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Low-Latency Orchestration for Workflow-Oriented Service Function Chain in Edge Computing

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Abstract: To realize a cost-efficient, affordable, economical, flexible, elastic and innovative network service, the concepts of Network Function Virtualization (NFV) and Software-Defined Network (SDN) have emerged in edge computing. In the case of NFV deployment, most research regards the deployment of Service Function Chaining (SFC), which is composed of several series-connected Virtual Network Functions (VNFs). Current NFV deployment approaches concern how to efficiently deploy the chaining service requests. They do not consider the possible form of the service requests in edge computing. Furthermore, the study regarding response latency in NFV is limited to the chaining service requests. Most studies consider the deployment of several VNFs in one SFC onto the same substrate node to reduce the total latency and resource consumptions. In this paper, we first propose a novel workflow-like service request (WFR), which is completely different from the chaining service request. Then, a Dynamic Minimum Response Time considering Same Level (DMRT_SL) has been proposed to efficiently map the workflow-like requests in edge computing. We use a randomly generated topology as our underlying network. It can be seen from the data obtained from a large number of simulation experiments that DMRT_SL not only is particularly outstanding in terms of response time delay but that blocking rate and deploy time behavior are also particularly surprising.

Key words: Network function virtualization; Workflow; Network service request; Latency; Edge computing.

1 INTRODUCTION

Network Operators (NOs) are anxious to find the time, power and cost-efficient approaches to dispatch the new network services and improve their high economic returns with increasing stringent market demands. Fortunately, the appearance of NFV [1] has become an effective solution to solve this situation. According to the OpenStack foundation, NFV is a new way to define, create and manage networks by replacing dedicated network devices with software and automation. The European Telecommunications Standards Institute (ETSI) NFV standards definition of NFV is that it is a solution that can solve the problem caused by increasing network components based on dedicated hardware. Additionally, it can satisfy the demands of cloud computing [2-4], mobile cloud computing [5] and big data [6].

NFV is fundamentally moving from a hardware-based solution to a more open, software-based solution as well as SDN [7]. For example, instead of dedicated firewall devices, software can provide the same functionality through virtual firewalls. As indicated in Figure 1, one virtual machine can implement several functionalities, such as data security [8,9], and secure storage [10], Network Address Transfer (NAT), load balancing, cache, Dynamic Host Configuration Protocol (DHCP), radio and other virtual network functions. The software-based solution of network function can also be easily scheduled for the edge computing and cloud computing environments [11-13].

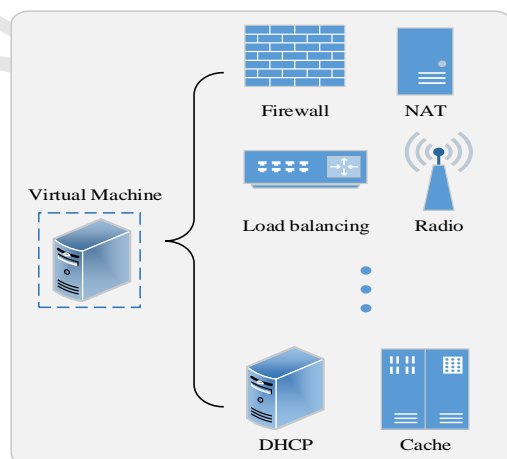


Fig. 1 The virtual network functions that one virtual machine can implement.

So far, both academics and industry have been keen on virtualization research [14-16]. Virtualization technology can be applied to several different networks, such as optical networks [14], wireless networks [15] and other common networks [16]. Moreover, the emergence of edge computing also provides a new idea for virtualization. More specifically, edge computing frees virtualization from reliance on cloud data, which allows the data on a virtualization function to be processed at the edge of the network [17]. The research on virtualization will continue because it still has value for further development and applications.

Usually, one SFC consists of a series of VNFs. As shown in Figure 2, each VNF represents a specific functionality and one SFC or network service contains one source and one destination node.

Since ETSI published the standard white paper on NFV, the volume of research on NFV has increased. Research regarding

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