Building Multi-domain Service Function Chains Based on Multiple NFV Orchestrators

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Outline

- NFV Overview
- Motivation
- Multi-SFC: Proposal
- Evaluation
- Conclusion

Network Function Virtualization

- Several network functionalities are implemented by a large variety of middleboxes
  - Specific purposes (*e.g.*, firewall, load balancers, proxies, etc.)
  - Match hardware and software from the same manufacturer
- Network Function Virtualization (NFV) allows to replace services traditionally provided using middleboxes by software
  - Software can be executed by virtualization systems on COTS hardware
  - Decreases costs, increases flexibility to operate and manage network services

Network Function Virtualization

- Virtual Network Function (VNF)
  - Responsible to process a specific network traffic
  - Operates on different layers of the protocol stack
- The European Telecommunications Standards Institute (ETSI) has proposed an architecture for NFV Management & Orchestration (NFV-MANO)
  - Disseminate the use and interoperability of the NFV
  - It provides the functionality required for the provisioning of VNFs and its related operations

Service Function Chaining

- Complex network services can be formed by composing a set of network functions
- The Internet Engineering Task Force (IETF) has proposed an architecture for the Service Function Chaining (SFC)
  - Composition of VNFs on a topology through which traffic is steered in a predefined order

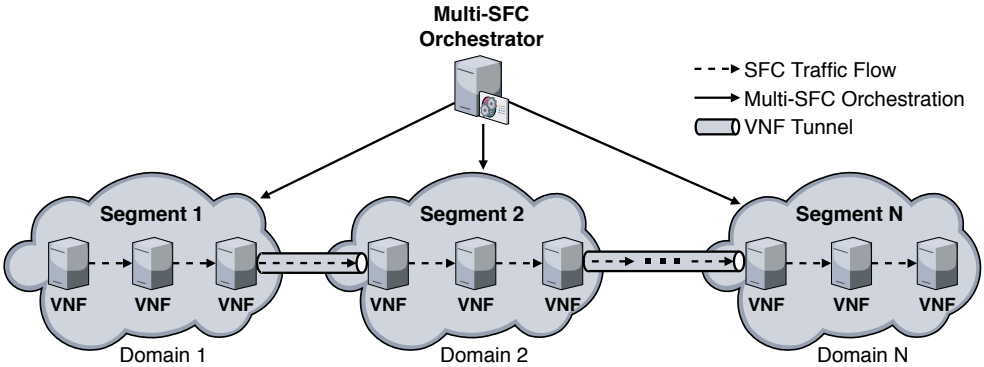
Motivation

- Current systems usually allow the instantiation and orchestration of all VNFs of an SFC composition to be done on a single NFV platform
  - In some cases, multiple instances of the same orchestrator are permitted
- Multiple different platforms have become available
  - It is just natural to allow an SFC to be built on several clouds/platforms/orchestrators
- Network services require VNFs that natively run on specific domains
- ETSI has discussed strategies for the communication of NFV orchestrators on different administrative domains
  - The problem is not yet solved
  - One has to deal with specific features and current different APIs and data models

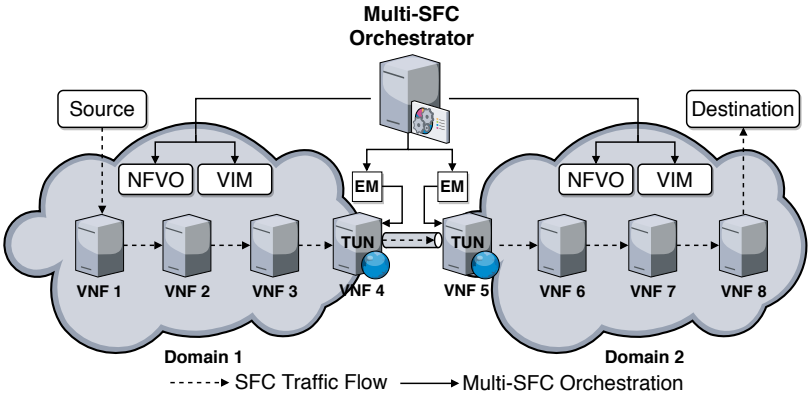
Multi-SFC: Proposal

- This work proposes a strategy that allows the execution of an SFC across multiple clouds of multiple administrative domains orchestrated by multiple NFV platforms
  - This strategy is called Multi-SFC
- A framework architecture is proposed as an extensible solution of the NFV-MANO
- Relies on a holistic approach and provides high-level abstractions for the management and composition of Multi-SFCs

