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Adaptive Service Function Selection for Network Function Virtualization Networking

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Abstract—In multiple Service Nodes (SNs) in a Network Function Virtualization (NFV) environment, numerous network functions are carried out. This study concerns the selection of Service Function Instances (SFIs) that are integrated into a Service Function Path (SFP) in resource-constrained networks with various functional requirements. Imbalanced loads in the network system are prevented and a service chain with a high Service Level Agreement (SLA) is developed. An NFV-based Service Function Chain (SFC) integration architecture is designed and an SFP selection mechanism is developed to provide a flexible service chain that satisfies service requests. Two cases are discussed to analyze the effectiveness of the mechanism. The proposed SFP selection mechanism improves the resource utilization of SFIs, prevents the overloading of SFIs, increases the number of service chains that can be serviced by the system, and reduces the packet loss rate. The proposed selection mechanism is compared with without selection mechanism to verify its performance. In case 1, only the load of the SFIs is considered. An SFC controller with the proposed SFP selection mechanism improves resource utilization by 21.32% and reduces the standard deviation of instantaneous loads by 30.02%. In case 2, the acceptable price of instances of service function is considered. The case 2 improves resource utilization by 10.31%, and the standard deviation of the instantaneous load is reduced by 18.73%. An analysis of the rejection rate indicates that the proposed mechanism improves the number of service chains that can be serviced by the system and reduces the mean packet loss rate by 1.91%.

Index Terms—Network Function Virtualization, Service Function Chaining, Service Function Path, Load Balancing

1 Introduction

With the growth of the Internet, the type of Internet ser-vices is changing, and the amount of data that is gener-ated is increasing. To solve the problems of the data storage and mass calculation, virtualization and the cloud are used for processing data and providing network services. Therefore, Network Function Virtualization (NFV) has evolved rapidly. Research and development in service chain-related technology and mechanisms are critical to enable networks to provide numerous service functions [1-5].

1.1 Motivation

The traditional network setup and adjustment configuration are static and fixed, and the network topology is coupled with the physical network. Therefore, operators must implement a complex configuration process that may change the connections in the original net-work when they import new services and adjust net-work service chains. Therefore, the network service supply mode of a traditional network cannot meet de-mand for several network services. With rapid devel-opment of the Internet and cloud technology, current network functions are tending toward virtualization. In the future, networks will be constructed in an NFV envi-ronment, and network functions will be implemented using Virtual Machines (VMs). NFV can decouple net-work topology from physical network resources [6-7]. It makes the configuration of network services more flexi-ble and dynamic, and can reduce the overall capital expenditure (CAPEX) and operating expenses (OPEX) of operators [8-10].

Data centers contain server clusters that provide various network services for service requesters, and terminal servers satisfy various demands of the service chain [11-12]. Servers that provide various services must perform different network service functions, as shown in Fig 1. For example, a web service requires a Proxy, a Firewall and Network Address Translation (NAT), while a video service depends on a Firewall and a Video Optimizer. A particular server may need to establish a different network service function with different clusters of clients. For example, a server may trust a client in cluster 1, and so require only a Firewall, but it does not trust a client in cluster 2, and so needs a protective sys-tem, such as an Intrusion Prevention System (IPS). This study concerns the use of existing resources to provide a network service chain that satisfies the needs of service providers for resource-limited networks with various functional requirements. To solve the above problems, Service Function Chaining (SFC) in NFV is combined with the proposed mechanism and the proposed selec-tion mechanism are used to select a Service Function Path (SFP) to provide a network service chain that satis-fies requests.

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