EXPLORING AND OPTIMIZING SCALABILITY FOR HIGH PERFORMANCE VIRTUAL SWITCHING

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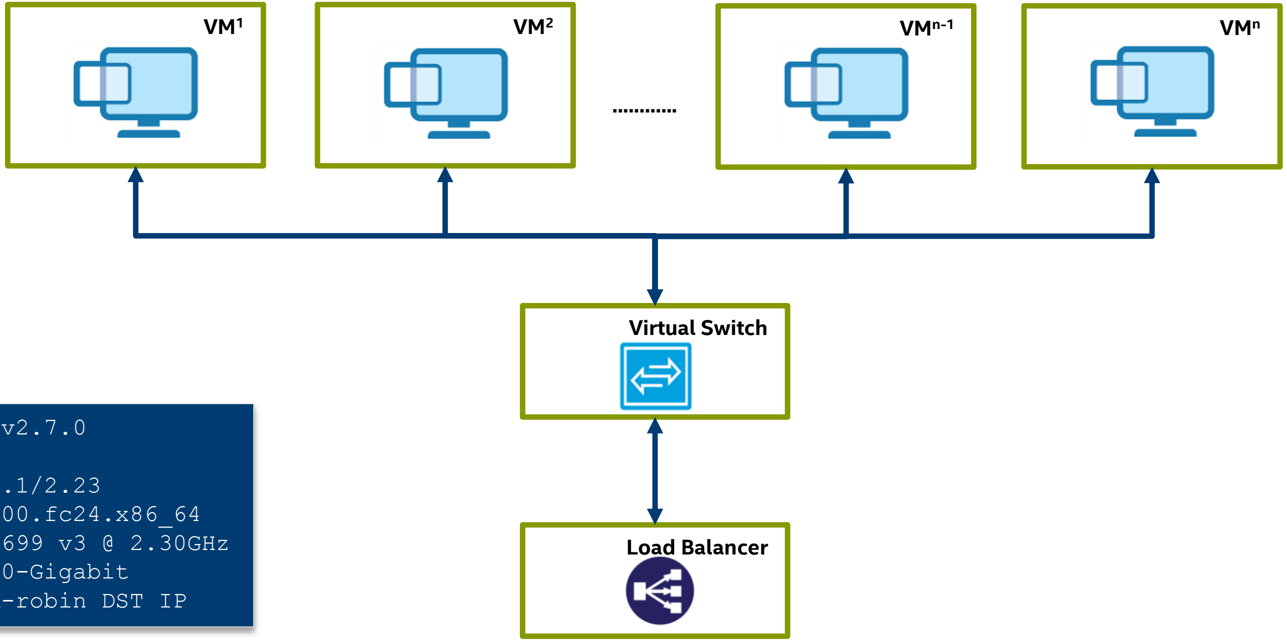
A Typical Use Case

Cloud computing multi-tenancy



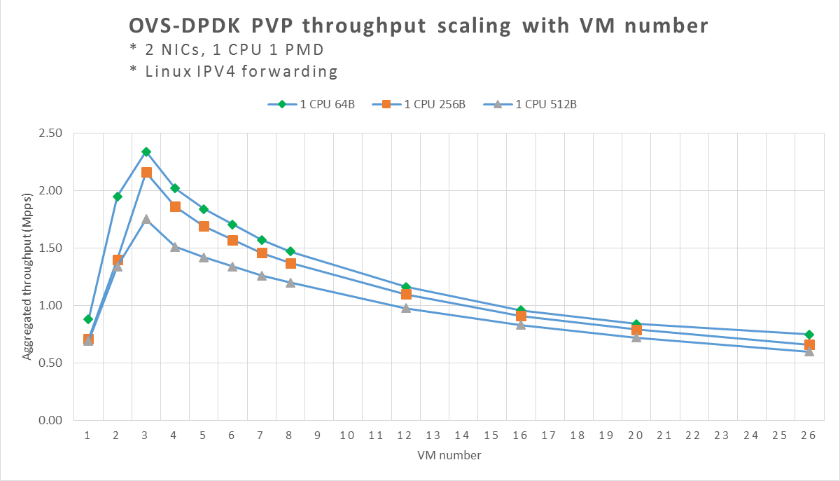
Open vSwitch: v2.7.0
DPDK: 17.02
GCC/GLIBC: 6.2.1/2.23
Linux: 4.7.5-200.fc24.x86_64
CPU: Xeon E5-2699 v3 @ 2.30GHz
NIC: 82599ES 10-Gigabit
Traffic: Round-robin DST IP

