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RIPE71 - Bucharest, Romania

Scalable high-speed packet capture

Using OpenFlow and Intel DPDK

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Who am I?

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Introduction

We want to capture large-scale DDoS attacks without significant packet loss, why?

- Mitigation is hard
- In-depth analysis could provide valuable insights

Other uses of high-speed packet capture:

- Intrusion detection
- Monitoring (start your own NSA!)

The Problem

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Table: Cisco Visual Networking Index 2015

Year	2014	**2015**	2016	2017	2018	2019
PB per Month	59,8	**72,4**	88,4	109,0	135,5	168,0

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- Storing $\geq$1.25 Gigabytes per second

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Goal

A **scalable** system that is able to capture and generate packets at high speed (e.g. $\geq$**40 Gbit/s**)

Proposal

- Use DPDK (Data Plane Development Kit) to maximize single machine performance.

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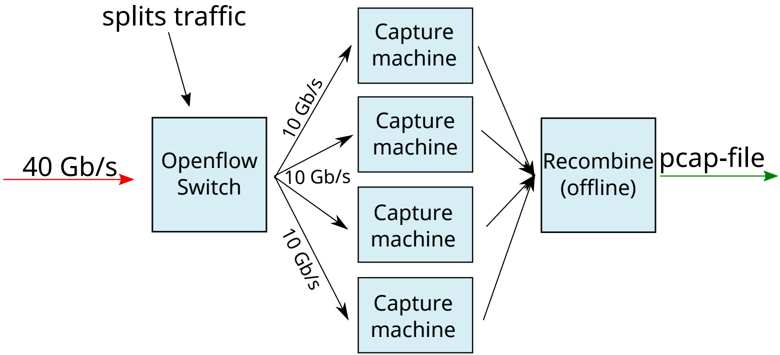
- Use OpenFlow-switches to distribute traffic over multiple machines

Proposal - Overview



Implementation - What is DPDK?

The **D**ata **P**lane **D**evelopment **K**it is a library for fast packet processing

Main features:

- Zero-Copy
- Fast buffers
- Designed for multicore

Zero-copy allows the network hardware to directly copy data to memory buffers using DMA

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Fast and thread-safe implementations of (ring) buffers making development of multithreaded applications much easier

DPDK
DATA PLANE DEVELOPMENT KIT

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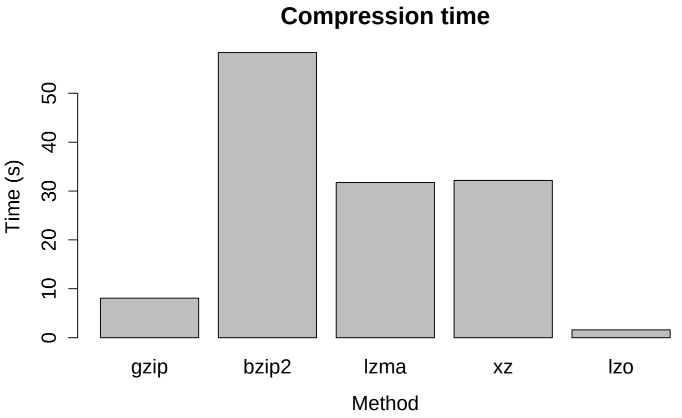
Has been designed from the ground up to support multiple cores, each thread runs on its own core

Implementation - Using DPDK

Capture 64-byte packets at 10 Gbit/s (1.25 GB/s or 1 DVD every 4 seconds) in PCAP-format on commodity hardware.

What to do with all this data?

Implementation - Adding compression



Compressing the linux kernel to a ram disk.

Source: http://catchchallenger.first-world.info

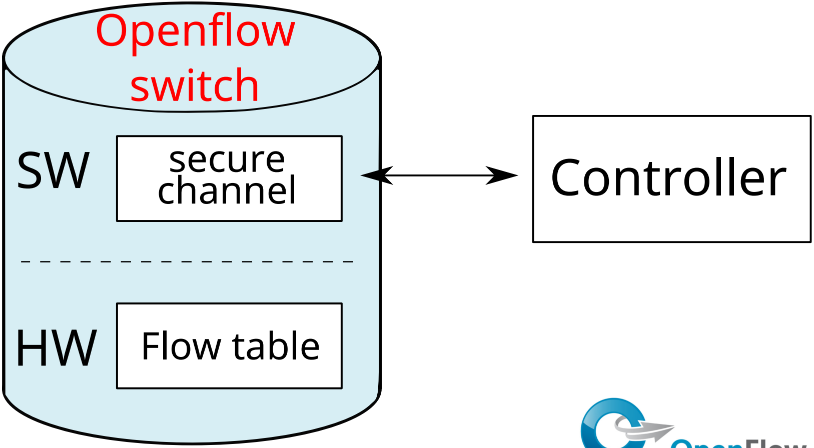
Intermediate results

- Using compression specially crafted 64-byte packets can be captured at line-rate on a single conventional HDD using 3 cores
- Generating packets at line-rate (10 Gbit/s) is possible using a single core

Implementation - What is OpenFlow?

> *”OpenFlow allows direct access to and manipulation of the forwarding plane of network devices such as switches and routers”*
>
> — Open Networking Foundation

Implementation - What is OpenFlow?