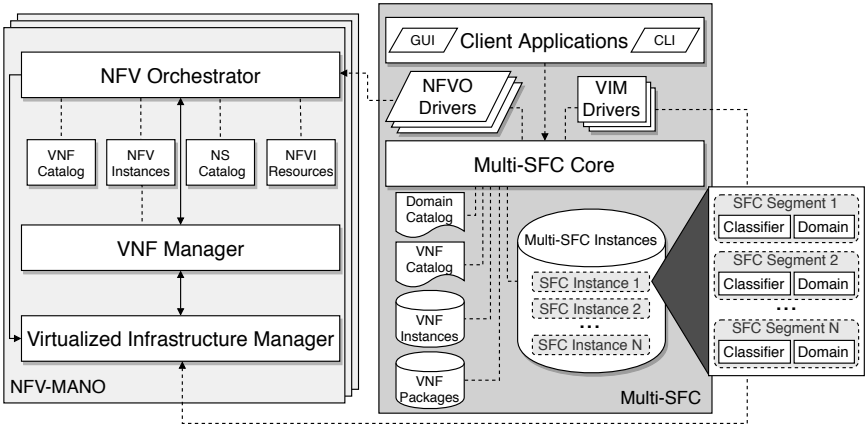
Multi-SFC Segmentation



A Multi-SFC Architecture



Architecture of the Multi-SFC Orchestrator



Prototype Implementation

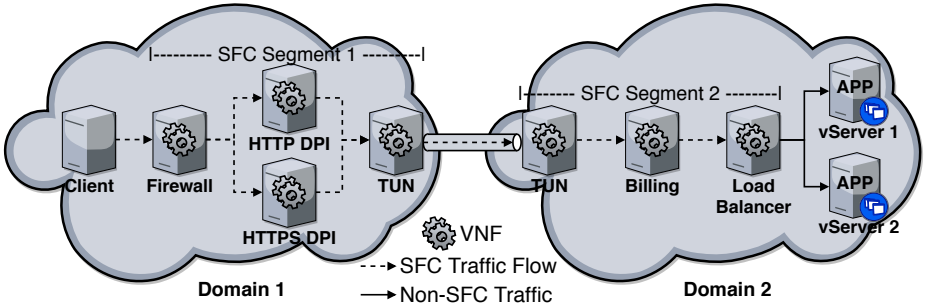
- A Multi-SFC prototype was implemented as proof of concept
  - NFV Enablers: OpenStack, Tacker and OSM
- Architecture components implemented in Python
- An EM was implemented to manage tunnel configuration
- Multi-SFC composition is based on the holistic workflow

Evaluation

- Resources:
  - 2 physical machines running 2 OpenStack versions
  - 3 virtual machines running on KVM (Tacker, OSM, and OpenStack Controller)
  - VNFs run Ubuntu Cloud with 1 vCPU and 256 MiB of RAM
  - Physical machines were interconnected on a Gigabit Ethernet network
- We are interested to evaluate the strategy in terms of interoperability, performance, and overhead of traffic steering on different domains

