Control and forwarding plane separation on an open-source router

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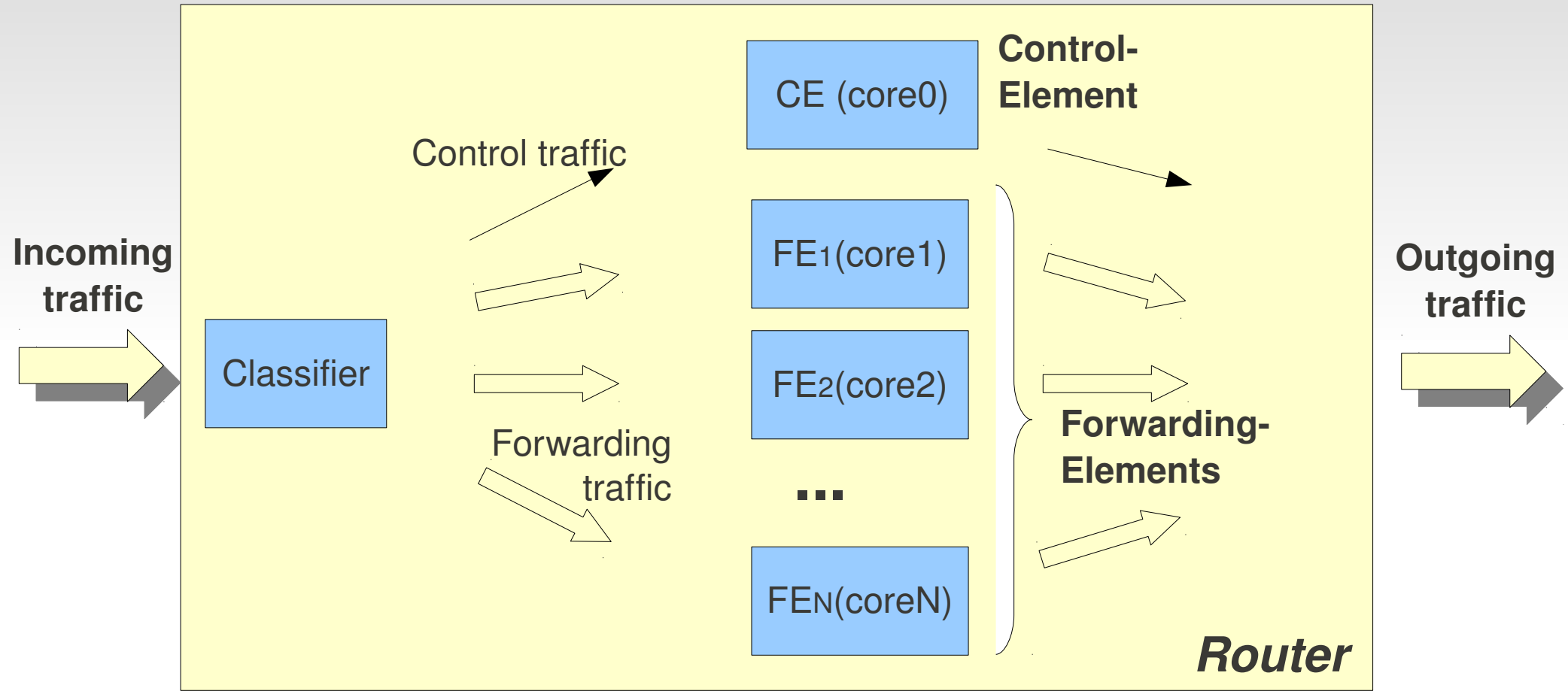
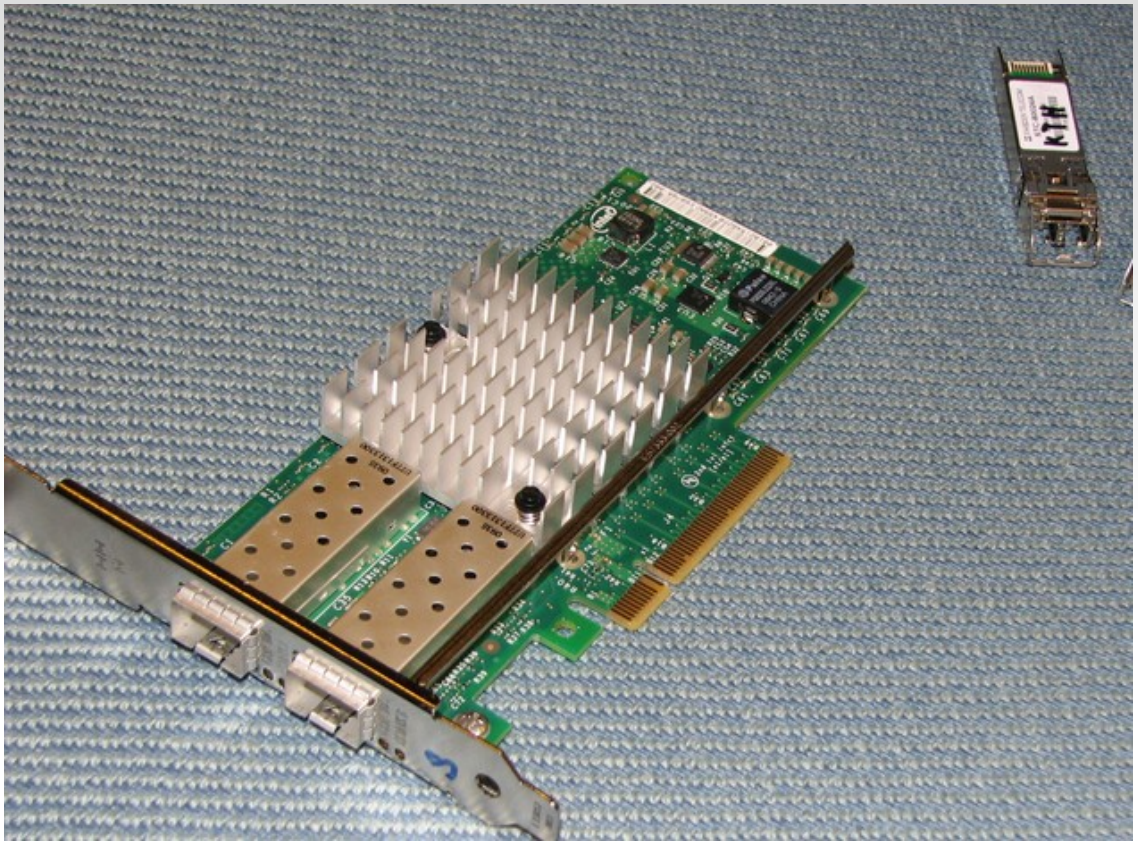
SUMMARY VERSION

