



# The Path to DPDK Speeds for AF\_XDP

Magnus Karlsson, [magnus.karlsson@intel.com](mailto:magnus.karlsson@intel.com)

Björn Töpel, [bjorn.topel@intel.com](mailto:bjorn.topel@intel.com)

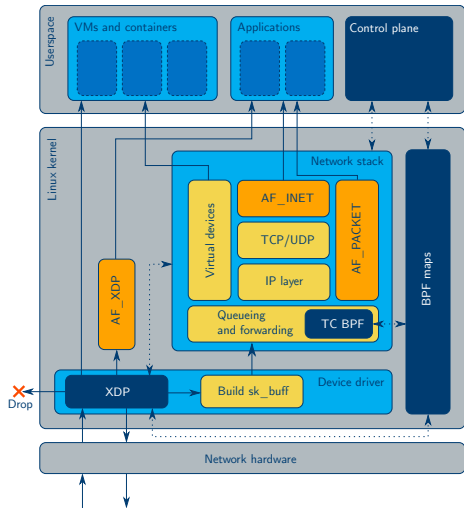
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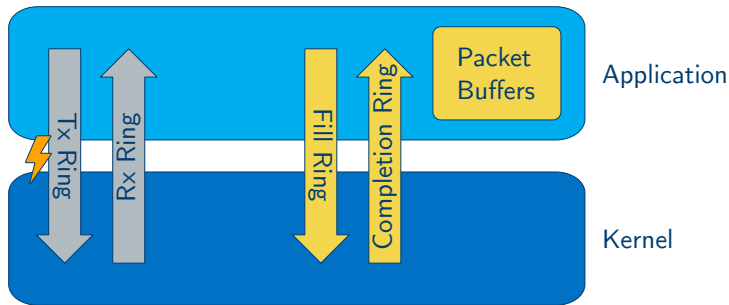
# XDP 101



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# AF\_XDP 101

- Ingress
  - Userspace XDP packet sink
  - XDP\_REDIRECT to socket via XSKMAP
- Egress
  - No XDP program
- Register userspace packet buffer memory to kernel (UMEM)
- Pass packet buffer ownership via descriptor rings



- Fill ring (to kernel) / Rx ring (from kernel)
- Tx ring (to kernel) / Completion ring (from kernel)
- Copy mode (DMA to/from kernel allocated frames, copy data to user)
- Zero-copy mode (DMA to/from user allocated frames)

# Baseline and optimization strategy

- Baseline
  - Linux 4.20
  - 64B @ ~15-22 Mpps
- Strategy
  - Do less (instructions)
  - Talk less (coherency traffic)
  - Do more at the same time (batching, i\$)
  - Land of Spectres: fewer retpolines, fewer retpolines, fewer retpolines

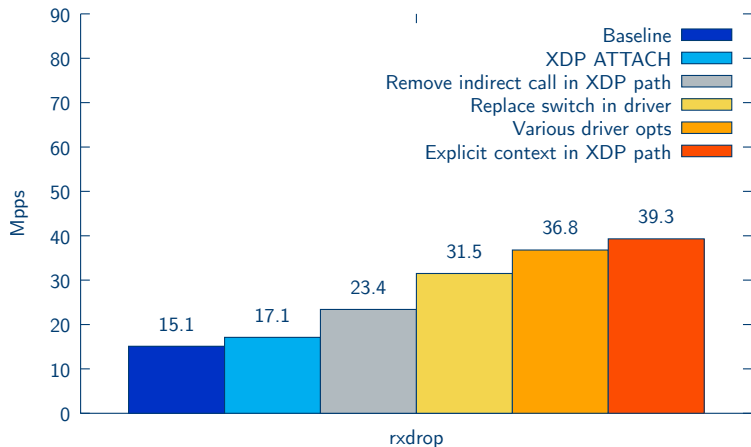
# Experimental Setup

- Broadwell E5-2660 @ 2.7GHz
- 2 cores used for run-to-completion benchmarks
- 1 core used for busy-poll benchmarks
- 2 i40e 40Gbit/s NICs, 2 AF\_XDP sockets
- Ixia load generator blasting at full 40 Gbit/s per NIC

