Poster:A SDN/NFV-Based IoT Network Slicing Creation System

Meng Wang, Bo Cheng, Xuan Liu, Yi Yue, Biyi Li, Junliang Chen
State Key Laboratory of Networking and Switching Technology
Beijing University of Posts and Telecommunications, Beijing, China
mengwang@bupt.edu.cn,chengbo@bupt.edu.cn

ABSTRACT

With the emergency of IoT, there are many IoT network slices with different network requirements. Most of the current IoT system are specific and non-programmable and therefore their slices are difficult to reuse. It is difficult to meet different QoS requirements especially in IoT system because there are plenty of IoT sensors in IoT system. In this paper, we propose a novel IoT network slicing creation system which based on two emerging SDN and NFV technologies. It provides an easily-operating service creation environment and a service execution environment based on micro service architecture. We implement an IoT muti-flow transmission scenario. After adding subservices and QoS policies into a business process at the design plane, the IoT scenario can run automatically at the execution plane. Experiment results on the scenario show that the numbers of packets per second of different flows are changing gradually depend on QoS policies.

CCS CONCEPTS

• **Networks** → *Network design principles*; *Network management*; *Mobile networks*;

KEYWORDS

Network slices; 5G; IoT; SDN; NFV

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Bo Cheng is the corresponding author.

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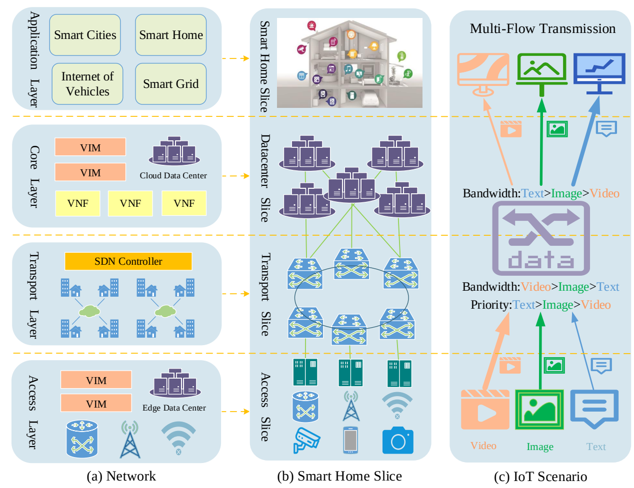

Figure 1: Network, Slice and IoT scenario

1 INTRODUCTION

With the development of Internet of Things (IoT) technologies, there have been plenty of IoT applications [1] such as smart cities, smart home, internet of vehicles and smart grid, as the Figure 1(a) shows. In this situation, network is facing a rapid change by embracing Software Defined Networking (SDN) and Network Function Virtualization (NFV). This problem is particularly difficult in the IoT environment because there are so many sensors in the IoT environment. The fifth generation (5G) mobile network slicing with SDN/NFV [2] is expected to support a multitude of IoT applications. Using SDN at the transport layer makes it easier to centralize the network intelligence in the SDN controller. Cloud and edge datacenter use NFV to decouple the network functionalities from the hardware. As shown in Figure 1(b), IoT network slicing based on SDN/NFV provides flexibility and support for various requirements of IoT applications.

However, there are some existing problems still remain to solve. Firstly, most of the current IoT system are specific and therefore the slices are difficult to reuse. Secondly, although there are many NFV management systems such as [3] [4], we want a management system that can manage IoT network slices, VNFs and IoT sensors in a unified way. Thirdly, as the

