Network Functions Virtualization

Bernardus A. Jansen, BSc

MSc System and Network Engineering
Universiteit van Amsterdam

bernardus.jansen@os3.nl

February 5, 2018
Virtualizing applications has been popular for a long time

- Virtualizing of network functions has notably lagged behind

Why?
Virtualizing applications has been popular for a long time
- Virtualizing of network functions has notably lagged behind
Why?
- Network functions generally require low latency and high throughput
Managing these devices can be a lot of work.
Introduction

Managing these devices can be a lot of work
Research Question (main)

How can services in a campus network be aided by virtualization by an external service provider?
Introduction

Research Question (sub questions)

- Which network functions within campus networks are suitable to be virtualized?
- Which technical aspects need to be considered if an external service provider would decide to provide one or more of these virtualized functions?
- Does the distance of the virtualized platform from the campus affect the performance of the virtualized function? Is this performance dependent on the function itself?
- How should redundancy be arranged?
- Is it feasible to just virtualize one function or are they so inter-dependent with other network functions in the campus domain that eventually a virtualized solution should be offered for all network functions within a campus network?
Related Work

NFV has received significant attention from researchers and the industry

- The NFV Industry Specification Group was started by ETSI
- Open source frameworks platforms and specification groups have spawned
  - OpenContrail\(^1\), OPNFV\(^2\)
- Hardware extensions and software frameworks have been developed to allow for high-performance virtualized networking
  - VT-d/AMD-Vi, SR-IOV, DPDK\(^3\)
- Vendors have recognized NFV as offering opportunities
  - Cisco already offers ”NFVaaS”\(^4\)

\(^1\)http://www.opencontrail.org
\(^2\)https://www.opnfv.org
\(^3\)http://www.dpdk.org
Outsourcing Network Infrastructure
Outsourcing Network Infrastructure
Both implementing network functions in hardware and software have their (dis)advantages

- **Hardware**: high performance, but low flexibility
- **Software**: high flexibility, but low performance
Technical considerations

Processing small packets at 10Gb/s:

\[
\frac{10 \times 10^9}{84 \times 8} = 14.88 \times 10^6 \text{ packets per second}
\]

\[
\frac{1}{14.88 \times 10^6} = 67 \text{ ns per packet}
\]

No problem for ASICs

The cost of a single context switch is upwards of 1000 ns\(^5\)

DPDK

---

Hardware awareness is very important to achieve multi-million packet-per-second throughput.

- CPU pinning, NUMA domains, passed-through hardware
- This negates a lot of the advantages of virtualization
Opportunities for NFV

Not all network functions require high throughput

- Uplink bandwidth for many organizations does not currently exceed 1Gb/s
  - These networks can already be completely virtualized
  - When edge devices are suitable to be virtualized, migration to an offsite NFV setup is much easier

- Low-traffic network functions may also be suitable for separate outsourcing
  - Network Access/Admission Control
  - VPN

- NFV may also be interesting within organizations
  - Already offered by Cisco
Opportunities for NFV

Service providers that provide internet connectivity are at an advantage

- No "ping-ponging" of traffic
- Not all network segments require equal bandwidth
  - (Large) organizations may choose for NFV for certain parts of their network
Network Functions Virtualization offers clear advantages over hardware appliances

- But performance offered by hardware is hard to match
- Advantages for high-performance NFV are less pronounced
  - But only from the perspective of the service provider
  - Service providers interested in offering NFV may set out with a hybrid setup

Physical distance between network functions was not considered in this project
Conclusion

- There is no catchall solution for NFV
- Hosted network functions can significantly unburden system administrators
- New functions can be easily and dynamically introduced
  - Developing network functions is easier as well
- Entire network function infrastructure can be physically multihomed
  - Increased reliability and availability
Future work

- Existing research into software packet-processing can be extended to include virtualization
  - Processing packets assisted by GPUs may be particularly interesting
  - Vendor and application agnostic add-in cards may also prove useful
- Strategies for migrating existing setups to a hosted setup
- Network Functions in containers
