Multi-Domain Network Slicing using Intent-Based Networking

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Abstract

5G networks have been envisioned to be a multi-service network that can cover a wide variety of industrial verticals with a distinct set of service requirements. Network slicing has emerged as a key to realize the main vision of the 5Gnetworks, where a single physical network can be partitioned into multiple isolated networks. Due to the importance of the network slicing, the best architecture is needed to support theE2E slicing of Core, RAN, and transport network. In this paper, we have designed and developed an E2E network slicing system using an intent-based networking approach that can create and configure the network slice automatically by just getting user contracts from the GUI of the system. Also, it can monitor and manage the network slice resources with the help of Machine Learning Models. So, this system is capable to slice the Core and RAN network resources dynamically.

Ⅰ. Introduction

5G networks seem to be an immense opportunity for telecommunication network operators to satisfy the disparate requirements of different vertical industries and their users. Network operators aim to serve many new heterogeneous services through these upcoming 5G networks. These specific requirements are classified into three broad categories such as URLLC (Ultra-reliable low latency), eMBB (enhanced mobile broadband), and mMTC (massive machine type communication) [1]. Besides the innovations in the era of new generation Core network and radio access network defined in 3GPP (Third generation partnership project), 5G networks are adequate to support the programmability of various virtual network functions and softwarization of networks. Due to the programmable nature of 5G, it supports multi-tenancy and improves the performance of various services as compared to legacy 3G and 4G networks. Leveraging SDN (software-defined networking) and NFV (network function virtualization) technologies assemble the 5G network highly programmable and cause to reduce the OPX and CAPX of network companies [2].

Network slicing is an auspicious solution to overcome the network sharing and QoS related issues faced by the 5G network operators. Indeed, it allows network operators to create multiple logically isolated virtual networks over a common physical infrastructure. Although each isolated network named as a slice serve for a specific application group. Further, it allows various parties to share common infrastructure resources such as compute, storage, network, and deploy their different services [3]. So, network slicing seems to be the main pillar of the 5G networks and it gains tremendous attention from various research groups, standardized bodies, and telco industries like 3GPP (Third generation partnership project), IETF(Internet engineering task force), 5GPP (Fifth generation Partnership project), NGMN (Next-generation mobile network alliance) and ETSI (European Telecommunications Standards Institute), etc. [1].

In this article, we have proposed and developed an autonomous E2E network slicing system for 5G networks where users can provide higher-level configurations in the form of user intents/contracts and in return, the system will automatically converts these higher level configurations into low language TOSCA/ JSON format and will deploy the resources accordingly. Our system has five major parts such as the IBN tool, OSM network orchestrator, M-CORD platform, FlexRAN, and machine learning (ML) module. This system is step toward automation and self-assurance of the complete network by using machine learning.

Ⅱ. Network Slicing system Overview

Our E2E slicing system has been divided into three layers such as application layer, management and orchestration layer, and physical layer. In the application layer, we have an intent-based networking IBN tool, OSM MANO, and M-CORD as orchestration platform in the orchestration layer, SDN based controller FlexRAN for access network, and lastly OAI (OpenAirInterface) [6] based deployment of EPC and eNB at the physical layer. The IBN tool is the brain of our E2E network slicing system which can automate the slice creation process by just providing the higher-level configurations in the form of contracts/intents. IBN tool receives the QoS requirements in configurations context from the users through GUI and converts these configurations into a slice template format for the underlying orchestrator. IBN system composed of six components namely Intent manager, Intent design, policy store database repository, E2E slice design generator, policy configurator for OSM, M-CORD, and RAN and Machine learning based update manager. The complete design of E2E slicing system is shown in figure 1.

The overall working of each component in the IBN system is as follows: users of the system can easily define their resource requirements or intention for slice instantiation through the GUI of the IBN tool. The intent manager is a center point of IBN and communicates with all the other components. Whenever a user input contract/intent for slice creation, the intent manager fetches the resource architecture information into a database repository and creates a forwarding graph with the help of the E2E slice design generator module by mapping the information provided by the resource modeler and architecture modeler. Afterward, these

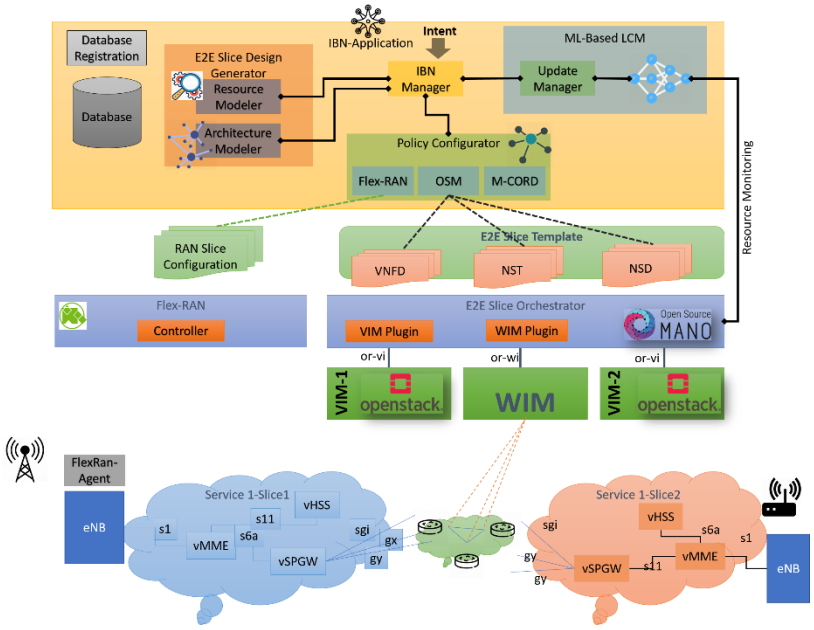

Figure 1: Overall Architecture of Network slicing through Intent- based Networking

generated configurations will send to the policy configurator module. Besides, policy configurator for OSM orchestrator converts these graph configurations into JSON string format for OSM orchestrator and on the other side, policy configurator for RAN slicing converts the RAN related configurations into JSON file for FlexRAN controller. After that, both OSM with the help of VIM (virtual infrastructure manager) OpenStack and FlexRAN can deploy the slice template information into the underlying infrastructure and map them to become an E2E slice. Moreover, we also develop a policy configurator for M-CORD to support multi orchestration platforms that can converts these configurations into TOSCA format for XOS (orchestrator of M-CORD). FlexRAN is responsible for the creation of slice at eNB and OSM is for the creation of CORE network slice resources. For the deployment of Core and RAN network, we are using open source OAI EPC and OAI eNB. Hence, our system is able to create, manage, and monitor the underlying slice resources and update the status of the resources accordingly in the database of IBN with the help of ML models. In this way, the Core and RAN networks are sliced automatically and we are also considering the slicing of the transport network which will be controlled by the SDN ONOS controller through WIM plugin like VIM plugins. Finally, our IBN based E2E slicing system can able to automate the slice instantiation process efficiently.

III. Conclusion

This article explains the orchestration of the E2E network slices through the intent-based network mechanism. The users of the system needs to provide just intent or QoS requirements through the IBN tool and in return system will automatically deploy the slice with the help of OSM orchestrator and FlexRAN controller. This system can automate the slice configuration and slice the instantiation process dynamically. It is one step forward toward self-assurance, automation, and self-healing of the network. It eliminates the need of an expert for controlling the network and also get rid of manual configurations. This system also proposed the integration of machine learning algorithms for the automation and control of future generation networks.

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