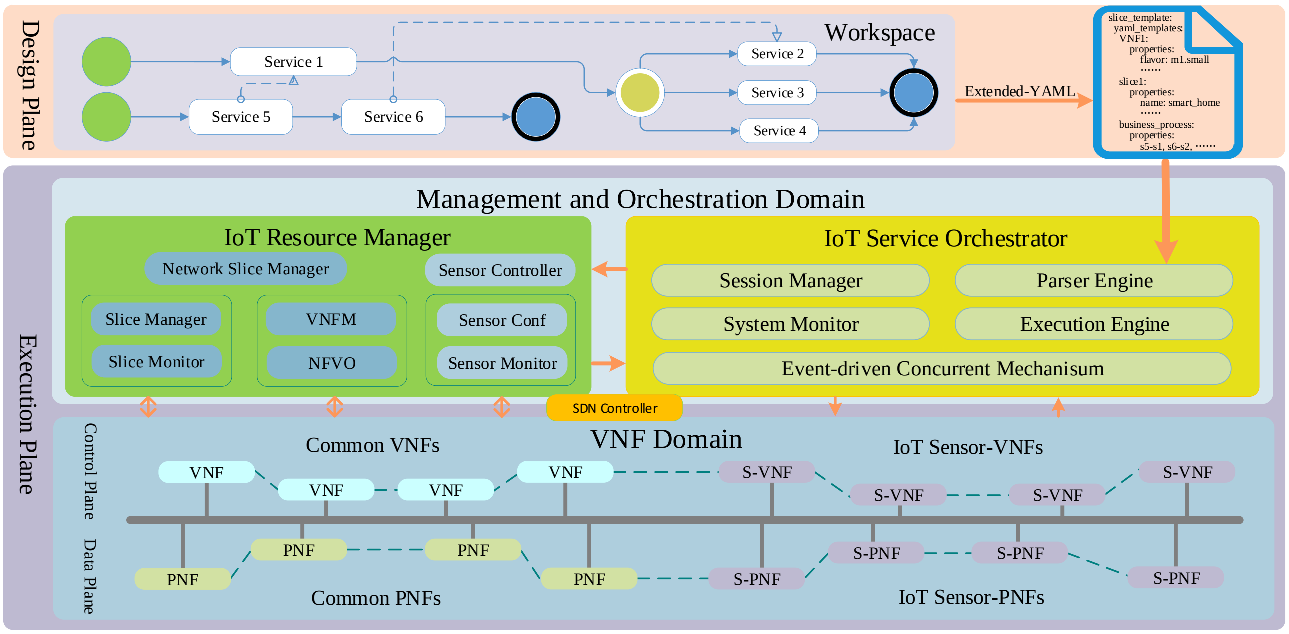

Figure 2: The architecture of IoT network slicing creation system.

Figure 1(c) shows, some services are not severely affected by temporary interruptions such as video. On the contrary, some interruptions may result in loss such as industrial control commands transmitted in text. Given these facts, we propose a novel IoT network slicing creation system.

- User can design the business processes of the IoT network slices in the design plane and deploy them in the execution plane. As the Figure 2 shows, we developed various types of subservices. By this way, we can reuse the subservice and design the business process more efficiently.
- We developed a sensor controller with a protocol stack that can adapt IoT sensors dynamically. And all components in management and orchestration domain are running in the docker containers and managed by kubernetes. We also proposed a novel SDN solution for communication mechanism of kubernetes.
- We also developed specific Sensor-VNFs for IoT sensors to implement the IoT scenario described in Figure 1(c). Then we implemented the IoT scenario by using three S-VNFs and a Priority-based QoS policy. We describe the scenario in detail in the implementation.

2 ARCHITECTURE

Figure 2 illustrates the design plane and the execution plane of IoT network slicing creation system. The former is responsible for designing and developing IoT network slices. The latter takes charge of the execution of the IoT network slices.

2.1 Design Plane

The Design plane provides a drag-and-drop workspace for end-users to design business process of the IoT network slices. An IoT network slice contains a set of subservices. When a subservice is dragged and dropped into the workspace, the related information will be written into a YAML script that we have extended.
As the Figure 2 shows, the Extended-YAML script is a collection of network slice descriptor, VNF descriptor and business process information. We can also add polices in the design plane, for example the QoS policies in the IoT scenario described in Figure 1(c).

