Accelerating Packet Processing with FPGA NICs

DPDK Summit - San Jose – 2017

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Introduction

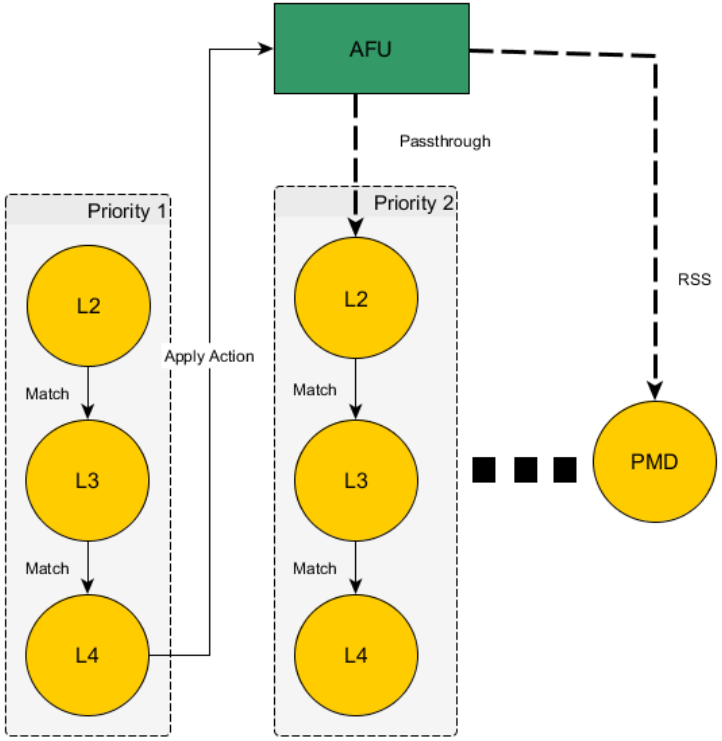
- NIC packet processing offloads has been proven to significantly assist packet processing, e.g.,
  - TCP/UDP checksum
  - TCP segmentation offloads
  - RSS
- The recently introduced rte_security APIs allowed NICs to accelerate crypto operations ***inline***
  - Received packets are decrypted by the NIC before being scattered to memory
  - Sent packets are encrypted by the NIC before being sent to the wire
  - No need to enqueue the packets to another cyprtodev PMD

Generic Inline Acceleration

- The benefits of inline acceleration can be generalized to support ***any*** application-specific action by FPGA-capable NICs!
  - A single NIC may support multiple Inline Acceleration Functional Units (I-AFUs) provided by multiple parties
  - The I-AFU can be programmed in the field to do any packet processing task
  - Any packet flow can be redirected to any I-AFU
- We have a good toolbox for handling flows which is constantly evolving
  - Count, Mark, Steer, modify…
- Generic acceleration flow actions are a natural fit
  - Steer any flow to any I-AFU
  - Continue packet processing according to steering

Examples

- Application-specific byte-intensive packet transformation
- Application-specific flow-steering
  - Accelerator parses packet and modifies header fields accordingly
  - Flow processing resumes normally afterwards



Generic Inline Acceleration Requirements

- Discovery
  - What I-AFUs are currently installed on the NIC?
- Control
  - Discovering the capabilities of an I-AFU
  - Configuring an I-AFU
- Flow processing
  - Packet flows are matched normally
  - Opaque action specifies the I-AFU that should handle matching packets
- Data path
  - Report/deliver I-AFU specific information via opaque mbuf meta-data

I-AFU Discovery

- Reports the following information
  - Vendor ID – This is the ID of the accelerator provider
  - Product ID – Uniquely identifies a product of the provider
  - Version – Product version
- Given this information, applications uniquely identify the I-AFU
  - Semantics are known to the application a-priori

Control Path

- Opaque command

```
struct rte_accel_session
*rte_accel_session(uint16_t id,

        struct rte_accel_sess_conf *conf,

        struct rte_mempool *mp,

);
```

- Create/Destroy/Configure Session

```
struct rte_accel_session_conf {
        unsigned short vendor_id;
        /**< AFU vendor ID */

        unsigned short product_id;
        /**< AFU product ID*/

        unsigned int cmd_id;
        /**< AFU command ID*/

        unsigned int length;
        /**< AFU command buffer length*/

        unsigned char buf[0];
        /**< AFU command buffer*/
};
```

Flow Steering

- New non-terminating action "call accelerator"
- For example: Customer AFU replaces FOO with BAR in payload of matching packets

```
/** security session configuration parameters */
struct rte_accel_session_conf  accel_cmd = {
        .vendor_id = 0x1234,
        /**< Customer AFU vendor  ID */
        .product_id = 0x5678,
        /**< Customer product  ID*/
        .cmd_id = 1,
        .length = 8;
        buf = "FOO|BAR"
        /**< String to replace */
};
```

```
/** flow parameters */
attr->ingress = 1; /** attr->egress = 1 */

pattern[0].type = RTE_FLOW_ITEM_TYPE_ETH;
pattern[1].type = RTE_FLOW_ITEM_TYPE_IPV4;
pattern[2].type = RTE_FLOW_ITEM_TYPE_UDP;
pattern[3].type = RTE_FLOW_ITEM_TYPE_END;

action[0].type =
RTE_FLOW_ACTION_TYPE_ACCEL;
action[0].conf = accel_session;
action[1].type =
RTE_FLOW_ACTION_TYPE_END;
```

Related Work

- rte_prgdev – focused on burning/loading images into programmable devices
  - Complementary to this proposal
- rte_raw_dev – abstracted the PMD device functionality for accelerators
  - Seems like a good direction for FPGAs that act as CPU-assists
  - Complements inline packet acceleration

Questions?