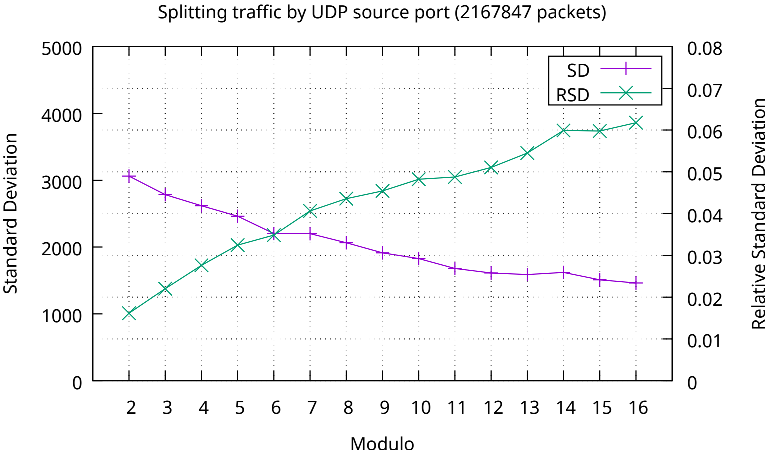


Implementation - OpenFlow

We need to define something that we split the traffic on.
Possible candidates:

- Source port for TCP/UDP (allows mask on Open vSwitch)
- IP-address (allows mask)
- Equal-Cost Multi-Path (ECMP) routing algorithms

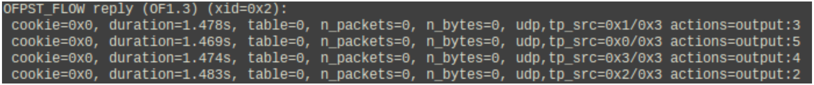
Implementation - UDP



Data: Random DRDoS attack PCAP from simpleweb.org

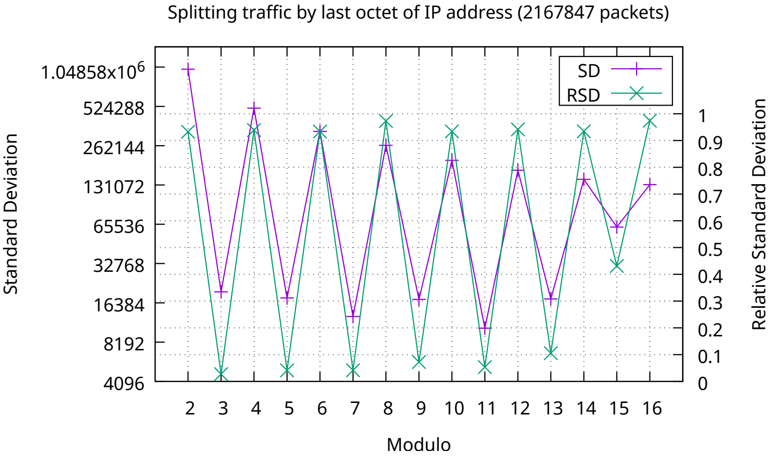
Implementation - Example flow table

Bitmask on last two bits of UDP source port



```
OFPST_FLOW reply (OF1.3) (xid=0x2):
 cookie=0x0, duration=1.478s, table=0, n_packets=0, n_bytes=0, udp,tp_src=0x1/0x3 actions=output:3
 cookie=0x0, duration=1.469s, table=0, n_packets=0, n_bytes=0, udp,tp_src=0x0/0x3 actions=output:5
 cookie=0x0, duration=1.474s, table=0, n_packets=0, n_bytes=0, udp,tp_src=0x3/0x3 actions=output:4
 cookie=0x0, duration=1.483s, table=0, n_packets=0, n_bytes=0, udp,tp_src=0x2/0x3 actions=output:2
```

Implementation - IP address



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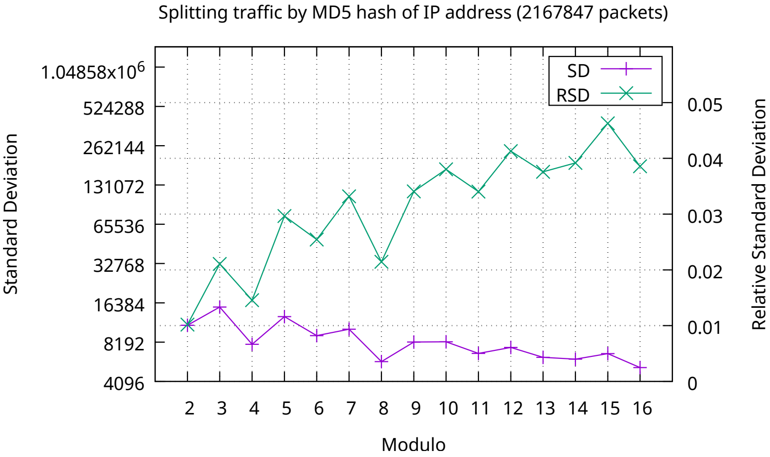
Implementation - IP address



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Implementation - ECMP

Equal-Cost Multi-Path routing is used to balance traffic over multiple links that have the same cost.

- ECMP Algorithm is not defined by OpenFlow
- Result: ECMP implementation varies by vendor

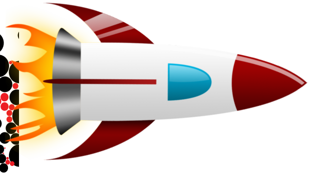
The **definition** of ECMP is a great match to our problem

Current state

- For some types of traffic splitting is easier than others
- On-going work to find a generic way to balance flows
- ECMP is promising, depending on the implementation by the vendor

Conclusion

- Using DPDK allows line-rate packet capture on 10 Gbit/s
- Using OpenFlow-compatible switches has the potential to scale the capture speed horizontally
- Combined, these two technologies allow us to capture $\geq$40 Gbit/s



Open-source

- DPDK-based packet capture tool (DPDKcap): https://github.com/woutifier/dpdkcap

Questions

Thank you for your attention!

Questions and/or comments are welcome!