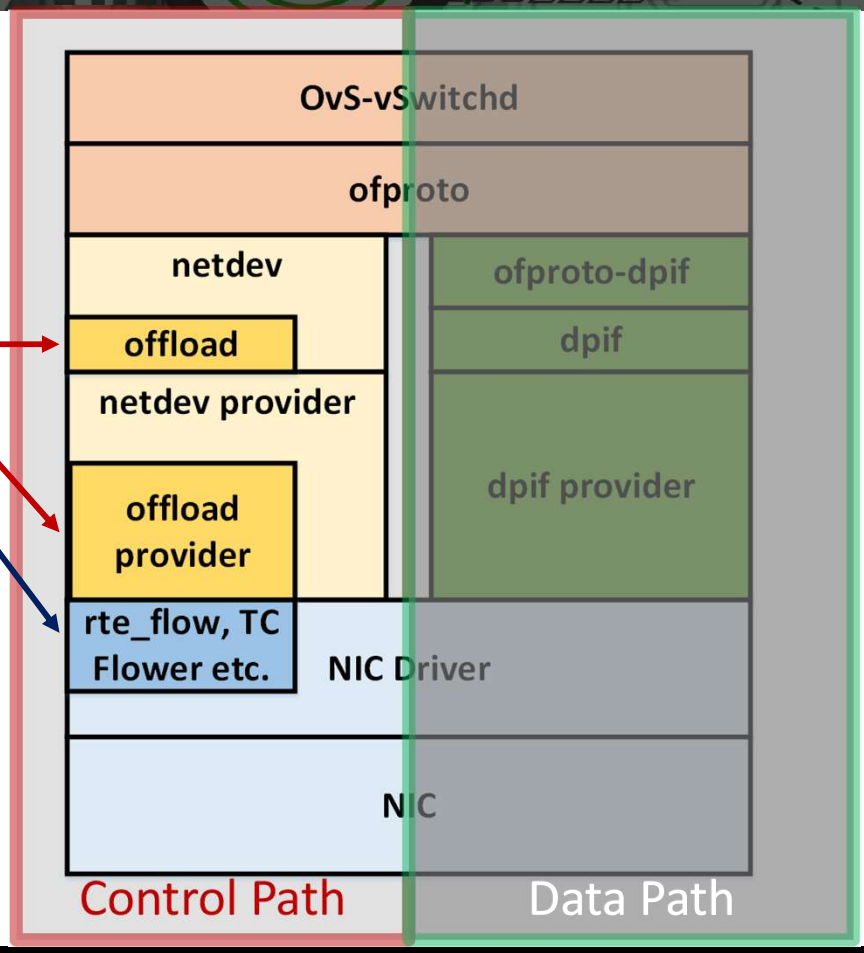
- OvS Offload Layer
- OvS Offload Capabilities
- OvS Offload Registration
- OvS-DPDK Offload Thread Model Issues
- Tunnel Decap Design Challenges
- OvS-DPDK Partial Action Offload Design Challenges
- Differences between User Mode and Kernel Mode Offload Data Paths
- Summary

OvS Offload Layer

- **Implements control path for flow offloads**
- **Device agnostic**
- **Hidden from ofproto layer**

- **Split in generic and provider sub-layers**
- **Enables multiple NIC flow offload APIs**
- **Flow APIs registered by specific provider**
- **Two subsets of flow APIs:**
  - Put, Delete, and Stat APIs for a specific flow
  - Create, Destroy, etc. APIs for flow dumps

Challenges with this layer – Focus of this talk



OvS Offload Capabilities

- **Match Fields and Actions supported by a device can't be expressed**
- **DPDK provides rte_flow_validate()**
  - But needs an additional trip to the device for every flow offload
  - OvS currently does not use rte_flow_validate()
- **Kernel TC Flower does not have equivalent of rte_flow_validate()**

- **OvS Offload layer can be optimized to support device flow offload capabilities**
  - Could be a simple bitmask of match and actions supported
  - Exported by each offload capable device
  - Offload layer can use this bitmap before offloading to a device

OvS Offload Capabilities Discovery and Usage can Improve Efficiency

OvS Offload Registration

- **Each provider (e.g. netdev-offload-dpdk) registers a DP specific flow_api object**
- **Registration is done at the time of offload provider initialization**
- **flow_api object is added to a global list of registered flow APIs**
- **At the time of netdev creation, the corresponding flow APIs are initialized**

- **Issues**
  - Assumes every eth device supports flow-api
  - No device (PMD) specific check
  - If ‘hw-offload’ enabled in OVS, offload attempted on any eth_dev attached to OVS

