Hardware Offloading for Connection Tracking

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Johan Edman, Raman Salih, Vignesh Purushotham Srinivas

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- Software offloading can increase the efficiency of CPU usage.
- Hardware offloading is an even more promising when it comes further increasing the hardware efficiency.

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- Develop and benchmark techniques to optimize the offloading.

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- DPDK uses Poll Mode Driver(PMD) to bypass the the standard networking stack to accelerate the packet processing.

Load Balancing

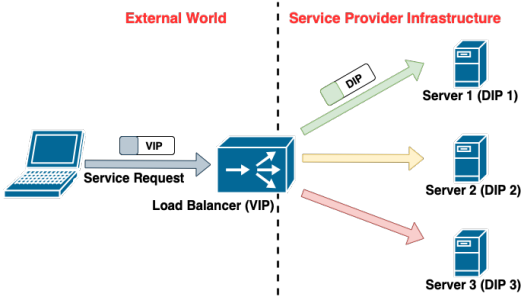

Figure 1: Load Balancing

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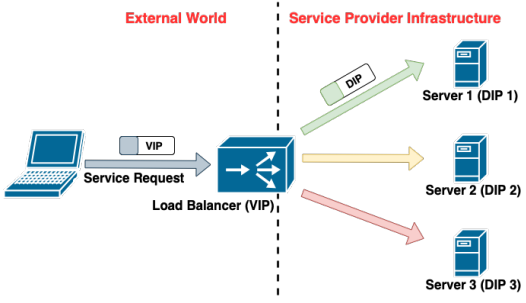

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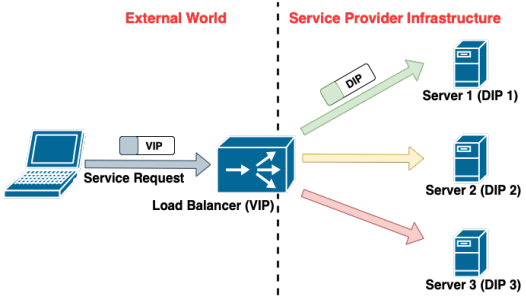

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- A load balancer provides translations from virtual IPs(VIPs) to direct IPs(DIPs)
- Can become a potential performance bottleneck

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Testbed Basic Forwarder

- 100 Gbps Mellanox ConnectX-5 cards

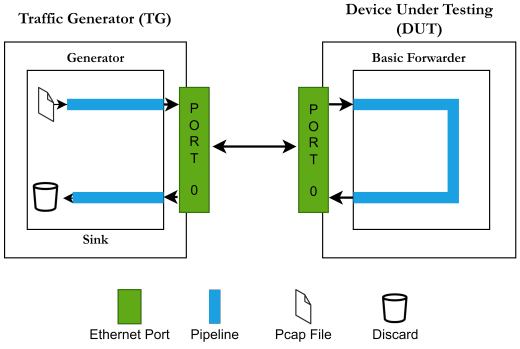

Figure 2: Hardware topology Basic Forwarder

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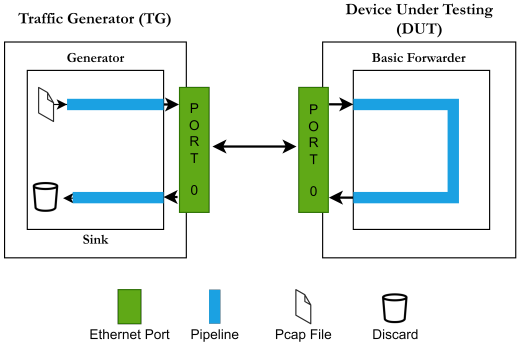

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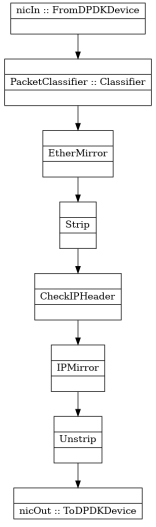

Figure 3: Internal structure Basic Forwarder

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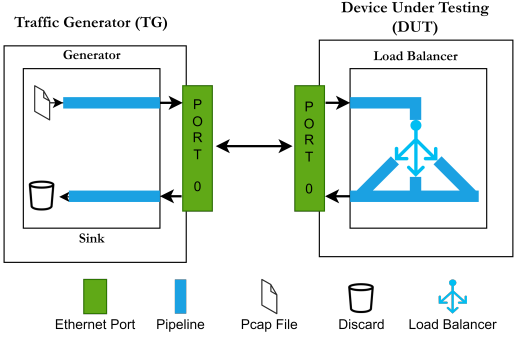

