# Energy-Efficient Packet Classification for Network Function Virtualization

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## INTRODUCTION

Network Function Virtualization (NFV)

- has gained significant attention from network providers
- migrates network services (e.g., firewalls, proxies) from hardware appliances to virtualized software packages
- is becoming more important due to the widespread adoption of Internet devices and mobile phones

At the same time, reducing energy consumption particularly of large-footprint data centers becomes increasingly important to

- meet regulatory and environmental standards
- reduce the most expensive part of a provider's operational expenditure [3]

Recent studies (e.g., from Bell labs) have reported that 10% of the current operational expenditure of network providers accounts for energy consumption, and it is likely to rise in the next years [1].

## PACKET CLASSIFICATION

Packet classification is a key core technology of all NFV systems and it is done using various techniques, such as:

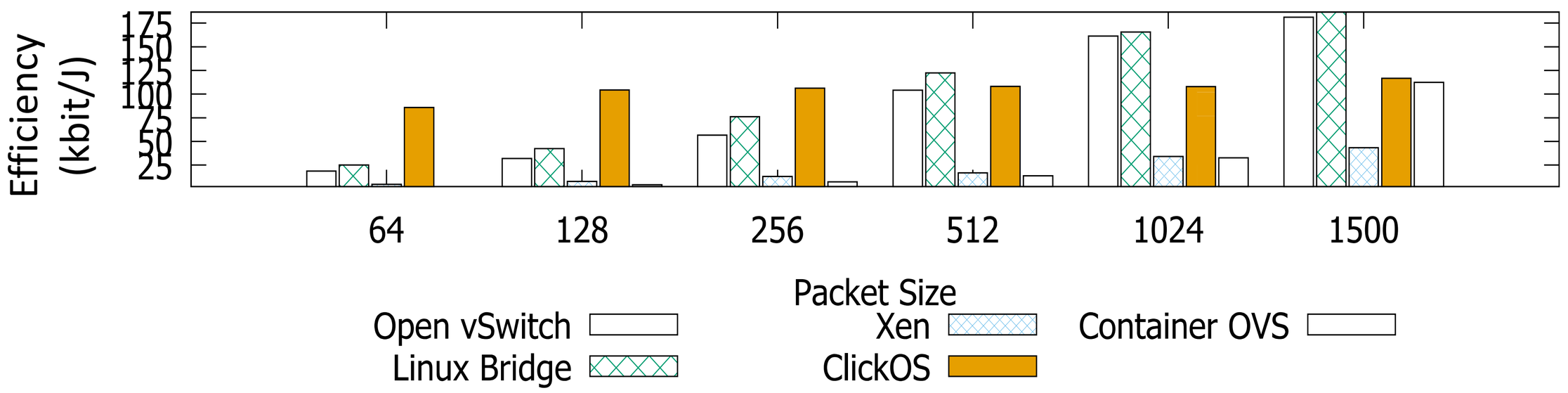
- using features of the network card (e.g., SR-IOV virtual interfaces to classify packets using the NIC's internal L2 switch)
- at various places in the operating system (e.g., interrupt or polling-based drivers)

The different ways of classification have different capabilities, use compute resources in different ways and therefore their suitability for a specific traffic and NFV application needs to be analysed.

| | | | |
|---|---|---|---|
| User-space | Fast Packet IO (Intel DPDK) | Virtual Switch (Open vSwitch, VALE, SnabbSwitch, OfSoftSwitch) | Custom Application |
| Kernel-space | Flexible Network IO (IOVisor/eBPF) | | Application Specific Kernel Module |
| Network card | Programmable NIC (NetFPGA) | Protocol Offload (TCP offload Engine) | Virtualization Offload (Intel SR-IOV) |

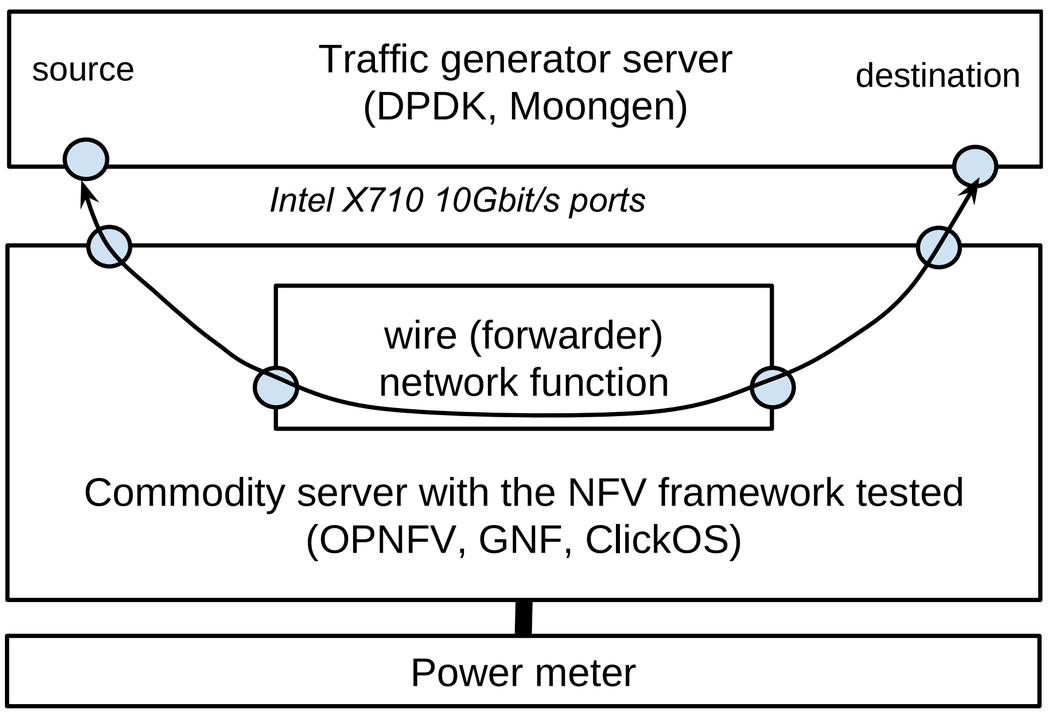
Few ways of classifying packets

## IMPACT OF PACKET SIZE ON ENERGY CONSUMPTION




Energy efficiency of packet forwarding in various NFV installations

## MEASUREMENT SETUP




Measurement setup in the lab

Our measurement setup consists of

- 10Gbit/s Intel X710 network cards
- DPDK-based packet generator (using Moongen [4])
- A power meter
- A commodity NFV server that we used to run NFV frameworks

## FUTURE WORK

Our work so far has focused on preliminary measurements and analyses. We have identified that energy consumption depends on packet size of the traffic the network function is applied to. Future work therefore can directions, such as:

1. Developing a NFV solution that optimizes energy consumption: Container-based, light-weight NFV solutions such as GNF [2] have proven low resource utilization in general and are therefore good candidates for energy-efficient NFV.
2. Working on an SDN-based traffic management to take energy consumption of classifiers used into account, in order to use an optimal one for all traffic (as an example, we don't want to use a DPI classifier for the traffic where packets need only a physical port-based inspection that can be done using less energy).

## REFERENCES

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[3] X. Fan, W.-D. Weber, and L. A. Barroso. Power provisioning for a warehouse-sized computer. In *ACM SIGARCH Computer Architecture News*, volume 35, pages 13–23. ACM, 2007.
[4] Emmerich, Paul, et al. "MoonGen: A Scriptable High-Speed Packet Generator." *Proceedings of the 2015 IMC*. ACM, 2015.