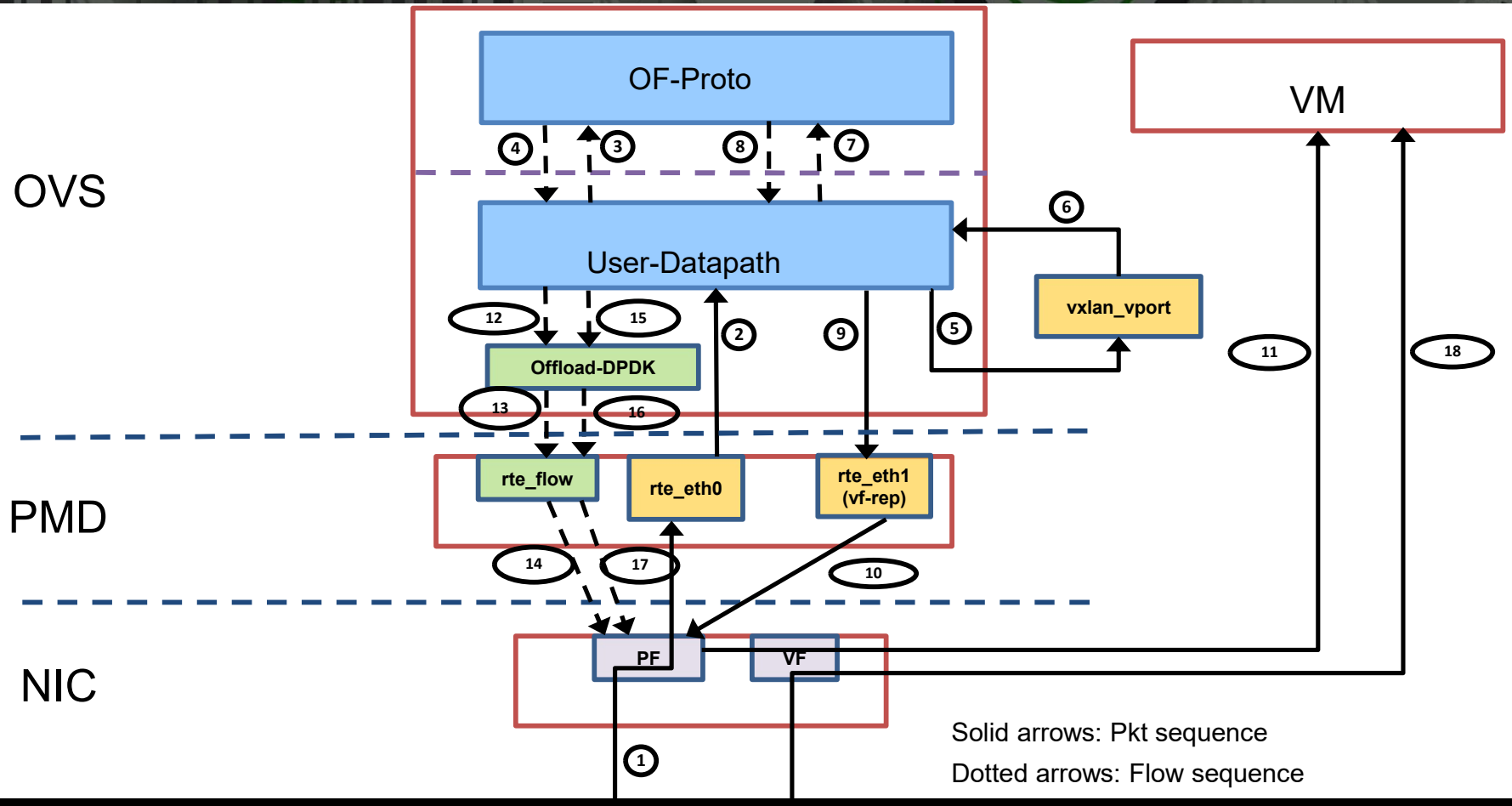
Room for Optimizing OvS Offload Registration

OvS-DPDK Offload Layer Thread Model Issues

- PMD threads process packets, handle DP misses, OF classification
- Offload request is deferred to an offload thread
- Scheduling latency is involved in running the offload thread
- N PMD-threads : 1-offload-thread (serialization across multiple devices)
- Lack of offload error propagation back to PMD threads due to this model
- Lack of infra to share data and synchronize DP and offload threads

