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Talha Ahmed Khan
Computer Engineering
Jeju National University
Jeju, South Korea
talhajadun@gmail.com

Asif Mehmood
Computer Engineering
Jeju National University
Jeju, South Korea
asif@jejunu.ac.kr

Javier Jose Diaz Ravera
Computer Engineering
Jeju National University
Jeju, South Korea
shaifvier@gmail.com

Afaq Muhammad
Computer Engineering
Jeju National University
Jeju, South Korea
afaq24@gmail.com

Khizar Abbas
Computer Engineering
Jeju National University
Jeju, South Korea
engr.khizarabbas14@gmail.com

Wang-Cheol Song
Computer Engineering
Jeju National University
Jeju, South Korea
philo@jejunu.ac.kr

***Abstract*— 5G networks are aimed at provisioning of a wide range of sophisticated services with uninterrupted user experience. In addition, it is very challenging to manage all the services due the variety in the service requirement and a very large number of users causing dynamic changes in traffic streamed over the network. Currently, the networks are managed manually and requires experts to control the behavior of network. Due to increase in network domain it is an esteem requirement to manage and control network autonomously. In this paper we have introduced and Intent-Based networking approach which on one side abstracts and automates the network configuration also it assures the network resource state stability by using machine learning. We have used an IBN abstraction layer and M-CORD as an next generation testbed for the implementation of this work.**

Keywords—IBN, ML, 5G, M-CORD, OpenStack, OAI, and ONOS.

I. INTRODUCTION

The upcoming 5G network is envisioned to introduce many new services to the network like AR/VR (Augmented/Virtual Reality), V2X (Vehicle to everything) and mIoT (massive Internet of Things) etc. Each of the service resides in a different domain in terms of the requirements. Some services require high latency, some require high bandwidth and other may require E2E (End to End) connectivity. It is really hard for the network operator to decide how to configure a slice or resources for each of the service in accordance with its requirements. As SDN (Software Defined Networks) and NFV (Network Function Virtualization) provides the basis for allocating different virtual resources over a single physical network also known as network slicing [3]. The proposed architecture stands on the pillars of SDN and NFV based orchestration concepts.

Currently, all the SDN and NFV platforms require tech-experts to configure the network slice resources. SDN basically handles the networking side of the system and provides connectivity among virtual and physical nodes. However, the NFV with use of orchestrator is responsible to orchestrate virtual network functions over the physical hardware hence providing freedom from specified hardware. In addition, the SDN and NFV based architecture itself has multiple layers and the manual control of such a complex system is always tedious and error prone. Furthermore, due to the large no of services and changing requirements that can be popped up dynamically can be very challenging to handle at runtime using a manual approach. One of the goal in the proposed architecture is to provide a solution that can automate the network configuration procedure and simplify how the network will be orchestrated and controlled in future [1][2].

IBN (Intent-Based Networking) is one of the key solutions focused by the IETF-standards (Internet Engineering Task Force) to automate the network configurations and operations. The IBN system must be self-configuring, self-healing and self-organizing [1]. Which means once a requirement is provided to the network it must configure itself automatically. Secondly, it should assure the resource availability i.e. whenever a user demands increase in such a way that it can cause resource shortage it must be able to respond and heal itself automatically. Finally, it must keep a stable state through organizing the resources and configuration autonomously with optimization. By following this approach, it is important for the network architectures to be equipped with intelligence so that they must take update decision to keep them stable and assure seamless service provisioning [1][2].

M-CORD (Mobile Central Office Re architected as a Datacenter) is one of the prestigious open source solution provided by ONF (Open Networking Foundation) and is accepted widely by industries to become an industrial standard. The aim is to converge the Telco central offices into the cloud using SDN and NFV. The major and most effective part of CORD is its orchestrator XOS (everything as a service Operating System) [3]. OpenStack and ONOS are integrated with XOS for their well-known functionality towards resource orchestration and networking capabilities. CORD accepts well defined TOSCA configurations in the form of service graph and reacts upon them to orchestrate the resources on physical layer. For this research CORD-XOS is used as an orchestrator and underlying network components are used from OAI (Open Air Interface) open source developments with an additional network function NSSF (Network Slice Selection Function) [3][5].