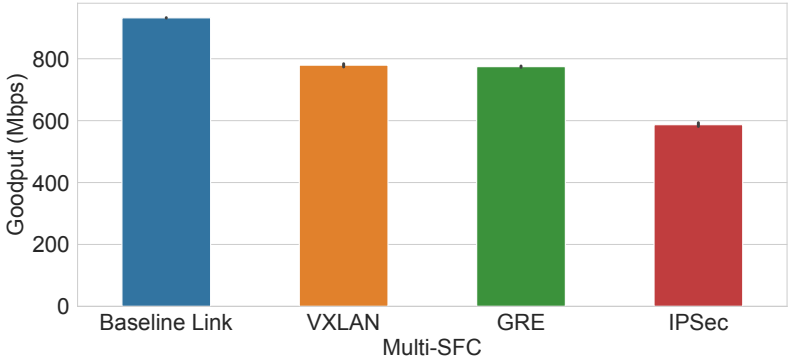
Evaluation Scenario

Goodput and Latency



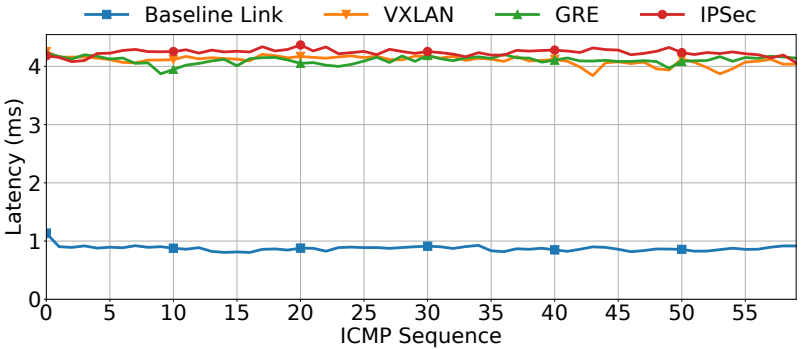
TCP Goodput of a Complete Multi-SFC

iperf3



Latency of ICMP Messages

ping



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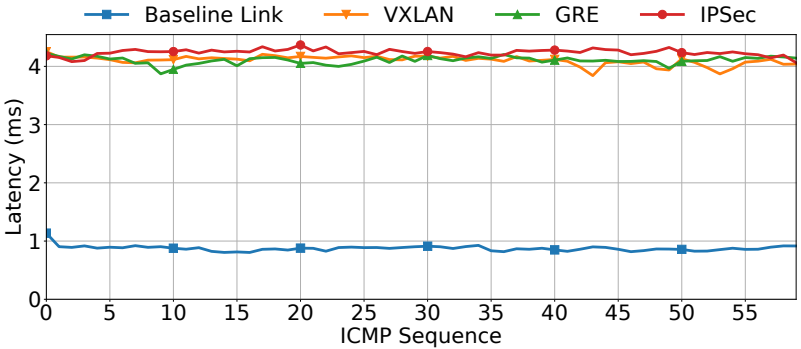

∗ Additional measurements can be found in the paper

Conclusion

- This work proposed the Multi-SFC architecture for the composition of SFCs on multiple clouds of multiple administrative domains orchestrated by multiple NFV platforms
- The Multi-SFC architecture is compliant with the ETSI NFV-MANO
- The configuration of the NFV infrastructure is taken to a higher level of abstraction by leveraging traffic steering over multiple clouds/domains/platforms
  - Segments are connected using tunnels implemented as VNFs

Conclusion

cont.

- A proof-of-concept prototype was implemented
  - Results show that the Multi-SFC presents low latency and sustains a satisfactory goodput
  - Provides interoperability of segments on multiple domains and NFV platforms

Future Work

- Design of strategies to allow efficient resource allocation and elasticity
- Investigate traffic steering using NSH between multiple domains
- Explore fault tolerance on Multi-SFCs
- Interconnection of multiple domains using federations

Thank you!

Source: https://github.com/alexandre-huff/multi-sfc

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Appendix

Domain/Cloud/Platform

Domain

Collection of systems and networks operated by a single organization or administrative authority

Cloud

Allows on-demand network access to a set of shared and configurable computing resources which can be quickly provisioned and released

One or more clouds are hosted at each domain

NFV Platform

Corresponds to a set of systems required to run the NFV-MANO stack

Each cloud runs an NFV Platform

Main operations of the Multi-SFC Core

- `GET /msfc/uuid`
  - generates and retrieves a unique identifier in order to compose a new Multi-SFC (msfc)
- `GET /catalog/domains`
  - retrieves information of all domains stored in the Domain Catalog
- `GET /catalog/vnfs/<dom-id>/<plat-id>`
  - lists all VNFP stored in the Domain Catalog repository of a specific platform and domain
- `POST /msfc/sfp/compose`
  - operation for the composition of a segment, which chains its VNFs
  - receives as input the domain, segment, and the VNFP ID stored in the VNF Catalog

Main operations of the Multi-SFC Core

cont.

- `POST /msfc/source`
  - indicates whether the incoming traffic of the Multi-SFC is internal or external
- `GET /msfc/acl/<sfc-id>`
  - returns all classifier policies of the NFV platform of the first Multi-SFC segment
- `POST /msfc/acl`
  - configures the corresponding SFC classifiers of the NFV platforms along the Multi-SFC

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- `POST /msfc/acl`
  - configures the corresponding SFC classifiers of the NFV platforms along the Multi-SFC
- `GET /tunnel/em`
  - returns the EM to configure the VNF tunnels
- `POST /msfc/start`
  - instantiates all segments on their corresponding NFV domains and orchestrators

Main operations of an NFVO Driver

- `compose_sfp`
  - connects VNFs along a SFP of a given Multi-SFC segment using information of a VNFP
- `get_sfc_traffic_src`
  - retrieves VNFs eligible to be configured as traffic source of the first segment
- `configure_traffic_src_policy`
  - configures the SFC classifier to encapsulate and forward the incoming traffic (internal or external)
  - selects in the cloud infrastructure the most appropriate network interfaces both for internal and external traffic

Main operations of an NFVO Driver

cont.

