A study on VNF state and flow migration orchestration

Xuan-Tuong Vu, Kim Young Han*
Soongsil Univ.

tuongvx@dcn.ssu.ac.kr, younghak@ssu.ac.kr*

Abstract

Network functions virtualization (NFV) together with Software-defined networking (SDN) are complementary technologies that offers elasticity in Network Functions (NFs) control. Together, NFV and SDN should enable to migrate NF state and redistribute packet processing across multiple instances of NFs to support NFV elasticity control (e.g. NF auto-scaling, NF maintenance.). Currently, many existing frameworks are proposed to implement these functions, but there is still a need for a standard method of how to dynamically orchestrate NF auto-scaling, state transfer and flow migration in optimal way based on collected data from monitor component. In this paper, we discuss NF state and flow migration method for high-availability NFV environment. A proposed architecture is also introduced to support dynamically state and flow migration to realize NFV elasticity control.

I. Introduction

Network Function Virtualization (NFV) [1] is a new network architecture framework where Network Functions (NFs) such as routers, firewalls, and load balancers are now decoupled from hardware to be implemented in software. These services are packaged to run as Virtual Machines (VMs) or Container on commodity hardware, which provides automated deployments and flexible operations while allows service providers to run the network on standard servers instead of proprietary ones. Since network functions are packaged as virtual objects, service providers can leverage performance of cloud computing platform such as OpenStack and Kubernetes to improve scalability and agility that deliver network services and application on demand.

Software Defined Networking (SDN) [2], in other hand, abstracts physical networking resources switches, routers and so on and moves decision making to a virtual network controller plane. SDN further provides flexible management of packet processing across multiple instances of network functions. NFV and SDN are not dependent on each other, but they can be used together to support each other. NFV provides the infrastructure on which SDN software can run. With NFV and SDN, the network architecture become more flexible, programmable, and uses resources efficiently.

With supports of NFV and SDN, the elasticity of NFV has been widely investigated in real world networks such as data centers and 5G networks. There are some typical situations of NFV elasticity control that includes NF scaling, NF failure recovery, NF load balancing and NF upgrading. One challenge is how to maintain the state information for processed flows after making elasticity control actions. To ensure the correctness of packet processing after flow redistribution, some research efforts [3],[4] have been proposed to transfer flow states alongside the flow migration. However, existing works mainly focus on designing mechanisms for safe migration of flow state among NF instances while there are a lot of questions left such as how to selecting suitable flows to migrate, which flows should be migrate to which NF instances to maintain Service Level Agreements (SLAs), how to orchestrate with two main questions: when and where should the system migrate NF state and flow.

To address this problem, in this paper, we introduce an architecture that support NFV elasticity control with stateful packet processing. The proposed architecture highlights the way how Network Function Virtualization Orchestrator (NFVO) can interact with migration control component to dynamically make appreciate actions in term of both state migration and flow migration in response to elasticity control actions such as: scaling out, scaling in, load balancing, fault recovery and maintenance.

II. Proposed Architecture

A. Architecture

This section describes our design for dynamically migrate both NFs state and flow state in response to elasticity control actions. We show in Figure 1 the main building blocks of the system and their relationship.

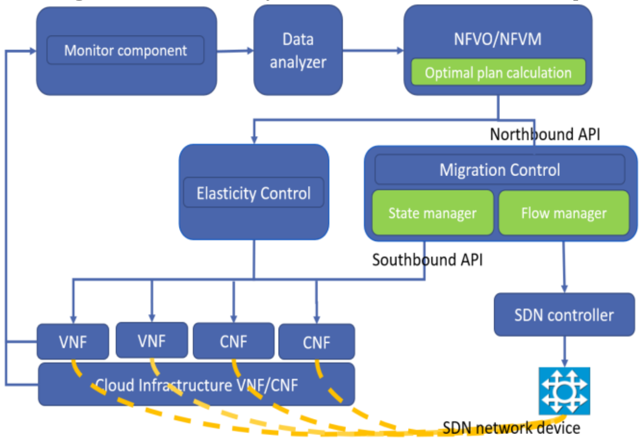

Figure 1. System architecture

The main components of the system are listed as follow:

- **Monitor component:** is response for collect data from multiple sources in Cloud Infrastructure and transfer data to Data analyzer for further processing.