Control-plane separation on a multi-core



Hardware - NIC



Intel 10g board Chipset 82599 with SFP+

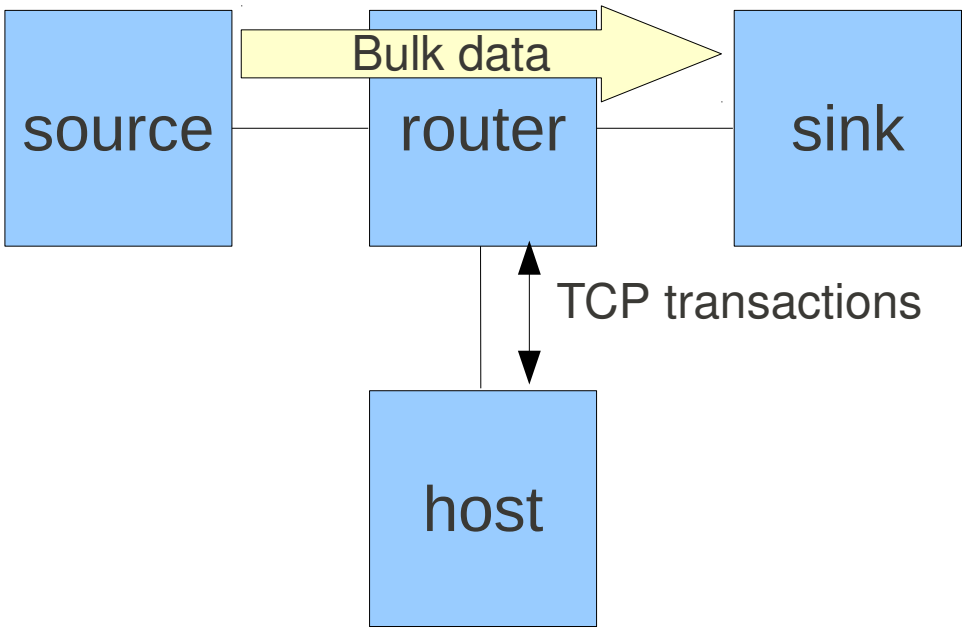
Open chip specs. Thanks Intel!

Classification in the Intel 82599

The classification in the Intel 82599 consists of several steps, each is programmable.
This includes:
- ***RSS*** (Receiver-side scaling): hashing of headers and load-balancing
- ***N-tuples***: explicit packet header matches
- ***Flow-director***: implicit matching of individual flows.

Experiment 1:
flow separation external source

- Bulk forwarding data from source to sink (10Gb/s mixed packet lengths)
- Netperf's TCP transactions emulated control data from a separate host
- Study latency of TCP transactions



N-tuple or Flowdirector

ethtool -K eth0 ntuple on

ethtool -U eth0 flow-type tcp4 src-ip 0x0a0a0a01 src-ip-mask
0xFFFFFFFF dst-ip 0 dst-ip-mask 0 src-port 0 src-port-mask 0
dst-port 0 dst-port-mask 0 vlan 0 vlan-mask 0 user-def 0
user-def-mask 0 action 0

ethtool -u eth0

N-tuple is supported by SUN Niu and Intel ixgbe driver.