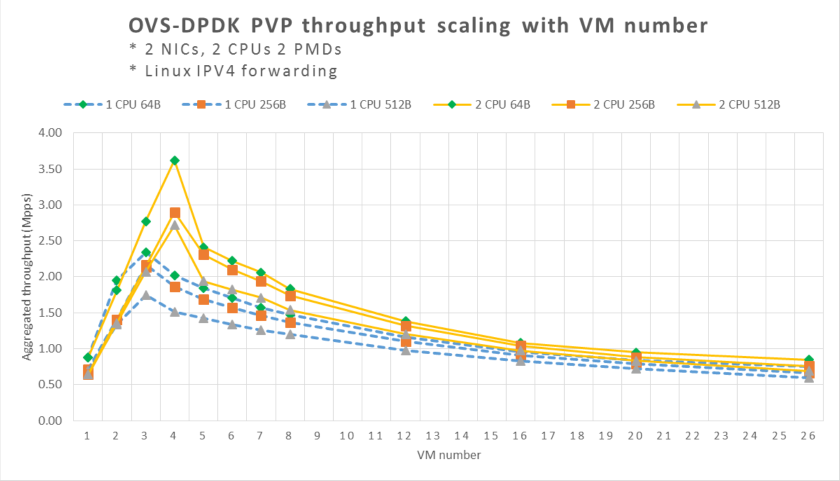
OvS-DPDK Scalability AS IS

Throughput drops significantly as the number of guests increases

Performance doesn't scale by increasing the number of CPUs

Lack of clear guidelines for customer deployment

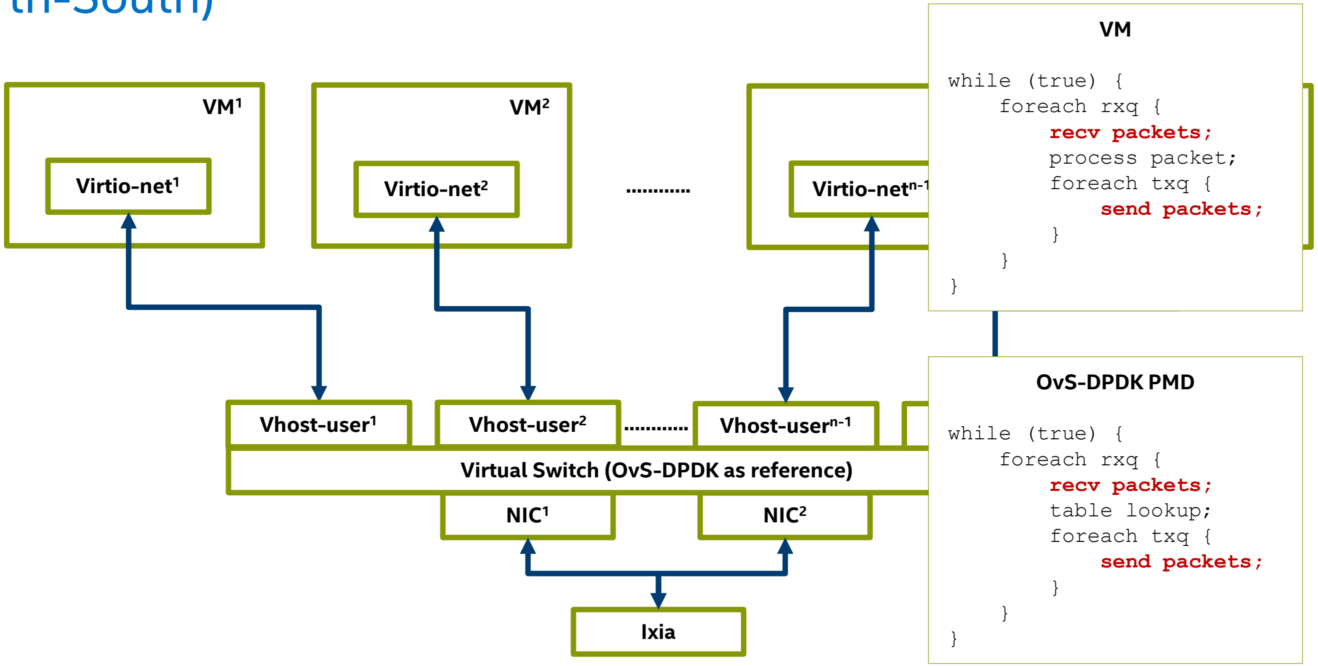




* Test and System Configurations: Estimates are based on internal Intel analysis using Intel® Server Board S2600WT, Intel(R) Xeon(R) CPU E5-2699 v3 @ 2.30GHz, Intel® 82599ES 10 Gigabit Ethernet Controller

