On The Impact of the Network Hypervisor on Virtual Network Performance

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IFIP Networking 2019
Introducing New Networking Solutions

SDN-based Solution

Control Plane (CP)
Ctrl. Routing is more efficient
Easier to verify
Update Needed!
But How?

Solution Testing

10% Traffic 90% Traffic
T-CP P-CP

Hypervisor

Test Results vs Production Traffic Tests

Performance

Samples

Performance is worse than expected!

Motivation: What happens in case of overload?

Hypervisor itself can be source of unpredictability!

This talk: A tool to analyze hypervisors and a performance evaluations of hypervisors!
Network Hypervisor Architectures

FlowVisor: A Network Virtualization Layer

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Abstract

Network virtualization has long been a goal of the network research community. With it, multiple isolated logical networks can run on a single physical network, allowing for different QoS, isolation, and security requirements to be met. FlowVisor is a network virtualization platform that we have developed to support this vision. It operates on top of an existing switch and allows multiple virtual networks to run simultaneously on the same physical network. By allowing for the creation of virtual networks, FlowVisor enables the creation of new networking services and applications.

Idea:
Combine Network Virtualization and Software Defined Networking

Network Virtualization
Software Defined Networking

Translation
Abstraction
Virtualization Layer
Isolation

SDN C1
SDN C2

CPU
Storage
Net I/O

Ph

Interference?
Predictable?
Hypervisor Network Function Implementations: FV vs OVX

**FlowVisor: A Network Virtualization Layer**

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**ABSTRACT**

Kentucky virtualization has long been a goal of the network research community. With it, multiple isolated logical networks co-exist with potentially different addressing and forwarding mechanisms on share the same physical infrastructure. Typically, this is achieved by means of the advantages of software to display and emulate experimental “clean slate” protocols in production networks. To better understand virtual networking, we first look closely at current virtualization. Computer virtualization’s success can be linked to a close collaboration of the underlying hardware. That is, the compute virtualization layer has a hardware abstraction that permits string

- **Translation:** Changes only CP information

- **Abstraction:** 1-to-1 Mapping

- **Main work done by single thread**

**OpenVirteX: Make Your Virtual SDNs Programmable**

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**ABSTRACT**

We present OpenVirteX, a network virtualization platform that enables users to create and manage virtual Software-Defined Networks (vSDNs). Virtual networks can contain multiple tenants, and to customize topology at instantiation time. Each tenant network can be instantiated along with the compute resources to deliver true infrastructure on-demand.

- **Translation:** Rewrites message headers

- **Abstraction:** 1-to-1 Mapping, Big Switch

- **Applies multi-threading for tasks**
Performance Analysis of Existing Network Hypervisor Architectures

FlowVisor: A Network Virtualization Layer

Rob Sherwood, Glen Gibb, Rock-Heng Yap, Guido Appenzeller, Martin Cavazza, Nick McKeown, Guru Parulkar

ABSTRACT
Network virtualization involves running multiple virtual network instances that share a physical infrastructure. Without a physical network switch, each virtual network instance (VNI) can be decoupled from the underlying hardware. We present FlowVisor, a network virtualization platform that enables operators to create and manage virtual Software-Defined Networks (SDN). FlowVisor is a virtual switch platform that provides an abstraction layer between VNI and the underlying hardware. This enables operators to create and manage virtual networks that can be decoupled from the underlying hardware.

OpenVirteX: Make Your Virtual SDN

Ali Al-Shabibi, Marc De Leenheer, Ayaka Koshibue, Guru Parulkar, and Bill Snow

ABSTRACT
We present OpenVirteX, a network virtualization platform that enables operators to create and manage virtual Software-Defined Networks (SDN). FlowVisor is a virtual switch platform that provides an abstraction layer between VNI and the underlying hardware. This enables operators to create and manage virtual networks that can be decoupled from the underlying hardware.

ONVisor: Towards a scalable and flexible SDN-based network virtualization platform on ONOS

Yoonsun Han, Thomas Vachuska, Ali Al-Shabibi, Jian Li, Haibai Huang, William Snow, James Won Ki Hong

ABSTRACT
We present ONVisor, a network virtualization platform that enables operators to create and manage virtual Software-Defined Networks (SDN). ONVisor is a virtual switch platform that provides an abstraction layer between VNI and the underlying hardware. This enables operators to create and manage virtual networks that can be decoupled from the underlying hardware.

“Andreas, SDN Network Hypervisors are still ahead of time … the industry is not yet ready for them” Rob Sherwood, Facebook

No detailed performance study! Why? No Tool available!
From non-virtualized SDN networks to virtualized SDN networks

Switch Benchmarks

- **Challenge**: Coordination and emulation complexity
- **Goal**: One tool emulating single tenant, single switch, multi-tenant, multi-switch

No doubt, great tools are available: OFLOPS, ... but
perfbench [1,2,3]

- Multi-tenant/multi-switch emulation
- Traffic modeling: inter-arrival time, burstiness
- Modular measurements: either controller(s), switch(es) or both entities
- OF 1.0 and 1.3

perfbench in action
*perfbench* in action: setting

- Container *perfbench*
- Container *FlowVisor*
- Container *Open vSwitch*
- Container *influxdb*
- Container *grafana*
Testbed setups

With OVS

Different OF Message types

Perfbench switch emulation

FLOW_MOD

High message rates! 10000 new flows in data centers per second [DCinTheWild]

Varying the number of tenants and switches!
Virtualization: What does it cost? (PACKET_IN)

- Latency of PACKET_IN: OVS < FV < OVX
- Not inline with original papers
### Impact of tenant controller behaviors (FLOW_MOD)

- Tenant controller behavior (Delay vs No Delay) determines latency.
- 15k – 30k: processing of hypervisor determines latency.
OVX impact of number of tenants (FLOW_MOD)

- Overutilization: With 100 tenants and 10000 FLOW_MOD messages per second
- Latency becomes high – worse service level agreements, unpredictable
Future Work: How to evaluate Fairness? (FV, FLOW_MOD)

Take maximum difference of median values

Already 20 tenants show a notable latency gap of 5 ms (high variance)

The more switches and controllers, the less predictable
Programmable network virtualization important: testing, slicing, guarantees, isolation, flexibility

**But**: Network Hypervisor itself can introduce unpredictability! Potential showstopper!

Hence, **deep understanding of architectures realizing programmable virtual networks important!**

This research:
- Benchmarking virtual environments is important … but not trivial

This paper:
- A tool for benchmarking virtual SDN networks
- Performance insights in hypervisor implementation aspects
Thank you!

Questions?