2.2 Execution Plane

The execution plane is a service execution environment designed to enhance the management of network slices, VNFs and IoT sensors.
1)management and orchestration domain: The management and orchestration domain mainly focus on service orchestration and resource management. This domain is based on micro service architecture and managed by kubernetes, a production-grade orchestrator for containerized applications. Because the kubernetes network solution is not satisfactory, it can only provide a simple connection function. We extended a SDN controller named OpenDaylight to manage the kubernets network. In this way, we can solve container communication and management problems effectively.
IoT Service Orchestrator: We have built a parser engine for

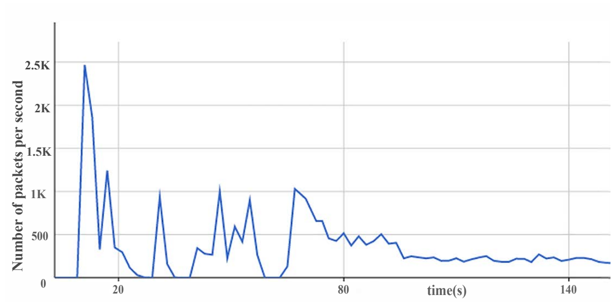

Figure 3: Number of packets per second of video

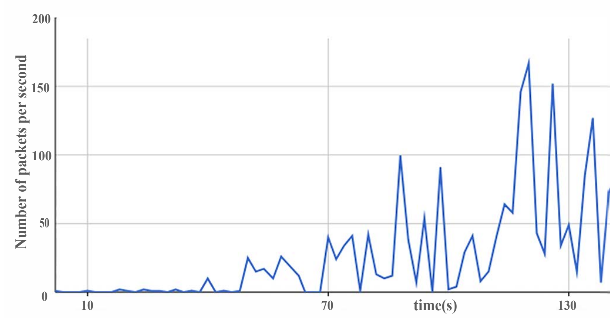

Figure 4: Number of packets per second of text

the Extended-YAML scripts and an event-driven execution mechanism. After designing the IoT slices, the service plane sends an Extended-YAML script to the parse engine. The information parsed from script mainly contains resource and control information. The former will be sent to the IoT resource manager while the latter that mainly includes polices will be sent to the SDN controller.

IoT Resource Manager: After the Extended-YAML script is parsed, IoT service orchestrator interacts with IoT resource manager. The network slice manager takes charge of managing the lifecycle of slices. The NFVO and VNFM responsible for the resource allocation and management of VNF lifecycle. The sensor controller with a protocol stack mainly focuses on sensor adapting and monitoring.

SDN Controller: We developed a control module in OpenDaylight to convert the QoS policy added by the user into a corresponding flow table and send it to the network. The control module using the Set Queue action in flow table to schedule traffic of different services to different queues. Then we can limit and reserve the network bandwidth of a given service by taking advantage of the maximum and minimum rates of the queue.

2)VNF domain: The VNF domain is the network infrastructure resource domain. It is divided into a control plane and a data plane according to the SDN control and data decoupling concepts. The two planes have available VNFs and PNFs, respectively. Some of these NFs are slice-specific for IoT environment, such as S-VNF and S-PNF, while others are common for all network slices.

3 IMPLEMENTATION

We have developed three S-VNFs to implement the IoT scenario described in Figure 1(c). The instance contains three data sources: video, image and text. The text contains some important commands. We just drag and drop subservices related to three data sources in the design plane.

At the beginning, the order of bandwidths is video, image and text. We want to receive commands quickly and video quality is less important to us. So the order of priorities is text, image and video. We can define priority-based QoS policies to guarantee the bandwidth of high priority service in the design plane.

We judge the change of bandwidth by observing the number of real-time data packets per second. At the beginning, the number of video packets is about 2.5k while the text is less than 10. As the Figure 3 shows, the number of packets per second of video is decreasing gradually. At the same time, the number of packets per second of text is increasing gradually described in Figure 4.

4 CONCLUSION

In this poster, we have proposed a novel network slicing creation system targeting on the IoT environment. And we have implemented an IoT scenario to solve the multi-flow transmission problems that are difficult to solve in the traditional way.

We also recognize the limitations of our research, and plan to focus on the following challenges and extensions. Firstly, optimize the architecture to develop better communication mechanisms aiming at reducing communication overhead between modules. Secondly, design resource allocation algorithms to make more efficient use of resources.

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