NETLAB
NETWORKED SYSTEMS RESEARCH LABORATORY

Container-based NFV: Opportunities and Challenges

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About me

- PhD candidate at University of Glasgow since 2013
  - Member of Networked Systems Research Laboratory (Netlab) http://netlab.dcs.gla.ac.uk
- Main research interests:
  - Cloud resource management
  - Network Function Virtualization
  - Software-Defined Networking
- Going to be an intern at NORDUnet for 4-5 months
  - Measurement / performance verification for GTS

Middleboxes

- Hardware-based network appliances that manipulate network traffic
  - Firewall
  - Load balancer
  - VPN
  - Intrusion Detection and Prevention Systems
  - WAN Accelerator
  - Web cache
- Enterprise networks rely on middleboxes
  - Middleboxes represent 45% of the network devices
  - The advent of customer devices will further increase the number

Problems with middleboxes

- They incur significant capital investment
- They are cumbersome to maintain
- They can not be extended to run new functionality
- The run proprietary software
  - limits innovation
  - creates vendor lock-in

Network Function Virtualization

- NFV decouples network functions from the hosting platform
- Can reduce capital and operational expenditure
- Improves resource efficiency
- Introduces fault-tolerance and scalability
- Works well with Software-Defined Networking

State of the art

- OpenStack: early stage demos for NFV
- OPNFV: Linux foundation project, first release “Arno” is out
- Cloud4NFV: VM-based NFV orchestration for private clouds
- ClickOS: a custom, high-performance XEN-based VM
- “Stateless network functions”
- …

Issues

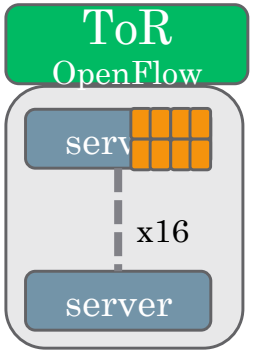
- Operator specific implementations
- Poor reuse of software components
  - Deploy and configure once for a specific server
  - Operator specific deployment system(s)
- Inability to create/destroy network functions quickly
  - Inserting routing rules and deploying + configuring software is complex
  - Costly operation
- VMs used as NFs introduce a high overhead
- Lack of scalability

Glasgow Network Functions

- Glasgow Network Functions (GLANF)
  - research and development project
  - Est. 2014
- Main characteristics:
  - Container-based
  - Transparent
  - Infrastructure independent
  - Open innovation
- Two key contributions of GLANF are
  - Using containers for NFs
  - End-to-end transparent traffic management (using SDN)

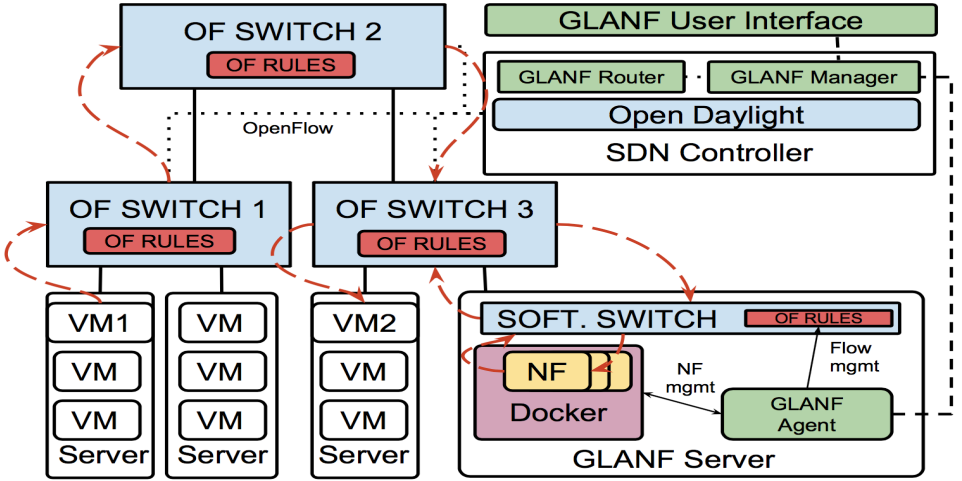
Containers

- Lightweight “virtualization”
- Fast create/start/stop/delete
- High performance
  - Small delay, high throughput, low memory footprint
- Reusable / Shareable
- Traditional software environment
- Microservice architecture