- **NFVO/NFVM:** is responsible for make Optimal plan for NFV elasticity and migration control.
- **Elasticity Control:** is responsible for execute NFV scaling in, scaling out, fault recovery.
- **Migration control:** is responsible for execute both NF state and flow migration [3].

B. NFV elasticity control procedure

Figure 2 describes in detail system procedure for supporting NFV elasticity control. First, the monitor component observes the status of every NF instances and cooperate with data analyzer to detect overload, under load and imbalance conditions. Then, the alert about the conditions are sent to NFVO/NFVM component to make an appreciate control plans. Some algorithms can further be embedded into Optimal Plan Calculation to create the optimized plan for both elasticity control and migration control. In one hand, the elasticity control decisions such as scaling in/out, fault recovery, etc. are sent to Elasticity Control component to be executed. On the other hand, the migration decisions are invoked through a Northbound API that supported by Migration Control component (e.g. OpenNF [3]). Finally, Elasticity Control and Migration Control modules would interact with the underlying resources to perform elasticity actions.

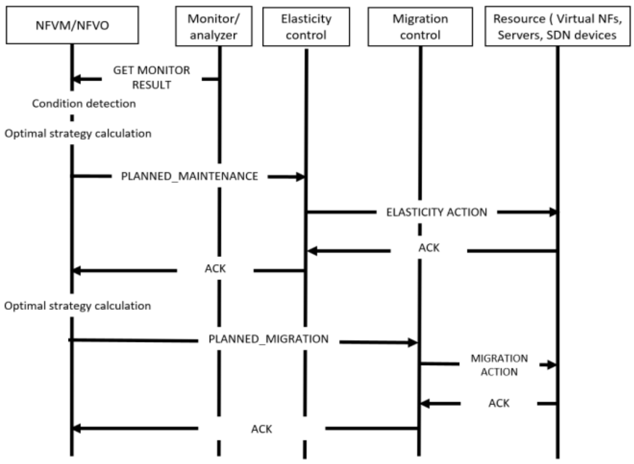

Figure 2. The procedure for NFV elasticity control

III. Conclusion

This paper proposed an architecture for supporting NFV elasticity control with stateful NF and processing. With proposed architecture, we can cooperate Elasticity actions (e.g. auto-scaling) performed by NFV and state and flow migration performed by SDN. Hence, there is one common component that orchestrates elastic NF, which will pave the way for deploying flexible, scalable, safe NF scaling, NF sate transfer and flow migration. For future works, regarding proposed architecture, an extended driver can be added to NFVO/NFVM component (e.g. OpenStack Tacker) to interact with Migration Control component (e.g. OpenNF [3]) to support NFV elasticity control.

ACKNOWLEDGMENT

"This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No.2020-0-00946, Development of Fast and Automatic Service recovery and Transition software in Hybrid Cloud Environment) "

REFERENCES

[1] NFV whitepaper. at the "SDN and OpenFlow World Congress", Darmstadt-Germany, October 22-24, 2012. https://portal.etsi.org/NFV/NFV_White_Paper.pdf/.

[2] Open Networking Foundation, "Software-Defined Networking: The New Norm for Networks", ONF White Paper, April 13, 2012.

[3] A. Gember-Jacobson et al., "OpenNF: Enabling innovation in network function control," in Proc. ACM Conf. SIGCOMM, pp. 163–174, 2014.

[4] S. Woo, J. Sherry, S. Han, S. Moon, S. Ratnasamy, and S. Shenker, "Elastic scaling of stateful network functions," in Proc. NSDI, pp. 299–312, 2018.