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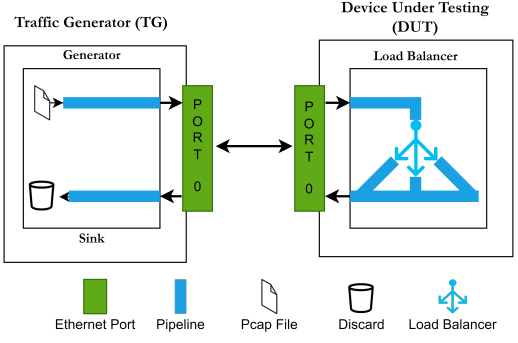

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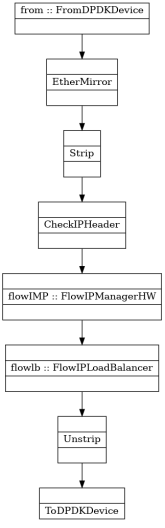

Figure 5: Internal structure Load Balancer

FlowIPManagerHW element

```
if not MARKED then
    FLOW = hashtable_lookup(PACKET)
    if FLOW < 0 then
        FLOW = hashtable_add(PACKET)
        FCB = fcb_get(FLOW)
    else
        FCB = fcb_get(FLOW)
    if OFFLOAD then
        switch OFFLOAD_TYPE do
            case SIZE
                stats_update(PACKET_LENGTH)
                if STATS_BYTECOUNT > THRESHOLD then
                    insert_flow(PACKET, FCB)
            case NAIVE
                insert_flow(PACKET, FCB)
else
    offload_fcb_get(MARKED)
```

Testing

Core Count	Hash Table Size	Flow Count	Packet Size
1	2E6	2E6	1500 bytes
2	4E6	8E6	
4	8E6		
8	16E6		

Table 1: Tested input variables

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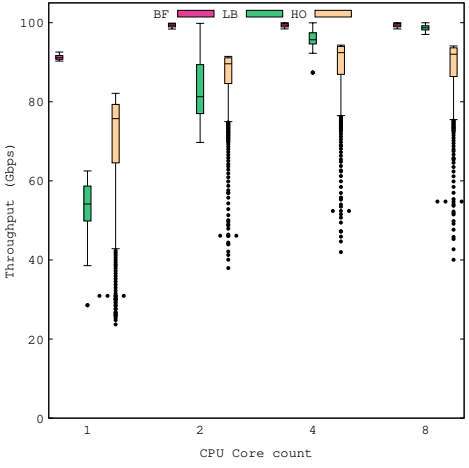
Metrics of interest:

- Throughput
- Latency
- Packetloss

Results 2M Hash Table Entries 2M Flows



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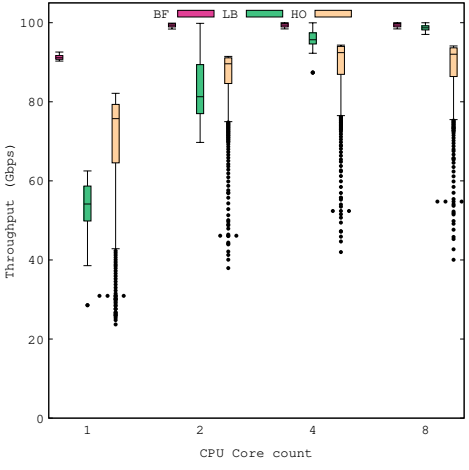

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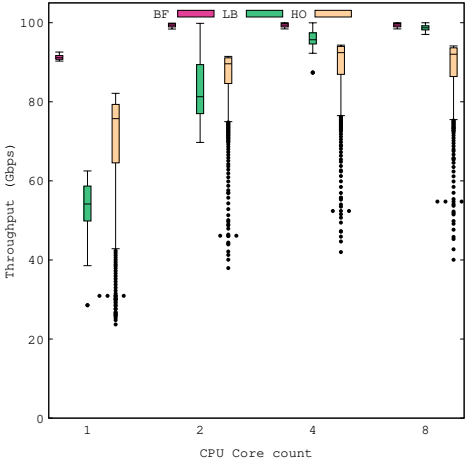