Actions are: 1) queue 2) drop

But we were lazy and patched ixgbe for ssh and BGP to use CPU0

N-tuple or Flowdirector

Even more lazy... we found the flow-director was implicitly programmed by outgoing flows. So both incoming and outgoing would use the same queue.

So if we set affinity for BGP, sshd etc we could avoid the N-tuple filters

Example:
taskset -c 0 /usr/bin/sshd

Neat....

RSS is still using CPU0

So we both got our “selected traffic”
Plus the bulk traffic from RSS

We just want RSS to use “other” CPU's

Patching RSS

Just a one-liner...

```
diff --git a/drivers/net/ixgbe/ixgbe_main.c b/drivers/net/ixgbe/ixgbe_main.c
index 1b1419c..08bbd85 100644
--- a/drivers/net/ixgbe/ixgbe_main.c
+++ b/drivers/net/ixgbe/ixgbe_main.c
@@ -2379,10 +2379,10 @@ static void ixgbe_configure_rx(struct ixgbe_adapter *adapter)
        mrqc = ixgbe_setup_mrqc(adapter);

        if (adapter->flags & IXGBE_FLAG_RSS_ENABLED) {
-               /* Fill out redirection table */
-               for (i = 0, j = 0; i < 128; i++, j++) {
+               /* Fill out redirection table but skip index 0 */
+               for (i = 0, j = 1; i < 128; i++, j++) {
                        if (j == adapter->ring_feature[RING_F_RSS].indices)
-                               j = 0;
+                               j = 1;
                        /* reta = 4-byte sliding window of
                         * 0x00..(indices-1)(indices-1)00..etc. */
                        reta = (reta << 8) | (j * 0x11);
```

Patching RSS

CPU-core	0	1	2	3	4	5	6	7
Number of packets	0	196830	200860	186922	191866	186876	190106	190412

No traffic to CPU core 0 still RSS gives fairness between other cores

Don't let forwarded packets program the flowdirector

A new one-liner patch....

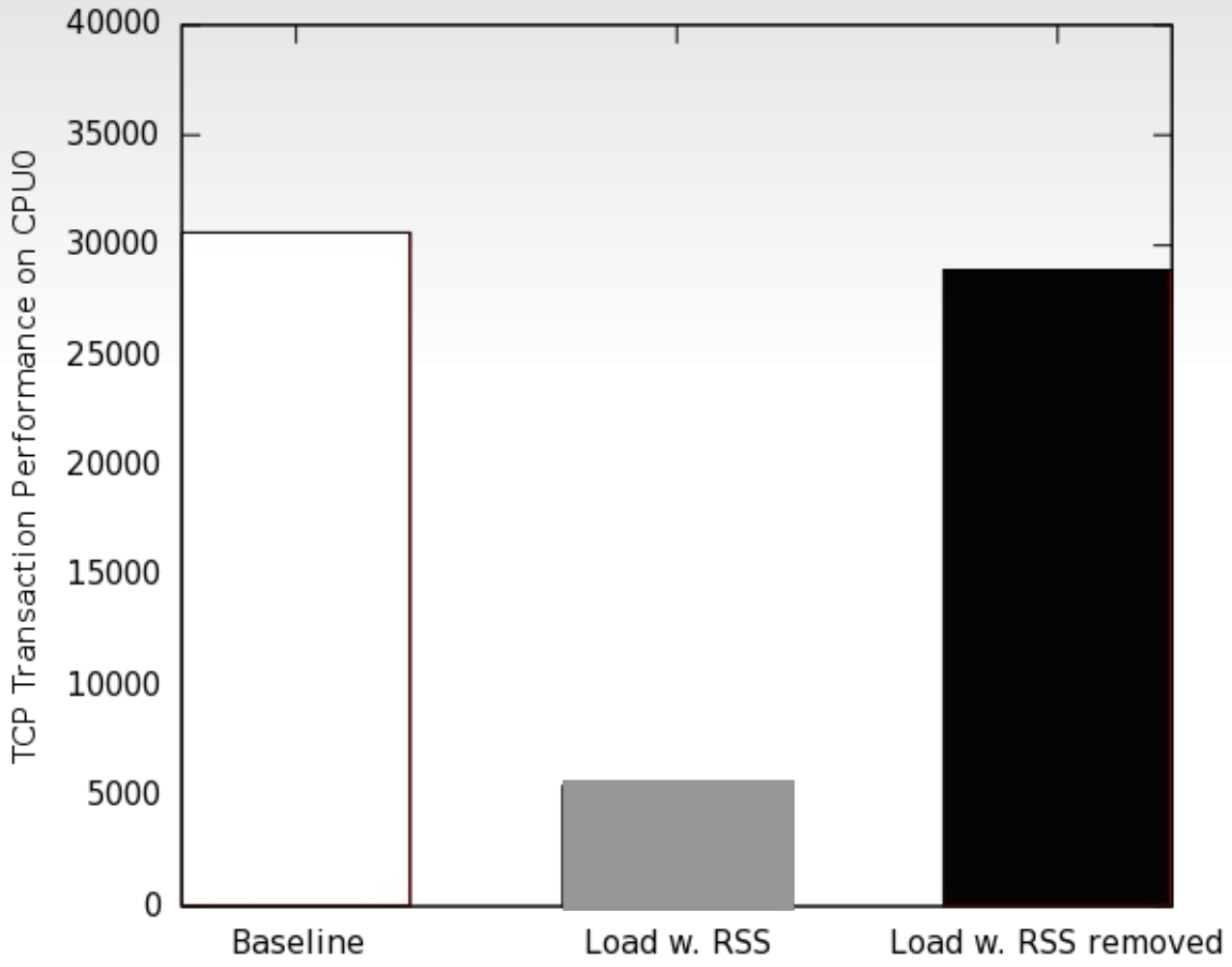
```
@@ -5555,6 +5555,11 @@ static void ixgbe_atr(struct ixgbe_adapter *adapter, struct
sk_buff *skb,
        u32 src_ipv4_addr, dst_ipv4_addr;
        u8 l4type = 0;

+       if(!skb->sk) {
+         /* ignore nonlocal traffic */
+         return;
+       }
+
        /* check if we're UDP or TCP */
        if (iph->protocol == IPPROTO_TCP) {
                th = tcp_hdr(skb);
```