- XDP\_ATTACH and bpf\_xsk\_redirect, attach at-most one socket per netdev queue, load built-in XDP program, 2-level hierarchy
- Remove indirect call, bpf\_prog\_run\_xdp
- Remove indirect call, XDP actions switch-statement ( $\geq 5 \implies$  jump table)
- Driver optimizations (batching, code restructure)
- bpf\_prog\_run\_xdp, xdp\_do\_redirect and xdp\_do\_flush\_map: per-CPU struct bpf\_redirect\_info + struct xdp\_buff + struct xdp\_rxq\_info vs explicit, stack-based context

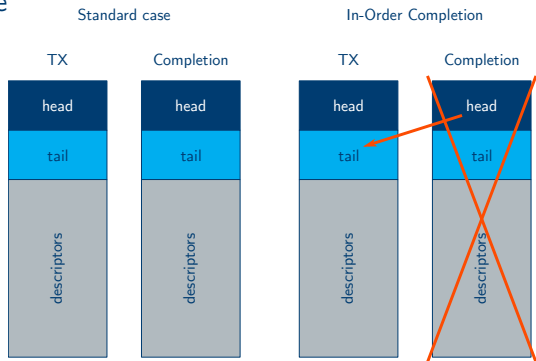


# Ingress, results, data not touched

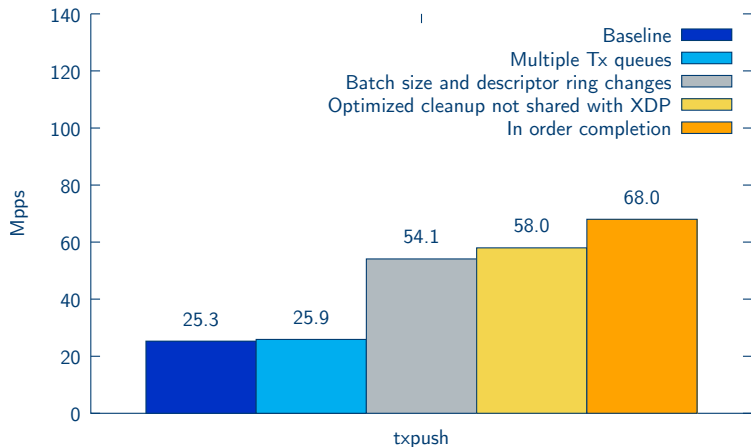


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- Tx performance capped per HW queue  
⇒ multiple Tx sockets per UMEM
- Larger/more batching, larger descriptor rings
- Dedicated AF\_XDP HW Tx queues
- In-order completion, setsockopt XDP\_INORDER\_COMPLETION