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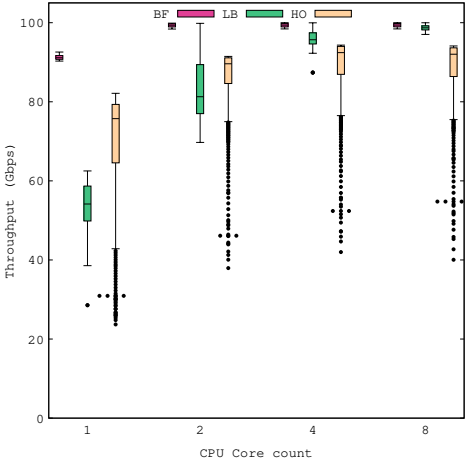

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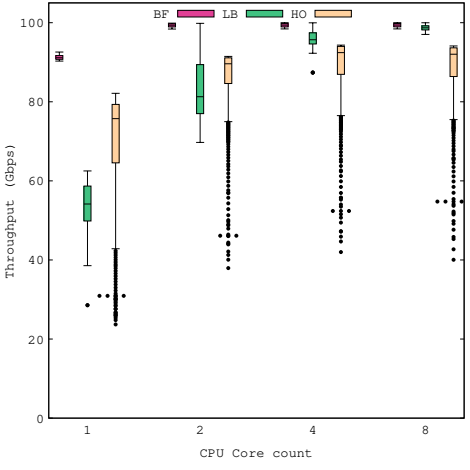

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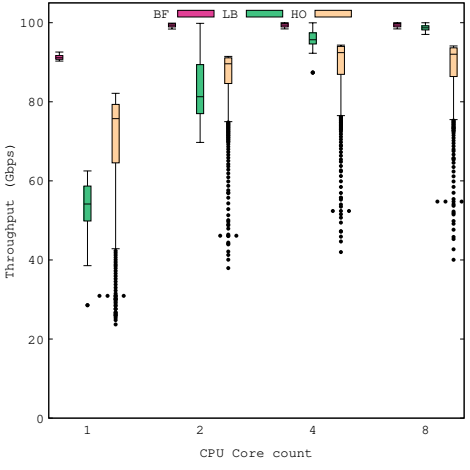

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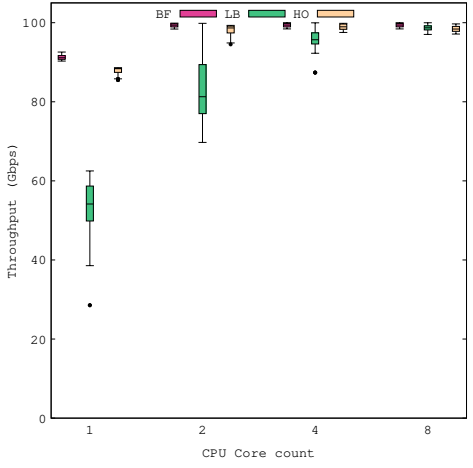

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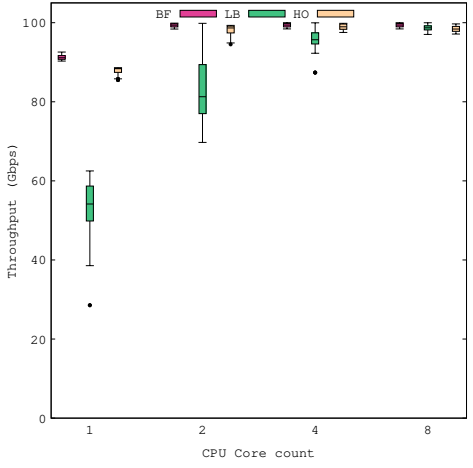

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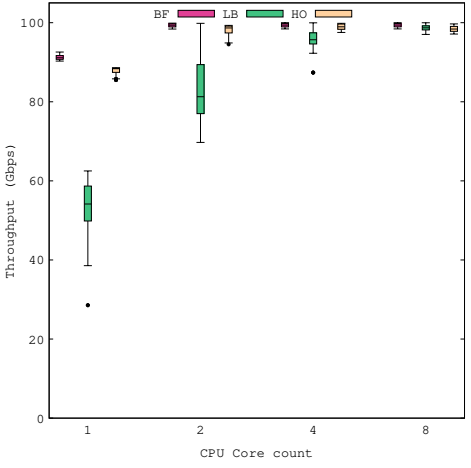