Flow-director stats/1

```
fdir_maxlen: 0
fdir_maxhash: 0
fdir_free: 8191
fdir_coll: 0
fdir_match: 195
fdir_miss: 573632813    <--- Bulk forwarded data from RSS
fdir_ustat_add: 1       <--- Old ssh session
fdir_ustat_remove: 0
fdir_fstat_add: 6
fdir_fstat_remove: 0
fdir_maxlen: 0
```

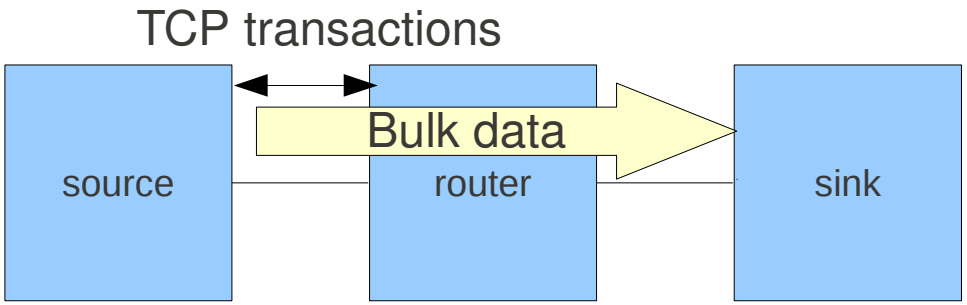