The major aim of this work is to provide an abstracted and autonomous solution for the implementation of IBN on top of SDN and NFV platforms. The manuscript takes one step forward in terms of automation and self-assurance by using Machine Learning. In addition, as a relief for administrator's configuration and management is handled automatically and eliminating the need of tech-experts. Hence the system administrator will only be required to provide High-level service requirements and they will be converted into low-level TOSCA configurations using intent policy engine [4]. Once the system policies are orchestrated they will be assured using ML based intent assurance and update engine. Furthermore, section II of this manuscripts briefs about system components and section III concludes the paper.

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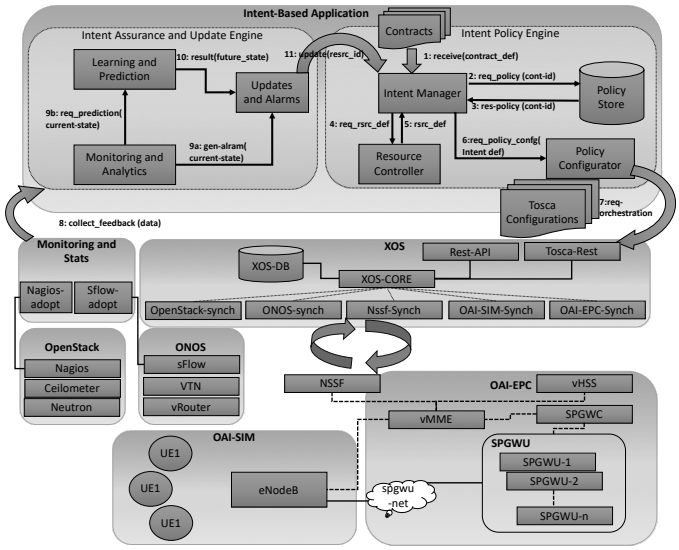

Figure 1: Overall System Architecture

II. System Components

System consists of three layers intent application layer, orchestration layer and physical layer. Intent application layer is the major contribution of this architecture and it is the brain of the architecture. Secondly, the management layer majorly consists of enhanced M-CORD setup with NSSF and Monitoring. Finally, at the physical layer OAI is majorly used with few enhancements [3].

A. Intent-Policy Engine

It is used to translate high-level intents into system level configurations. Basically, intents are provided in the form of contracts which defines "WHAT" is required by user e.g. QoS, type of service and specified service or subscription. Furthermore, it through its well populated policy stores translates them into required resource and policy catalogs. Finally, using the policy configurator it generates specific format of configurations required for underlying platform [4].

B. M-CORD based Test-Bed

M-CORD is a vastly supported by industry and is an ONF based open-source standard platform for implementing next generation Mobile networks. It basically consists of XOS orchestrator integrated with ONOS and OpenStack. In addition to that, very important part of the test-bed is NSSF (Network Slice Selection Function) which stores dynamic information of slices and selects proper slices while in operation [3]. Also, it includes monitoring of resources we used Nagios and sflow for monitoring of resources. Nagios Collect OpenStack based CPU, Memory and Storage utilization matric and sFlow is used for network resource monitoring [5].

C. Intent Assuarnce and Update Engine

After monitoring of resources it is important to react in accordance with the system state to assure stable provisioning of service. Firstly, we used reactive approach which introduced alarms and are activated directly upon receiving max utilization according to preset value for any of the resource and it requests update manager with the information of the resource status. Secondly, a proactive approach is introduced using machine learning model which periodically receives the resource status and updates the system in accordance with future state requirements [4].

III. Conclusion

This paper provided a fully automated IBN based network orchestration platform that can assure the provisioning of network slicing with dynamic user demands. The architecture eliminates the requirement of network experts being the middle man to control the network by using its close loop architecture. Also, it proposes the integration of artificial intelligence to automate and control the next-generation networks. This paper also motivates the developers with research lab resources to use open-source projects to innovate and find new things in the domain of networking. Also, the paper leaves some issues in the field of artificial intelligence as a future work and challenge for the others to develop their approaches for more enhanced control of network using IBN and ML.

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