Datapath Abstraction

PVP (North-South)



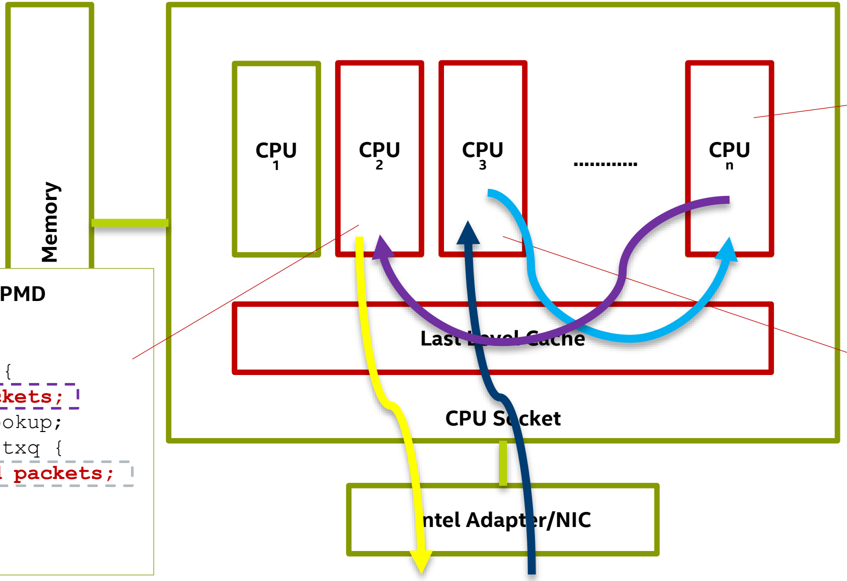

```
while (true) {
    foreach rxq {
        recv packets;
        process packet;
        foreach txq {
            send packets;
        }
    }
}
```

```
while (true) {
    foreach rxq {
        recv packets;
        table lookup;
        foreach txq {
            send packets;
        }
    }
}
```

Mapping To Hardware

VM

```
while (true) {
    foreach rxq {
        recv packets;
        process packet;
        foreach txq {
            send packets;
        }
    }
}
```



OvS-DPDK PMD

```
while (true) {
    foreach rxq {
        recv packets;
        table lookup;
        foreach txq {
            send packets;
        }
    }
}
```

OvS-DPDK PMD

```
while (true) {
    foreach rxq {
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            send packets;
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}
```

Analysis

Cache efficiency

CPU efficiency

CPU utilization

Work hard

Work smart

Multitasking

=

Good hardware work ethic

So-called optimization

Cache Efficiency: Maximize Burst Size

Vhost Tx Fragmentation: 1 burst for multiple guests

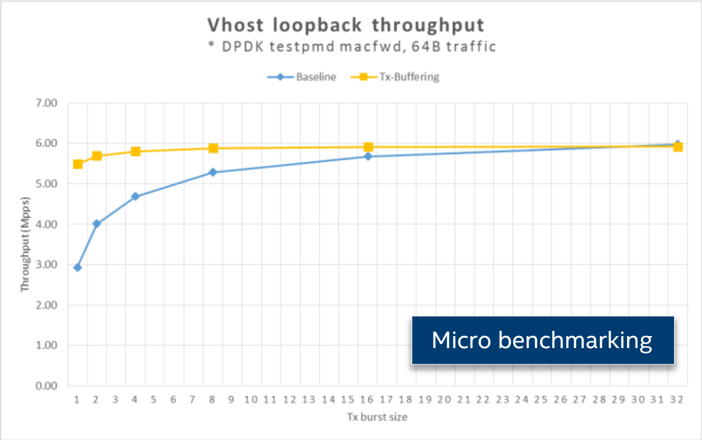
How does it impact? Poor cache efficiency!