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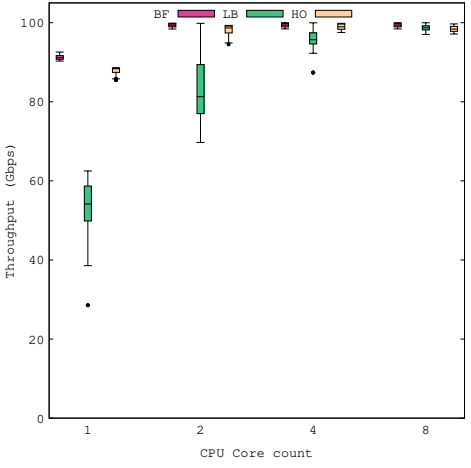
- Around half of the flows are offloaded to hardware for classification



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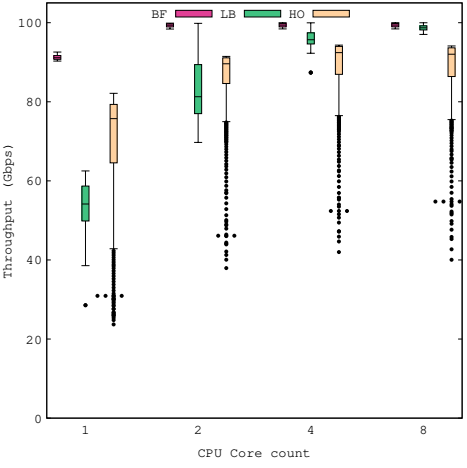

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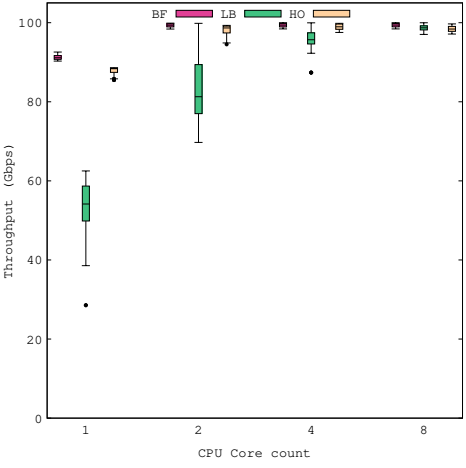

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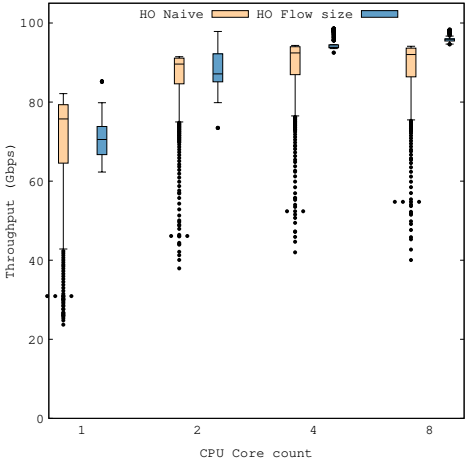
Results optimally offloading 2M Hash Table Entries 2M Flows



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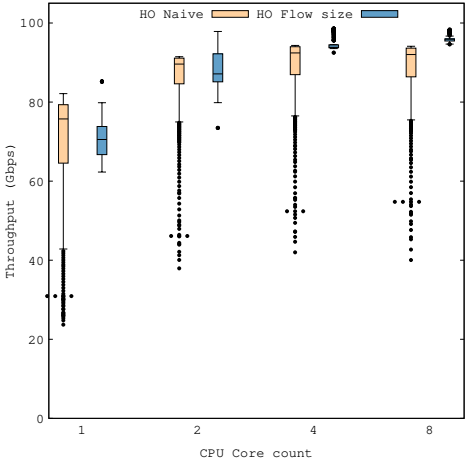

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- Selectively choosing which flows to offload in blue

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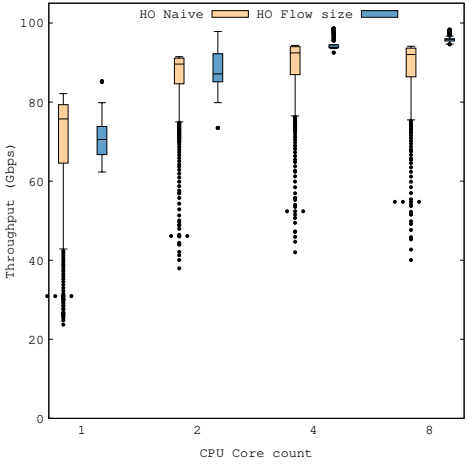