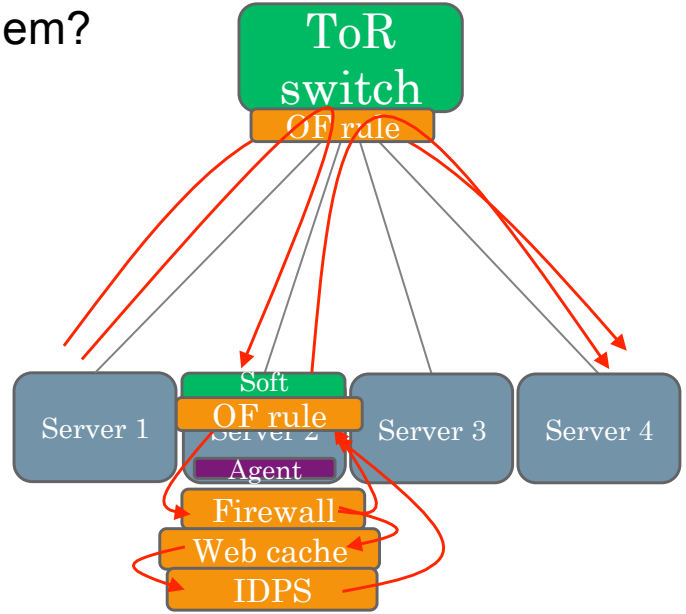
GLANF design

- Router
  - Hosted on the Open Daylight Controller
  - Creates and inserts the rules to apply a specific forwarding policy
- Manager
  - Provides a REST API to the system
- Agent
  - Daemon running on the GLANF servers
  - Manages containers and local routing
  - Provide host/container status information
- UI
  - Talks to the Manager
  - Adds/removes network functions

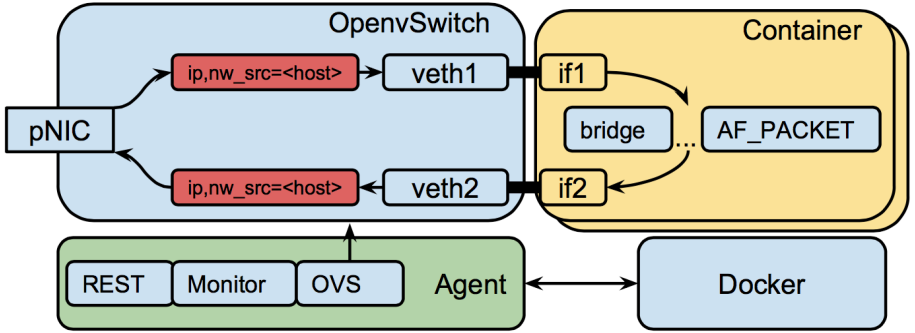


Step-by-step

- Traffic from Server1 to Server4
- Need a new Firewall placed between them?
  - Controller find a GLANF server
  - Pull the firewall image
  - Spawn an instance
- Apply the policy
  - Reroute the traffic matching:
    - FROM server1
    - TO server2
- Chaining Containers
  - Web Cache
  - IDPS



Inside the GLANF Server



Demo

- https://youtu.be/W7aa4L2piBQ (4:49)

Container NFV - challenges

1. Exclusive allocation of CPU resources
2. Direct I/O (e.g. SR-IOV)
3. Inter-NF communication (direct memory mapped)
4. High performance software switch is required on the host (maybe in a VM?)
5. Fast live migration

Challenges - performance

- If we don’t need to copy the packet from kernel space
  - Good throughput and latency
  - Examples: iptables, tc
- If we need to copy a packet to user space

Challenges - performance

- Using SR-IOV NIC for VNF Containers
  - High performance
  - H/W offloads
  - Low latency using user-mode driver
- Intel DPDK runs in Docker container (Intel 06/2015)
- Using DPDK / SR-IOV we can reach close to physical appliance
  - The trade-off is flexibility
  - DPDK and SR-IOV requires support of the NIC

Container NFs in GTS?

- Could a (container) NF be a resource in GTS in the future?
- Example use-cases:
  - Firewalls
  - Transparent measurement modules for network researchers
  - Introduce delay
  - Rate limiter
  - Load balancer
  - ?

Thank you!

- Contact: Richard.Cziva@glasgow.ac.uk

- GLANF has been published in two papers so far:
  - *Container-based Network Function Virtualization for Software Defined Networks*. Richard Cziva, Simon Jouet, Kyle White and Dimitrios P Pezaros, IEEE ISCC 2015, Cyprus
  - *GNFC: Towards Network Function Cloudification*. Richard Cziva, Simon Jouet and Dimitrios P Pezaros, IEEE NFV-SDN 2015, US.