ustat → user stats
fstat → failed stats

Transaction latency using flow separation

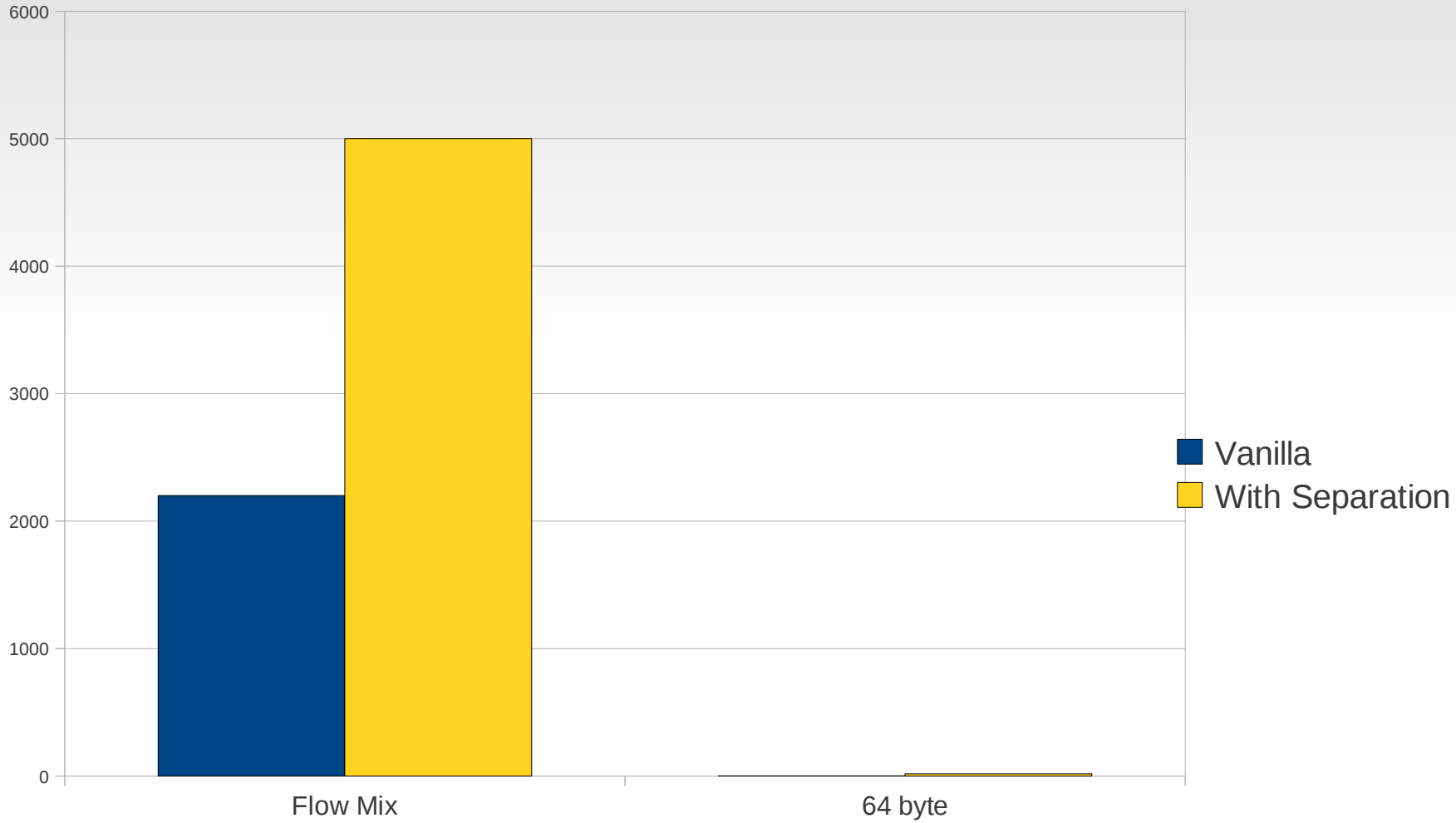


Experiment 2:
Flow separation in-line traffic

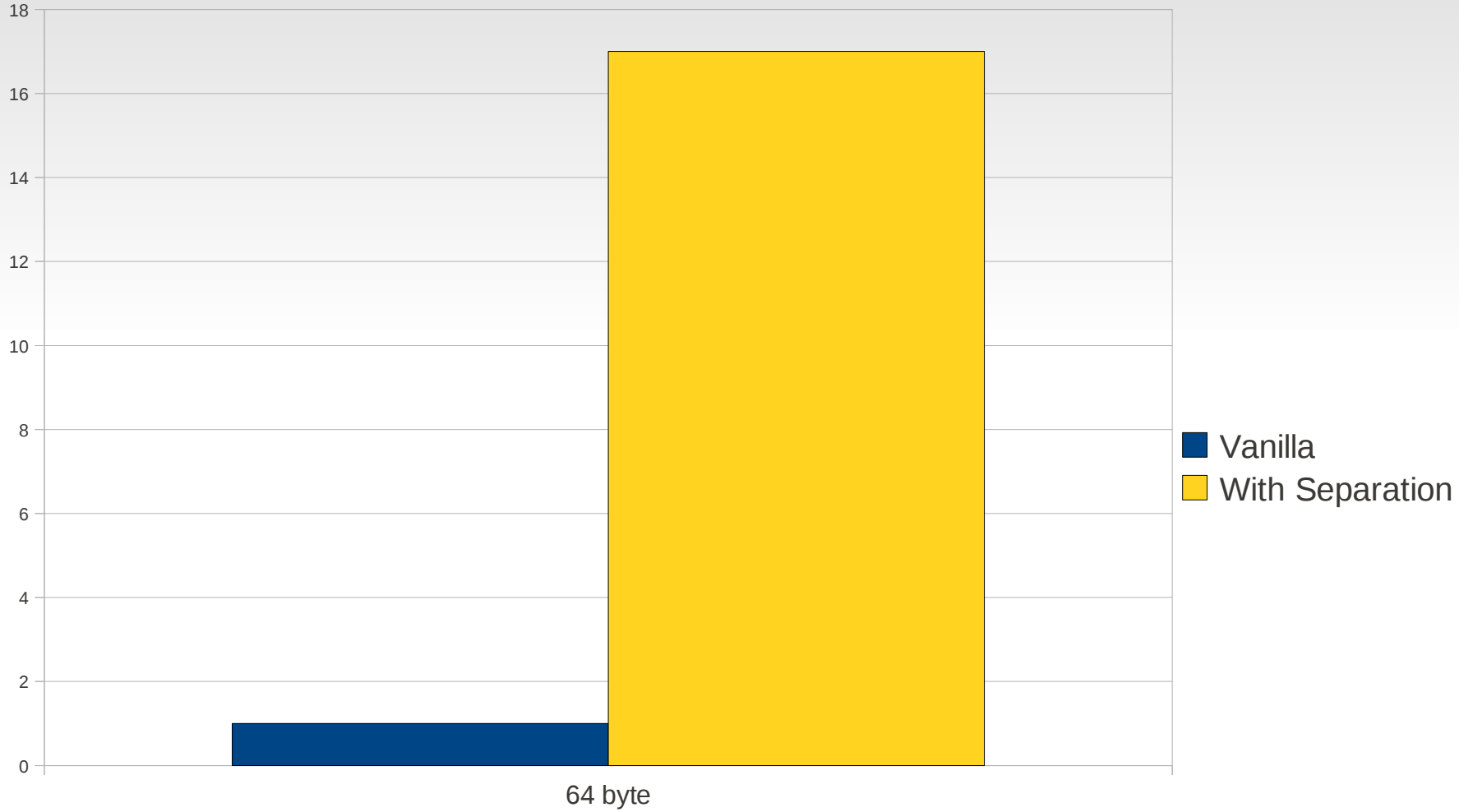
- Inline control within bulk data (on same incoming interface)
- Study latency of TCP transactions