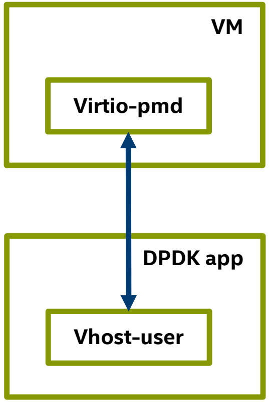
The solution: Tx-Buffering

Side effects: Increase of latency

Narrow the gap

- For throughput peaks only
- Timeout settings tuning





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CPU Efficiency: Minimize Empty Polling

Allocate CPU based on expected traffic model

- NIC cycle per 64B packet: ~30
- Vhost cycle per 64B packet: ~70 + memory latency
- NIC Rx + Vhost Tx ~= Vhost Rx + NIC Tx

```
[root]# ./ovs-appctl dpif-netdev/pmd-rxq-show
pmd thread numa_id 0 core_id 13:
        isolated : false
        port: Vhost-user1       queue-id: 0
        port: Vhost-user2       queue-id: 0
        port: Vhost-user4       queue-id: 0
pmd thread numa_id 0 core_id 12:
        isolated : false
        port: dpdk0     queue-id: 0
        port: Vhost-user3       queue-id: 0
```

The default core mapping doesn't fit for all

pmd-rxq-affinity

1:1 core allocation for NIC and Vhost if 1:1 north vs. south traffic

```
[root]# ./ovs-appctl dpif-netdev/pmd-rxq-show
pmd thread numa_id 0 core_id 13:
        isolated : true
        port: Vhost-user1       queue-id: 0
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        port: Vhost-user3       queue-id: 0
        port: Vhost-user4       queue-id: 0
pmd thread numa_id 0 core_id 12:
        isolated : true
        port: dpdk0     queue-id: 0
```
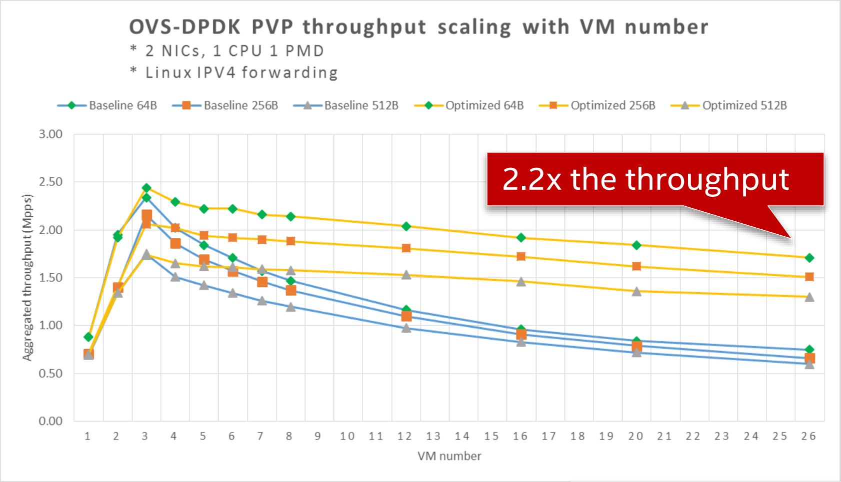
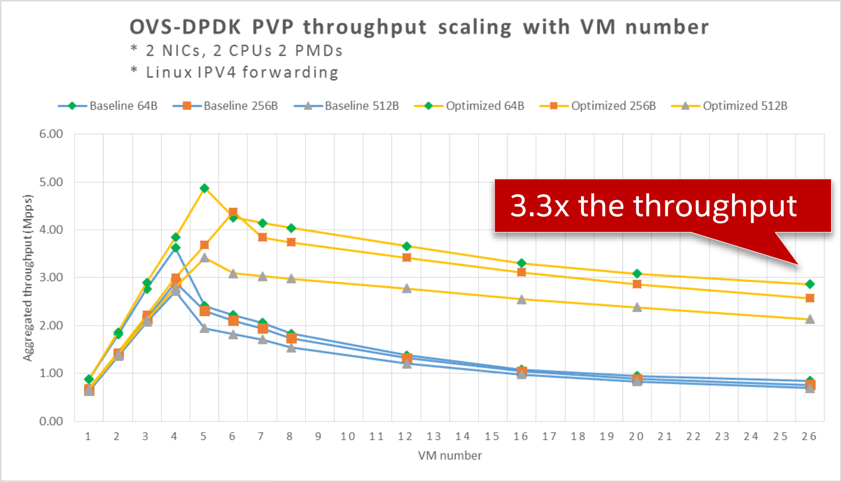

How Did We Do?