Concurrency and Synchronization can Improve Offload Layer Thread Model

Tunnel Decapsulation HW-Offload Sequence



Packet and Flow Processing Sequence Enumerated

- **Diagram shows ingress packet/flow sequence**
- **Solid arrows: packet traversal; dotted arrows: flow processing**
- **(1) First tunneled packet from the wire received by the PMD (via upink/PF)**
- **(2) Packet is received by OVS datapath (when OVS polls PF)**
- **(3) No datapath rule (flow miss); upcall made to classify the packet**
- **(4) Ofproto classifies the packet; creates a datapth rule with actions**
- **(5) Datapath rule/action executed**
  - **tnl_pop() and recirculate the packet to tunnel port**
- **(6) Packet is received by OVS datapath (in the ctx of VXLAN vPort)**
- **(7) No datapath rule (flow miss); upcall made to classify the packet**
- **(8) Ofproto classifies the packet; creates a datapth rule with actions**

Packet and Flow Processing Sequence Enumerated

- **(9) Datapath rule/action executed (forward); packet sent down to the VF-Rep**
- **(10) VF-Rep transmits packet down to the PF**
- **(11) PF loops the packet to the VM via the VF**
- **(12) Datapath adds the flow; initiates an offload request (F2)**
- **(13) Offload layer issues a rte_flow_create() to the PMD**
- **(14) PMD programs HW tables**
- **Control returns back to datapath in the ctx of the PF**
- **(15) Datapath adds the flow; initiates an offload request (F1)**
- **(16) Offload layer issues a rte_flow_create() to the PMD**
- **(17) PMD programs HW tables**
- **(18) Next packet from the wire decapsulated and sent directly to VM via VF**

Tunnel Decap Offload Issues

- **Tunnel Decap involves two flows and recirculation in OvS**
  - Flow-F1 (Match: t_dmac, t_dip, t_proto, t_port; Action: Tunnel pop and Output to tunnel port)
  - Flow-F2 (Match: t_dip, t_sip, t_id, inner eth, Action: Output to VF-Rep)
- **Packet can't be processed entirely in HW, until both flows are offloaded**
- **Decap Flow Offload Sequences can be different (F2→F1, F1→F2, F2 only)**
  - PMDs can not assume a specific sequence
  - PMDs need to internally handle all possible sequences
- **Tunnel metadata handling is complex**
  - OVS SW datapath action is "tnl_pop" for F1, SW DP passes tunnel header as metadata
  - HW can't really pop tunnel header when F1 is offloaded (otherwise it loses tunnel metadata)
  - HW miss on F2: Packet couldn't be decapsulated since there is no F2 in HW (packet hit F1)
- **Statistics: Double counting of F1 for F2 miss in HW complicates the design**
- **Mapping tunnel vPort to Phy port: otherwise F2 is offloaded on all phy ports**

OvS Two Bridge Model for Tunnel Processing Makes Tunnel Decap Offload Complicated

OvS-DPDK Action Offload Challenges

- **Challenges in extending partial offload infrastructure for action offload**
- **Partial offload currently supports only classification offload: Flow match**
- **Partial Action Offload RFC**
  - Idea is to extend partial offload to support real actions
  - Actions like tunnel-encap/decap, vlan push/pop offloaded to HW
  - HW classifies + executes specified actions
- **Challenges**
  - Today, partial offload is only supported on the ingress device
  - Scenarios that involve a SW ingress, but a HW egress offload are not considered
  - Deferred offloading in the context of a separate offload thread creates transient out-of- sync
  - PMD threads may continue processing actions after the flow was already offloaded
  - Lack of APIs to determine whether a flow is eligible for partial actions offload
  - An additional problem with ingress-partial-action is lack of data path assistance

OvS Datapath and Offload Layer Designs are not Amenable to Partial Actions Offload

User/Kernel DP Offload Differences

Kernel-DP/Offload	User-DP/Offload
Handler threads process flow-miss/upcall	PMD threads process flow-miss/upcall
Flow added to either DP or offloaded	Flow always added to DP and offloaded
Offload attempted first; if fails added to DP	Added to DP first and offload scheduled
Offload synchronous; handler thread waits	Offload async; dispatched to offload thread
Offl errors returned to initiating thread	Offl errors not returned to initiating thread
Dynamic rebalancing supported	Dynamic rebalancing unsupported
Single (logical) flow table; no duplicate flows	Flow table per-port, per-PMD; offload handles duplicate flow-add

Inconsistencies between User and Kernel Offloads

Summary

- OvS Offload Layer Design is Complicated
- Offload Capability and Discovery is primitive
- Serialized Threading Model poses challenges for partial actions offload
- Two bridge model poses significant challenges for tunnel decap offload
- Differences between user and kernel mode offloads need to be reconciled
- Overall, redesign of OvS offload layer should be considered