Classifier issues/setup/1



Classifier issues/setup/2 (zoom in)



Classifier small packet problem

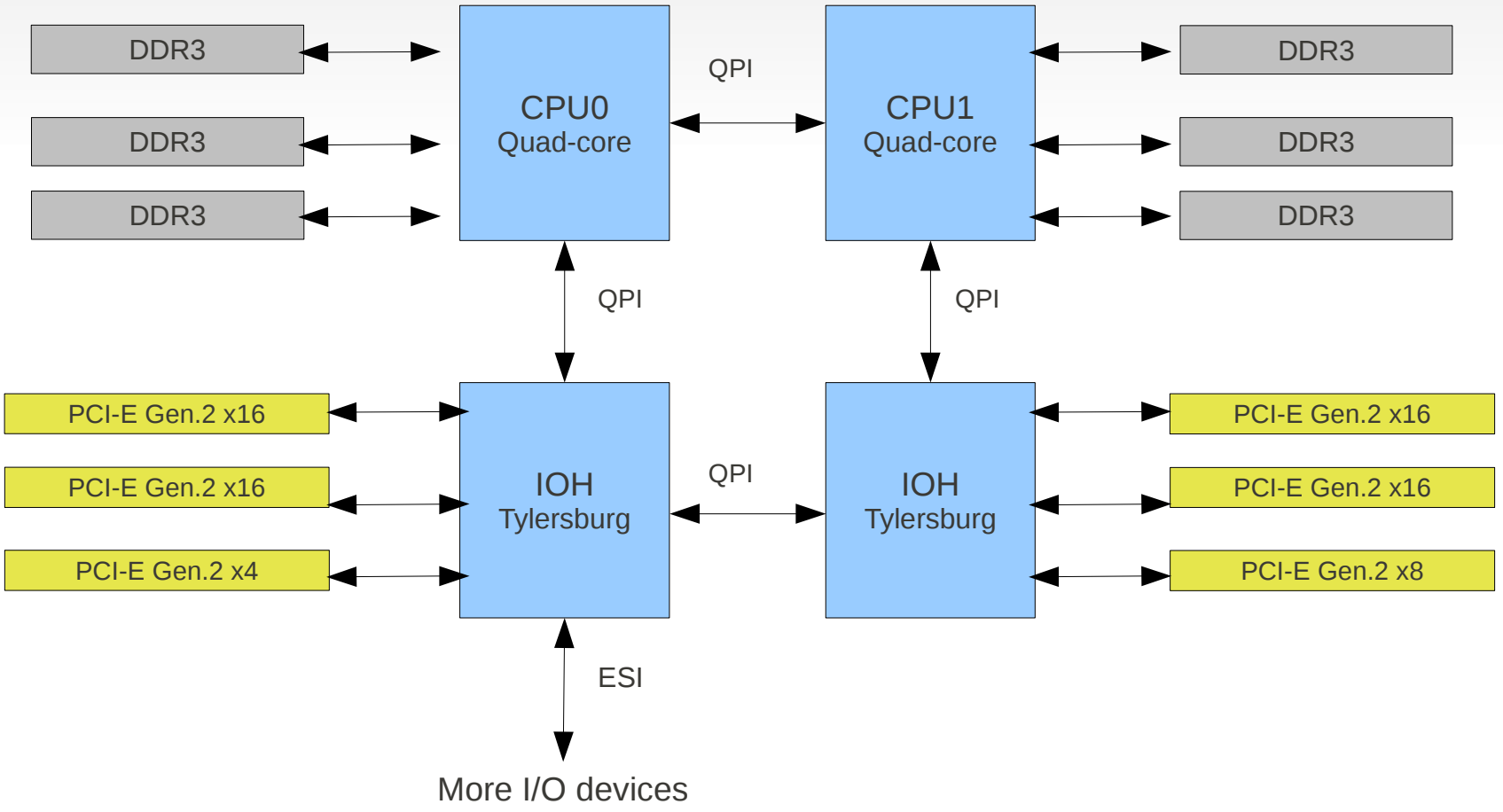
Seems we drop a lot packets before they are classified