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- Selectively choosing which flows to offload in blue
- Not as limited while inserting flows

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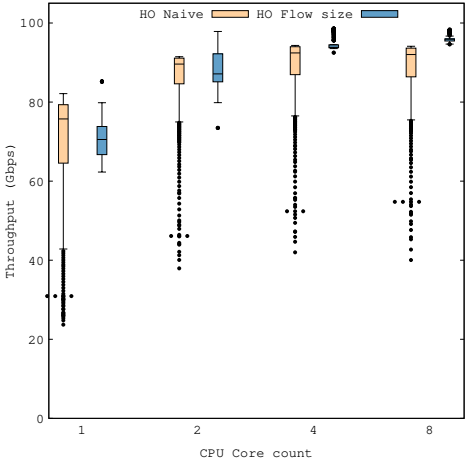

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- Selectively choosing which flows to offload in blue
- Not as limited while inserting flows
- Fewer outliers

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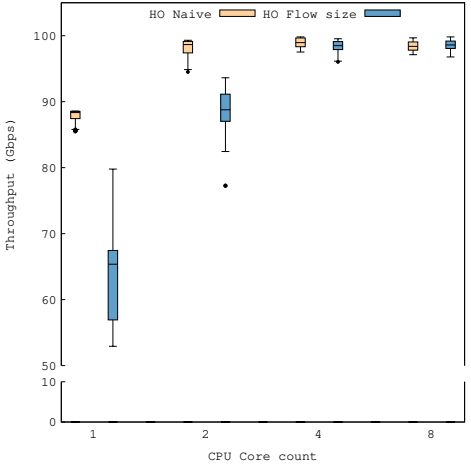

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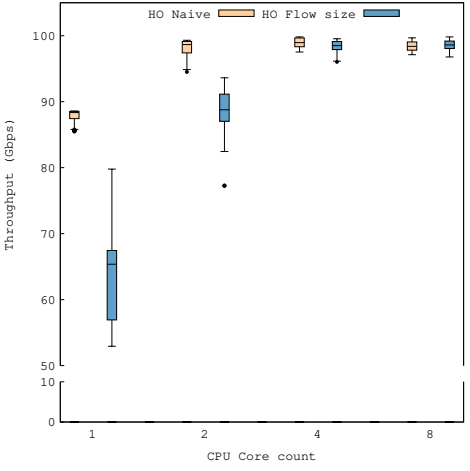
Results optimally offloading 2M Hash Table Entries 2M Flows

- After insertions performance seem better for the naive solution



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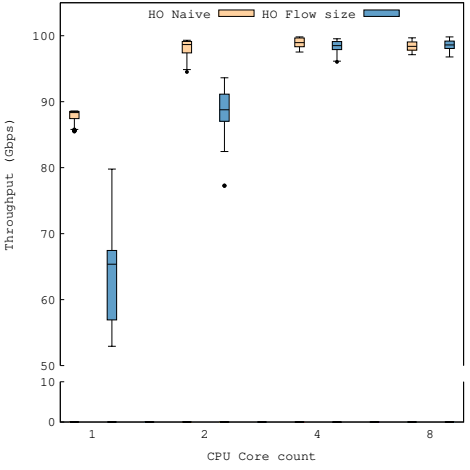

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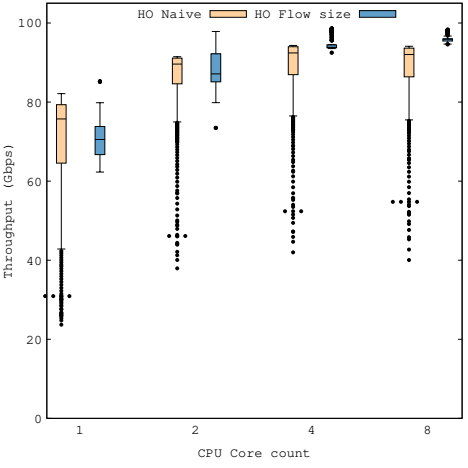