Not bad





Test based on a POC patch, OvS formal patch WIP

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CPU Utilization: Enable Hyper-Threading

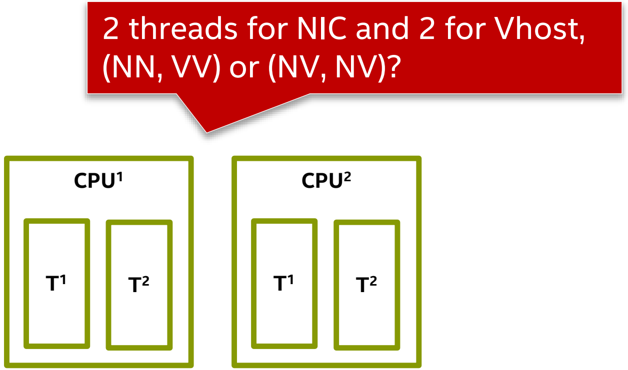
Does Hyper-Threading help? Yes!

- Hiding memory access latency
- Squeezing execution units

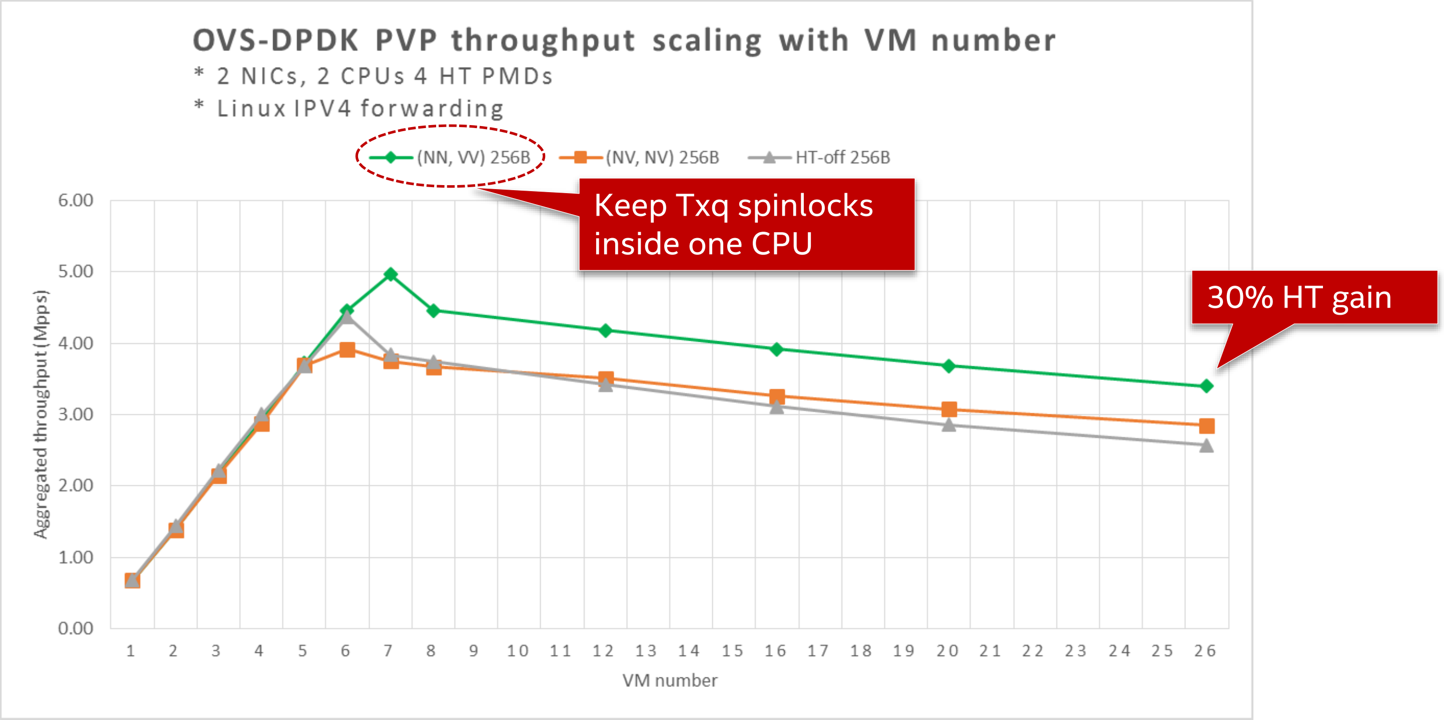
But don't spoil it!