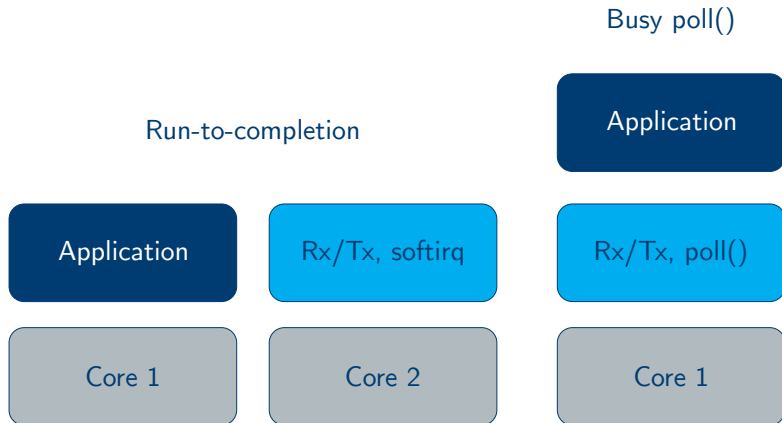


## Egress, results, data not touched

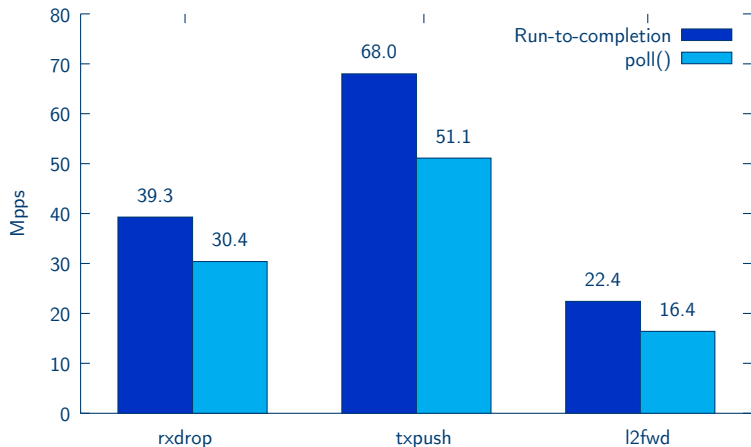


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## Busy poll() vs run-to-completion



## Busy poll() vs run-to-completion, results

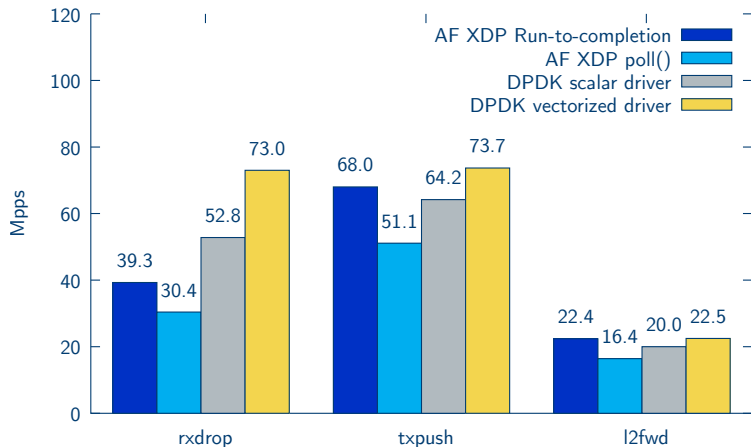


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## Comparison with DPDK

- Userspace, vectorized drivers
- “Learning from the DPDK” [http://vger.kernel.org/netconf2018\\_files/StephenHemminger\\_netconf2018.pdf](http://vger.kernel.org/netconf2018_files/StephenHemminger_netconf2018.pdf)

## Comparison with DPDK, results



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## Next steps

Upstream!

- XDP: switch-statement
- Rx/Tx: drivers
- Rx: XDP\_ATTACH and bpf\_xsk\_redirect
- libbpf AF\_XDP support
- Tx: multiple Tx sockets per UMEM
- selftest, samples



## Future work

- Hugepage support, less fill ring traffic (`get_user_pages`)
- `fd.io/VPP` work vectors (`i$`, explicit batching in function calls)
- “XDP first” drivers
- Collaborate/share code with RDMA (e.g. `get_user_pages`)
- Type-writer model (currently not planned)

## Summary

- Rx 15.1 to 39.3 Mpps (2.6x)
- Tx 25.3 to 68.0 Mpps (2.7x)
- Busy poll() promising
- DPDK still faster for “notouch”, but AF\_XDP on par when data is touched
- Drivers need to change when skb is not the only consumer

# Thanks!

- Ilias Apalodimas
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- William Tu
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- Jingjing Wu
- Qi Zhang

AF XDP

The logo features the text "AF XDP" in a bold, italicized, white sans-serif font. The letters have a slight 3D effect with thin outlines. Below the text are three white, curved, parallel lines that sweep from left to right, suggesting speed or motion. The entire graphic is set against a solid blue background.