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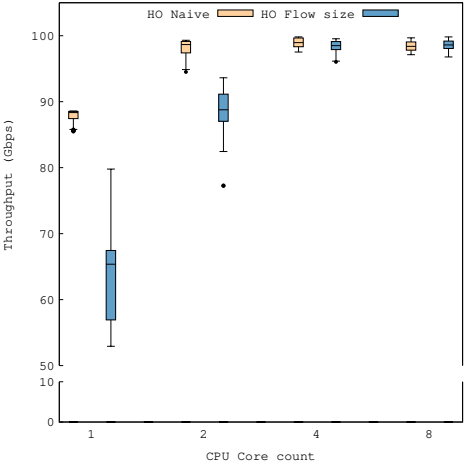


Figure 9: Run 2

Results optimally offloading 16M Hash Table Entries 8M Flows

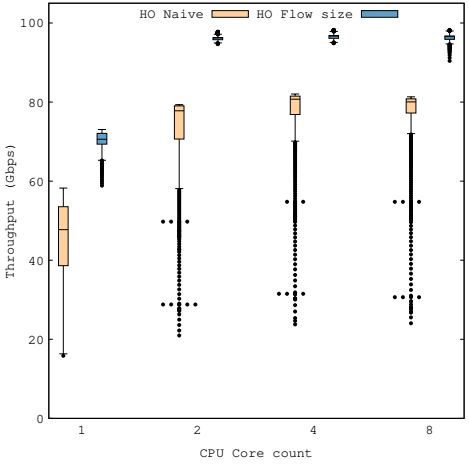


Figure 10: Run 1

Results optimally offloading 16M Hash Table Entries 8M Flows

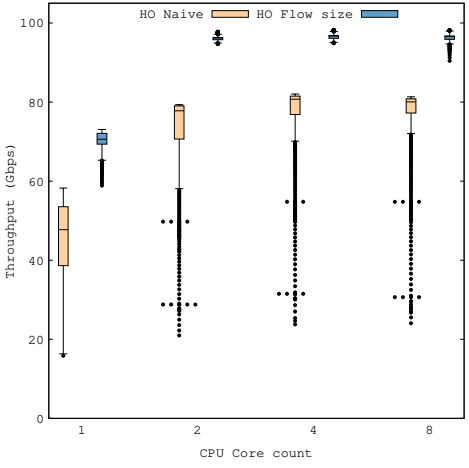


Figure 10: Run 1

- Amount of flows increased

Results optimally offloading 16M Hash Table Entries 8M Flows

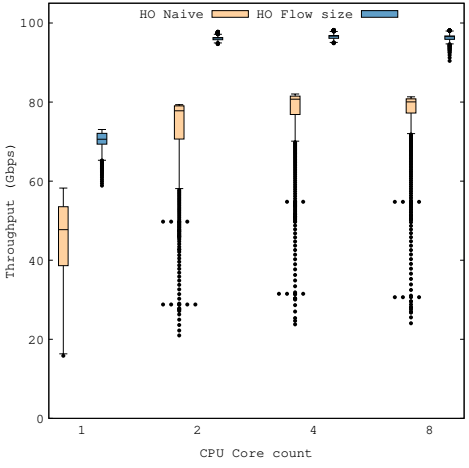


Figure 10: Run 1

- Amount of flows increased
- Selective variant runs away in throughput during insertion

Results optimally offloading 16M Hash Table Entries 8M Flows

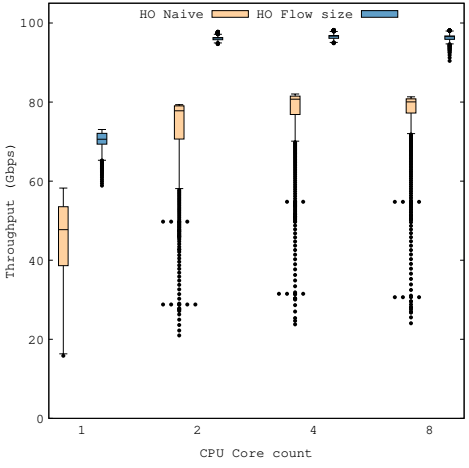


Figure 10: Run 1

- Amount of flows increased
- Selective variant runs away in throughput during insertion
- More outliers than previously

