

Network Functions Virtualization

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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

Introduction



Firewall



IDS



Spam filter



Load Balancer



VPN



Anti-piracy

Introduction



Firewall



IDS



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Load Balancer



VPN



Anti-piracy

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?*

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?*

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
 - OpenContrail¹, OPNFV²
- Hardware extensions and software frameworks have been developed to allow for high-performance virtualized networking
 - VT-d/AMD-Vi, SR-IOV, DPDK³
- Vendors have recognized NFV as offering opportunities
 - Cisco already offers "NFVaaS"⁴

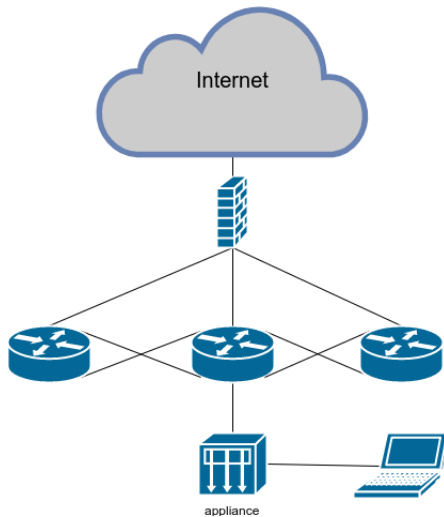
¹<http://www.opencontrail.org>

²<https://www.opnfv.org>

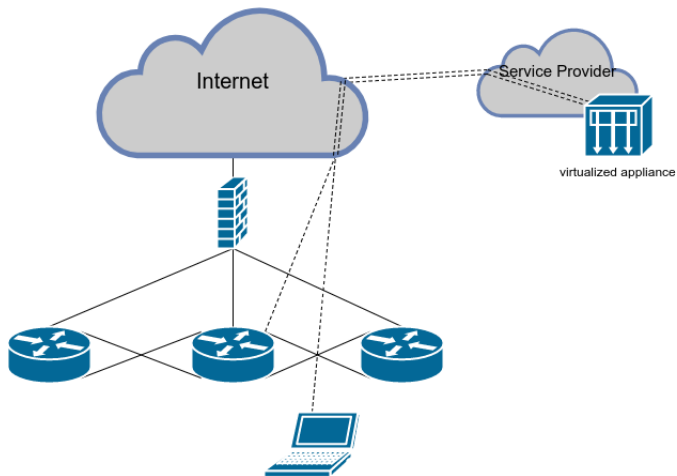
³<http://www.dpdk.org>

⁴<https://www.cisco.com/c/en/us/solutions/service-provider/network-functions-virtualization-nfv/index.html>

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

Processing small packets at 10Gb/s:

- $\frac{10 * 10^9}{84 * 8} = 14.88 * 10^6$ packets per second
- $\frac{1}{14.88 * 10^6} = 67$ ns per packet
- No problem for ASICs
- The cost of a single context switch is upwards of 1000 ns⁵
 - DPDK

⁵Benoit Sigoure. *How long does it take to make a context switch?*. <http://blog.tsunanet.net/2010/11/how-long-does-it-take-to-make-context.html>. (Accessed on 2018-01-24). 2010.

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

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

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

- 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

- Existing research into software packet-processing can be extended to include virtualization
 - Processing packets assisted by GPUs may be particularly interesting⁶⁷
 - Vendor and application agnostic add-in cards may also prove useful
- Strategies for migrating existing setups to a hosted setup
- Network Functions in containers

⁶Sangjin Han et al. “PacketShader: a GPU-accelerated software router”. In: *ACM SIGCOMM Computer Communication Review*. Vol. 40. 4. ACM. 2010, pp. 195–206.

⁷Anuj Kalia et al. “Raising the Bar for Using GPUs in Software Packet Processing.”. In: *NSDI*. 2015, pp. 409–423.

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