DCB (Data Center Bridging) has a lot of features to prioritize different type of traffic. But only for IEEE 802.1Q

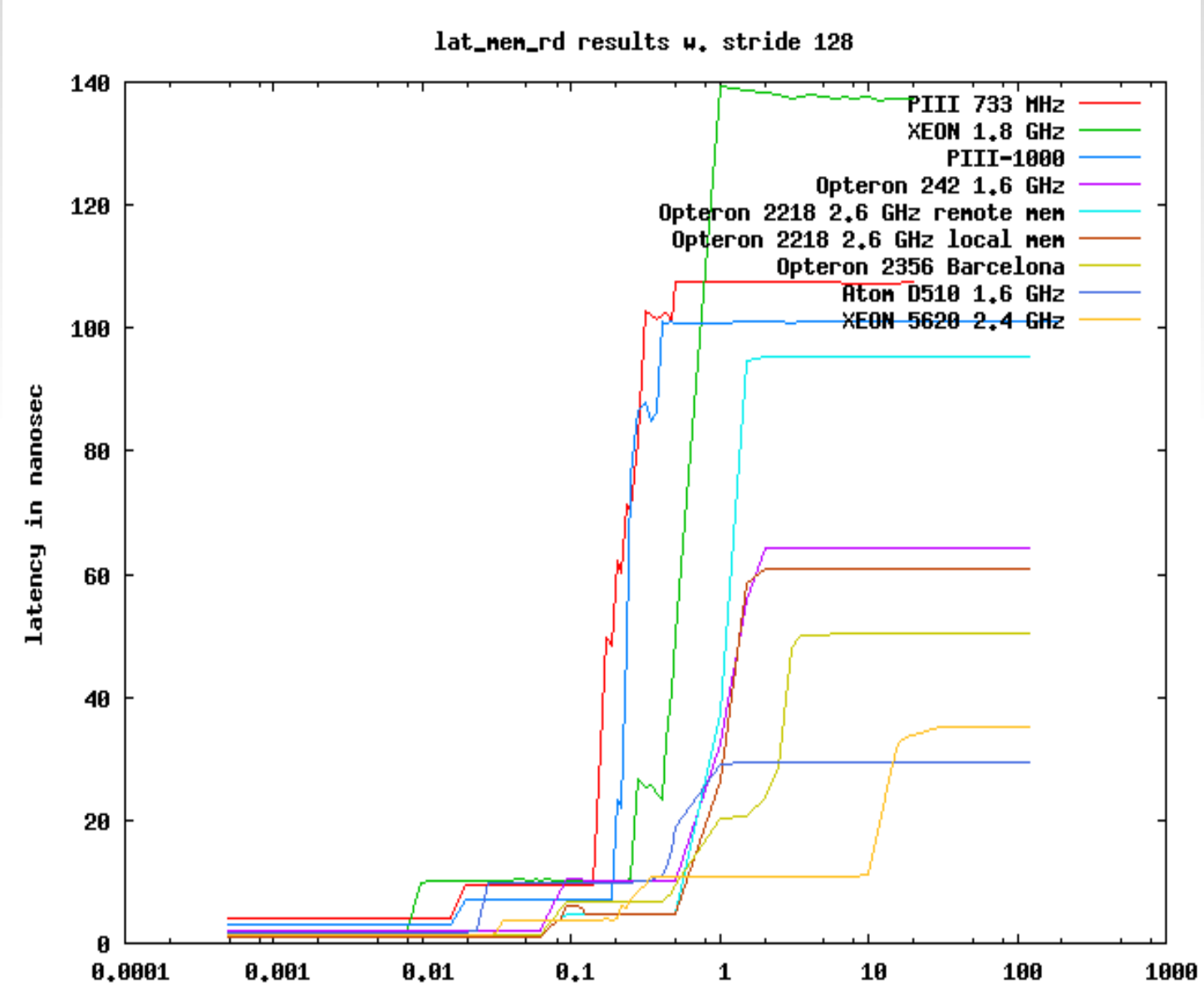
VMDq2 suggested by Peter Waskiewicz Jr at Intel

Experiment 3:
Flow separation in-line traffic

Investigate hardware limits by transmitting as much as possible from all cores simultaneously.



