Demo: Intent-Based 5G IoT Application Slice Energy Monitoring

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***Abstract*—Current Telco Network Service Provisioning requires proficient expertise on Infrastructure equipment. Moreover the process is tedious and erroneous making Network Service lifecycle a daunting task for Network Operators (NOs) and 3rd Party Network Tenants. This paper, proposes an Over-The-Top Intent Based Network Framework for Network Slice Energy Monitoring and Provisioning. The aim is to automate the task of network slicing through a declarative approach known as Intents while hiding network complexity enabling NOs monitor Network Slice energy consumption. We provide an experimental validation of the Intent Framework with a scenario of a 5G IoT Application Network Slice energy monitoring.**

I. Introduction

The next generation mobile network, 5G is becoming a reality. The backbone or foundation of 5G is viewed as Software Defined Networking [1] and Network Function (SDN) Virtualisation (NFV) [2]. These technologies provide potential cost cutting .i.e. Capital Expenditure (CAPEX), Operational Expenditure (OPEX) and they will help Network Operators (NOs) maintain elastic networks to meet growing network demands.

5G will potentially provide a window for NOs to extend their infrastructure services to Mobile Virtual Network Tenants (MVNO) and Vertical Markets such as Over-The-Top Application Providers. The services envisioned by NOs to potential tenants will include physical or virtual shared end-to-end network resources known as a Network Slices. This encompasses network resources from Cloud Radio Access Network (CRAN) [3] through to Evolve Packet Core Network (EPC) [4] which traverses a transport network. Both NOs and Network Tenants will want an idea of how much energy these network slices consume. This will help NOs to bill their clients based on network slice energy consumption and other factors.

The current approach to realise network services by NOs requires proficient expertise on infrasturucture equipments and moreover the process is tedious and erroneous. They exert a manual method to deliver the network services to their clients i.e. MVNOs and vertical markets. Such an approach will not suffice on 5G mobile networks due to a 30 million expected connected devices. Intent-Based Networking (IBN) [5] aims to ease such challenge of manual network service provisioning through network automation. Networks Tenants will only have to specify their Intents i.e. "WHAT" network service while an Intent-Based Management Framework handles the automation process of realising the Intent, that is, the "HOW". An Intent in this paper refers to an Over-The-Top (OTT) Network Application Slice.

We propose an OTT Intent-Based Network Framework which provides a simplified and non-technical interface for MVNOs and vertical markets to request for OTT Network Application Slice without knowledge of the physical insfrastructure details such as configuration, topologies and protocols. The framework enables energy monitoring of such Network Application Slices.

II. Proposed Over-The-Top Intent Based Networking (IBN) Framework

The proposed IBN Framework provides network tenants and NOs with a simple service platform. The framework speeds up service request placement and provisioning, provides a feedback for network service feasibility and guarantees the platform reliability. The modules of the OTT IBN platform on top of a Cloud-Over-The-Top Application Slicing Platform (COASP) are shown in Fig. 1.

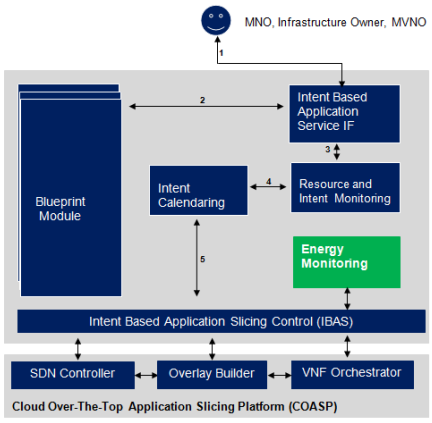

Fig. 1. OTT IBN Framework

We provide details on the energy monitoring module for VNFs on the OTT IBN Framework. Details of other

sub-modules of the framework are skipped here and provided in our related work on Intent-Based Real Time 5G Cloud Service Provisioning. We employ the term micro-services for VNFs. These micro-services are cloud native Docker containers [6] which provide numerous advantages over traditional virtual machine. They are lighter and setup time is in order of few seconds compared to minutes for virtual machines.

A. Energy Monitoring Module

This module is responsible for microservices energy consumption monitoring. The module comprises a Software Defined Network middleware power metering, PowerAPI [7]. This tool enables the power measurements of micro-services which will be important for NOs about possible VNF placement decisions and furthermore identify high energy consuming ones. The energy data will be potentially useful in the future for data analysis and learning purposes.

III. DEMONSTRATION

The demonstration involves the setup of the physical insfrastructure. This is made up of two Nokia Airframes Front-End Unit (FEU) and Edge Cloud (EC) and a laptop for Central Cloud (CC) interconnected by two switches. The table I shows the physical platform specifications.

	Front End Unit	Edge Cloud	Central Cloud
OS	Ubuntu 16.04	Ubuntu 16.04	Ubuntu 16.04
RAM (GB)	128	128	16
CPU Cores	24	24	8

TABLE I
CLOUD PLATFORMS

The next phase is the virtual network setup, deployment of a VNF Orchestrator, distributed key-value store, ETCD [8] and ONOS [9], an SDN controller as a docker container on the Central Cloud (CC). This phase also involves the installation of Open Virtual Switches (OVS) [10] on FEU and EC. ONOS is responsible for the management of the OVS to establish connectivity for the Virtual Network Infrastructure (VNI).

Phase two involves deployment of 5G helper VNFs, these are VNFs necessary for the deployment of 5G Network Application Slices. 3 VNFs and 5 VNFs are deployed on FEU and EC respectively by a VNF Orchestrator.

The above steps ensure that the VNI is properly set up to receive network service requests. The Network Tenant provides the type of service (Intent), which is a 5G IoT Application Slice from a GUI interface. Energy monitoring option is activated for End-to-End Network Slice monitoring. End-to-End Network Slice monitoring comprise energy monitoring of all micro-services on the VNI. The tenant request is transmitted to the Intent Engine for feasibility of service deployment. In the absence of any problem, a 5G IoT VNF is deployed as well as PowerAPI docker containers for individual microservices monitoring on the VNI. The individual consumption of the VNFs are summed and stored in a real-time database, influxDB. The total network slice energy consumption is displayed on a dashboard as shown in Fig. 2.

Fig. 2. 5G IoT Application Slice Energy Consumption

IV. CONCLUSION AND FUTURE WORKS

Our proposed OTT Intent Based Networking Framework simplifies network slice energy monitoring through automation. The NO does not need to manually setup different configuration for OTT Application Network Slice components for energy monitoring.

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