- Keep spinlocks inside one CPU

Side effects: Again, increase of latency



Hyper-Threading Gain



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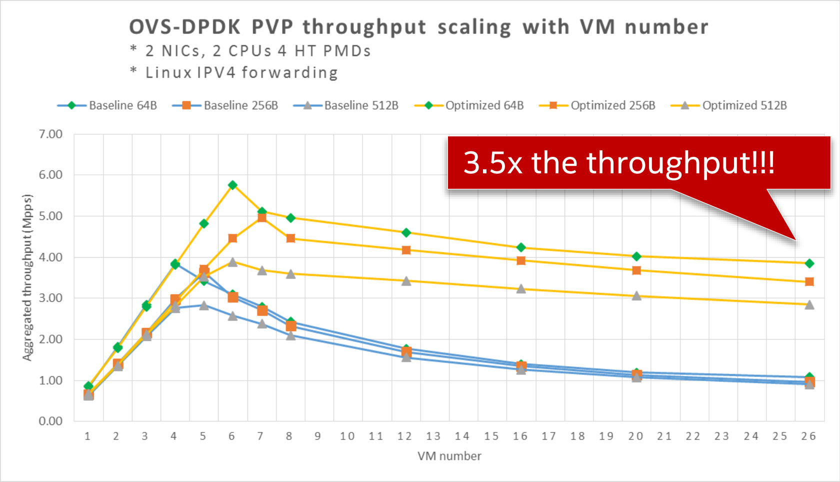
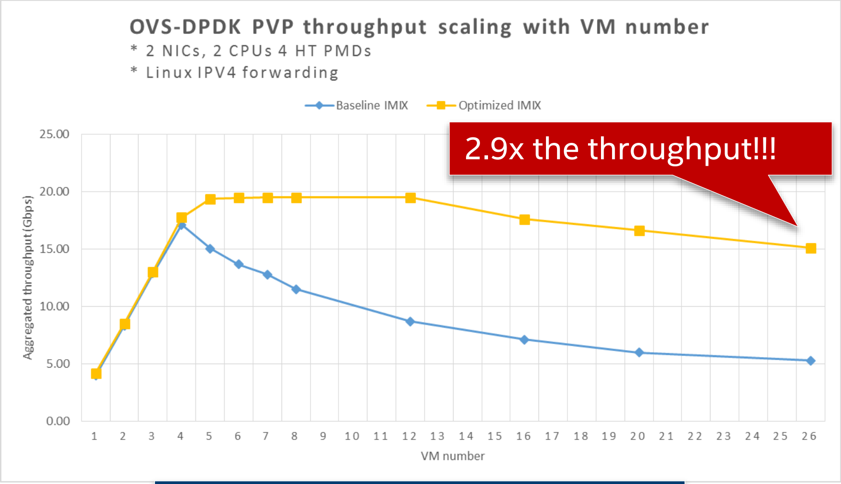
Finally, With All Due Optimization

About 3x the throughput





IMIX: Uniform distribution random [64, 1518]

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Latency Is The Price To Pay

Latency is increased due to

- Extra overhead of buffering mechanism
- Lower frequency due to Hyper-Threading

Latency is decided by

- Guests per PMD core (Round-Robin)
- Traffic pattern (How fragmented?)
- Tx-Buffering timeout settings

No silver bullet, only tradeoffs and priorities

Deployment Guideline

Enable Vhost Tx-Buffering for throughput

- Enable for throughput peaks dynamically
- Evaluate timeout settings carefully

Allocate CPU based on expected traffic model

Utilize Hyper-Threading for PMDs

- For 1 CPU, 1 HT for NIC, 1 HT for Vhost
- For 2 CPUs, 2 HTs on 1 CPU for NIC, 2 HTs on another for Vhost
- *For more than 2 CPUs, per case tuning is required*

experience
what's inside™