Hi-End Hardware/Latency

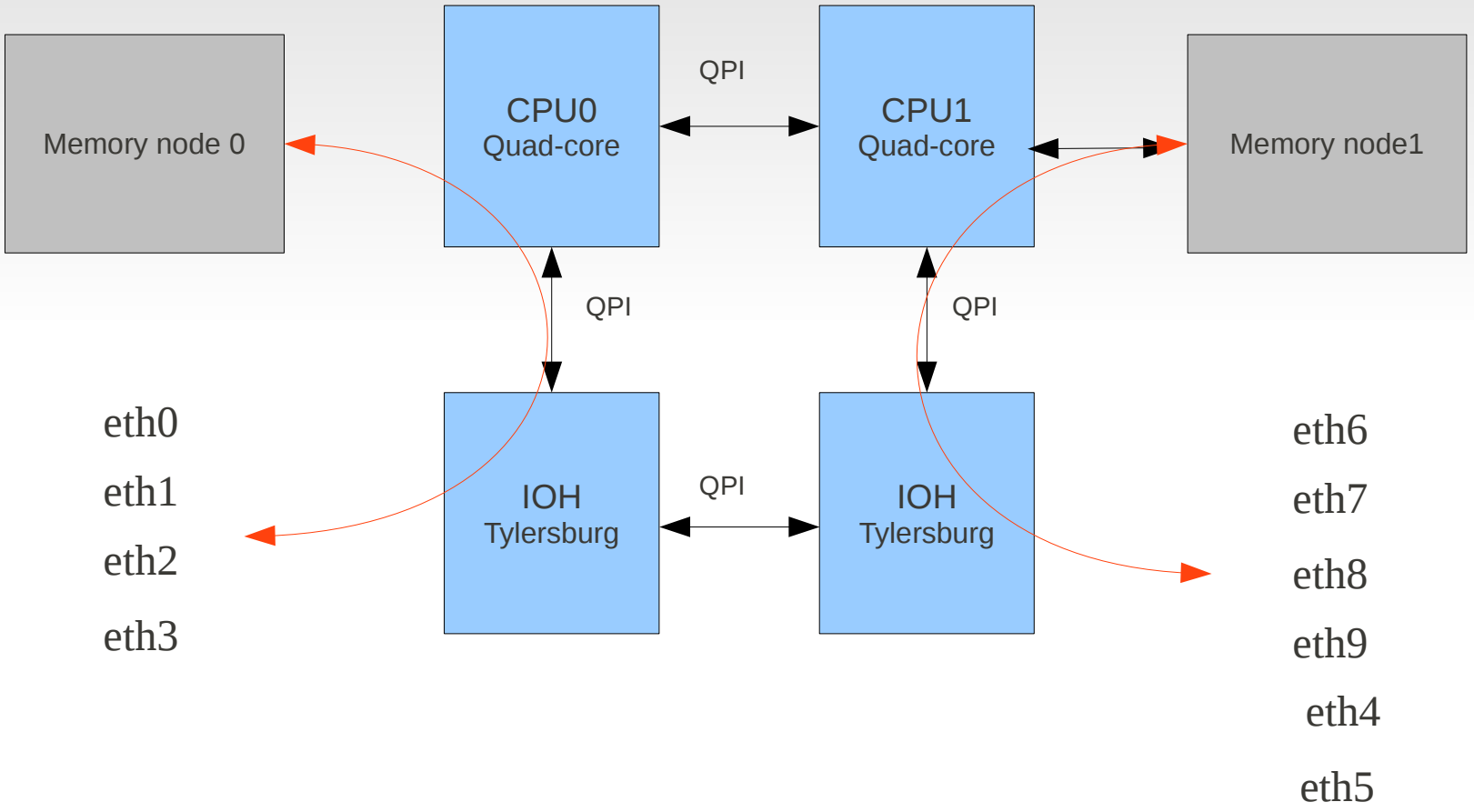


pktgen/setup

Inter-face	eth0	eth1	eth2	eth3	eth4	eth5	eth6	eth7	eth8	eth9
CPU-core	0	1	2	3	4	5	6	7	12	13
Mem node	0	0	0	0	1	1	1	1	1	1

eth4, eth5 on x4 slot

Setup


Memory node 0
CPU0
Quad-core
QPI
CPU1
Quad-core
Memory node1
QPI
QPI
eth0
eth1
eth2
eth3
IOH
Tylersburg
QPI
IOH
Tylersburg
eth6
eth7
eth8
eth9
eth4
eth5

TX w. 10 * 10g ports 93Gb/s “Optimal”

That's all

Questions?