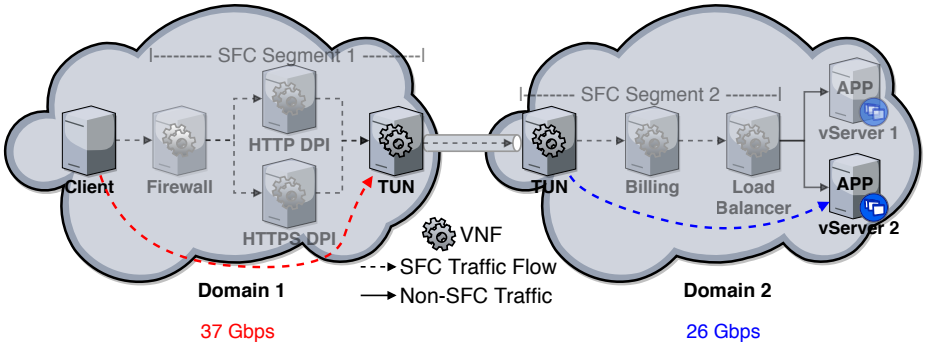
- `get_available_policies`
  - returns the list of classifier policies available on a given NFV platform (NFVO Driver)
- `configure_policies`
  - configures the SFC classifier policies on a given NFVO platform (NFVO Driver)
- `get_configured_policies`
  - returns the list of policies configured in the classifier
  - employed by the Multi-SFC Core to configure VNF tunnels and firewall rules on VIM network nodes

Main operations of a VIM Driver

- `configure_network`
  - checks if a network is configured in the VIM, if not, it configures the network
- `configure_routers`
  - configures the routers of a given segment to forward the traffic to the tunnel
- `configure_security_policies`
  - configures firewall rules in the network node to allow traffic incoming to the segment

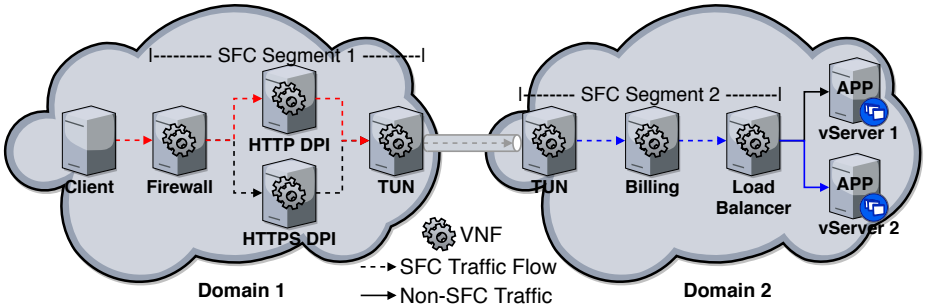
Evaluation Scenario

Goodput without SFC



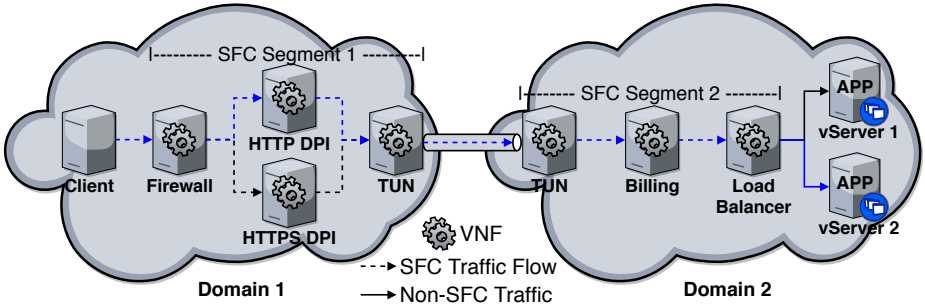
Evaluation Scenario

Goodput of each segment



Evaluation Scenario

Goodput of a complete Multi-SFC



- Provides end-to-end measurements
- Traffic steered on all VNFs of an SFP