Results optimally offloading 16M Hash Table Entries 8M Flows

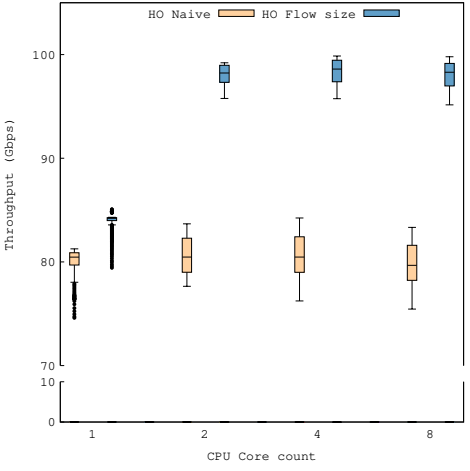


Figure 11: Run 2

Results optimally offloading 16M Hash Table Entries 8M Flows

- The previously seen increase in throughput holds up the second run

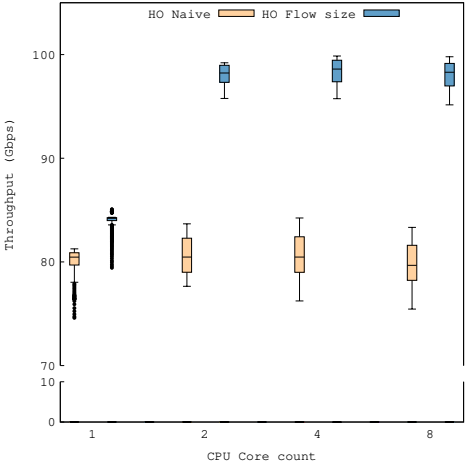


Figure 11: Run 2

Results optimally offloading 16M Hash Table Entries 8M Flows

- The previously seen increase in throughput holds up the second run
- The naive solution don't seem as performant as before when the amount of flows increase

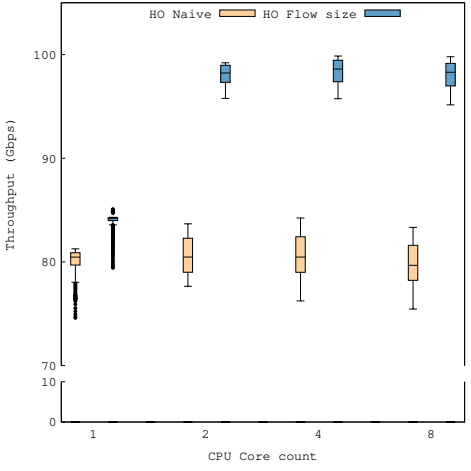


Figure 11: Run 2

Results optimally offloading 16M Hash Table Entries 8M Flows

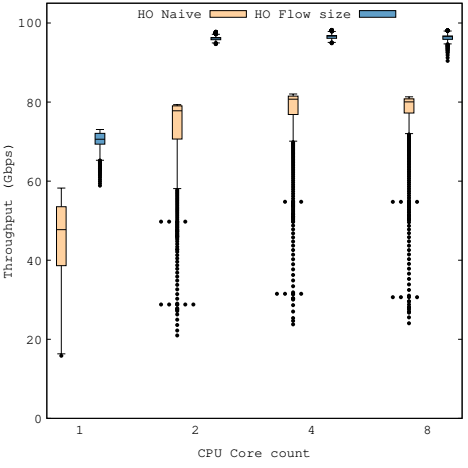
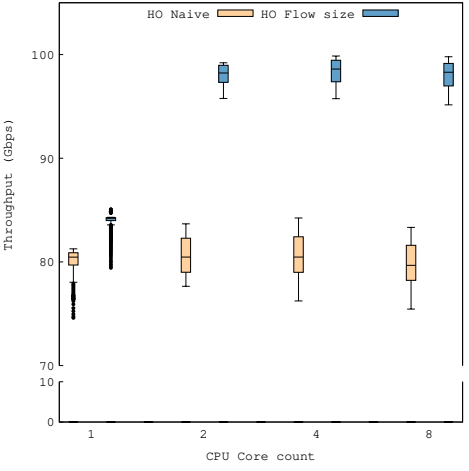


Figure 10: Run 1



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Conclusion

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Conclusion

- Hardware Offloading allow for higher packet throughput while using the same amount of clock cycles
- This comes at the expense of the need to insert the offloaded flows into hardware for classification
- This cost can be somewhat deterred by being selective with which flows to insert

References

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Thanks for listening

Questions?