Network as a Service - A Demo on 5G Network Slicing

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***Abstract*—5G mobile networks have to support a huge number of different service types such as health, automotive, logistics, energy, and public safety. A one-size-fits-all solution like it exists today that delivers all the services to every device everywhere in the network is not a viable option. Network slicing allows to offer programmable network instances, which match the requirements of the individual use cases, subscriber types, and applications. Within a slice, network functions and elements can be instantiated according to the specific service demands such as ultra-low latency, massive IoT, or dense broadband. This demo presents 5G network slicing using the example of a health insurance provider. The health service includes the use of a smart wearable for the customer with a specific traffic pattern. A tailored-to-fit network slice enables the health provider to connect these smart devices efficiently to the cloud.**

***Keywords*-network slicing; orchestration; NFV; VNF; cloud**

I. Introduction

Currently, all different mobile devices are using one single mobile core network - regardless of their demands. While this works very well today, mobile operators will face serious problems in 5G networks due to the different demands and device types as well as the increasing number of devices [1]. For example, current mobile networks are able to handle 10s of users with a few Mbps, but are not able to handle 100.000 devices in a single cell transmitting with a few kbps. Thus, future mobile networks will have to be able to support at least the following four different demands:

- mobile broadband
- ultra-low latency
- dense broadband
- massive connectivity

Here, mobile broadband stands for the normal traffic from smartphones, tablets, etc. In contrast, autonomous driving, tele-medicine or certain types of industrial communication have high demands on the latency. Furthermore, during a mega event, e.g., concert or sports event, high bandwidth has to be provided in addition to caching servers and edge computing capabilities. Finally, Internet of Things (IoT) devices are popping up everywhere. These devices have little bandwidth and mobility requirements but the mobile network has to cope with a huge number of devices. Having just one mobile network architecture for coping with all these different demands will not suffice in future 5G networks. This is where network slicing comes into play. Using network slicing, multiple independent and dedicated network instances can be created within the same infrastructure to run services that have completely different requirements for latency, reliability, throughput, and mobility.

In the next section, we introduce network slicing in detail and present the challenges. Section III describes our 5G network slicing demo and finally, we draw conclusions and give a brief outlook on future work in Section IV.

II. Network Slicing

The concept of network slicing dates back to the early 1990s, when virtual connections could be established using Asynchronous Transfer Mode (ATM). Newer approaches already define virtual network controllers, resource managers, and virtualized physical resources [2] [3]. A prerequisite for network slicing is the virtualization of the different network elements of the mobile network. Thus, network slicing gained momentum with the setup of the ETSI Network Functions Virtualization (NFV) group [4].

According to NGMN [5], a network slice, namely "'5G slice"', supports the communication service of a particular connection type with a specific way of handling the C- and U-plane for this service and only provides the traffic treatment that is necessary for the use case, avoiding all other unnecessary functionality. Thus, with the combination of NFV and Software Defined Networking (SDN), the mobile network can be instantiated on demand.

Considering an IoT network slice, the slice has to support on the one hand a lot of C-plane traffic but the U-plane traffic is generally quite low and the mobility management can be simplified as IoT devices are often fixed. In addition to the optimized mobile core, the Radio Access Network (RAN) can also be optimized for the specific use case. To be able to support millions of IoT devices and to not waste the limited energy resources of the devices, the signaling overhead on the air interface can be reduced to a minimum without harming any standards and the devices can also transmit in another frequency band, e.g. narrow band [6].

Thus, network slicing is a key enabler for network operators to expand existing businesses and creating new ones. Slices can be offered to third-parties such as media, automotive, health, and public safety via a suitable API for providing Network as a Service (NaaS). Figure 1 shows the concept of network slicing starting on the

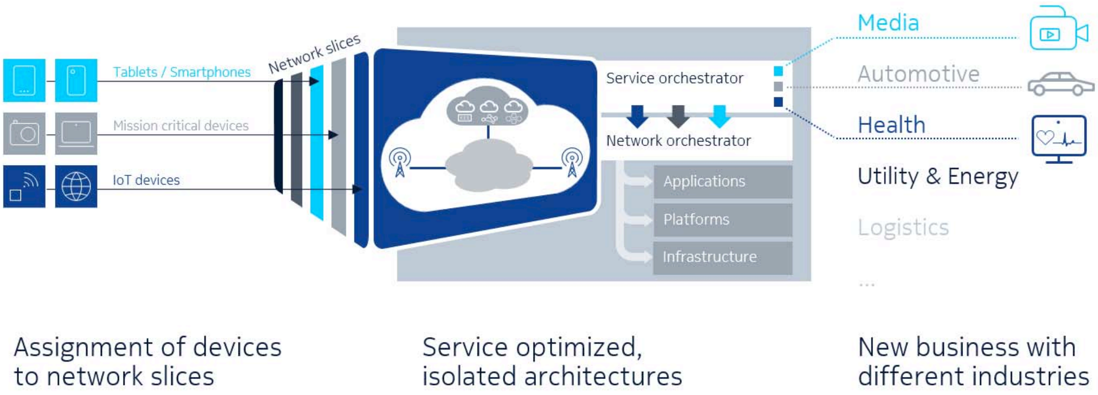

Figure 1: The concept of network slicing including the service and the network orchestrator.

left with the assignment of devices to network slices, the service optimized architectures, and the service and network orchestrator for mapping the different service and network demands.

There are currently three main challenges for the introduction of network slicing. The first challenge is, how to assign the devices to the network slice. If one device can only be assigned to one slice, this can be handled by the IMSI. However, if each service of a device can use different network slices, the assignment has to be handled via service identifiers and signaled via the control channel. The second challenge is the isolation of the slices. This is especially challenging in the eNodeBs. Finally, the estimation of the required resources for a service to be able to guarantee certain SLAs while not wasting resources is quite ambitious.

III. Demonstration

Our showcase is a health insurance provider who requests a network slice for offering individual services for the customers. The so-called H&F provider advertises a health insurance together with a smart watch. The smart watch, as an IoT device, allows for online training with direct professional feedback to the user based on submitted vital parameters. In return, the service provider gets an overview about the health condition of his customers allowing to adjust the tariffs accordingly and can help the customer in case of an emergency.

Within the demo, we illustrate network slicing for this use case from three different angles:

- Operators perspective
- Third party service providers view, in our example the health insurance provider
- End user with the smart watch

We show how to configure and order a network slice as a third party provider. Afterwards, we illustrate from the operators point of view, how the functional elements of the slice are set up and configured using a Network Orchestrator, cf. Figure 2, implemented by Nokia Bell Labs and Nokias Cloud Application Manager (CAM) [7]. The network orchestrator is responsible for evaluating the required number of network elements based on the parameters entered in the ordering portal. In our example, these are two edge gateways, one Internet gateway, and one controller instance shown in the cloud in Figure 2. The four radio nodes are physical instances. Although it is possible to include also the radio access, we focus on the setup of the mobile core network in our demo. The screenshot of the CAM, cf. Figure 3, illustrates the setup of the virtual Internet gateway based on OpenStack. The CAM is responsible for dynamically deploying, interconnecting, monitoring, and configuring virtual network instances.

The functional elements are set up in the cloud and the network is automatically configured according to the selected setup of the health insurance provider. Finally, we illustrate the communication via a network slice with the smart watch. The end user can monitor its vital parameters and gets an individual training. The health insurance provider instead, gets detailed statistics about the network slice, including the number of active end users and network statistics. From the operators perspective, the demo illustrates how easily a network slice can be set up on demand according to the customer needs and how slicing can help to reduce the TCO.

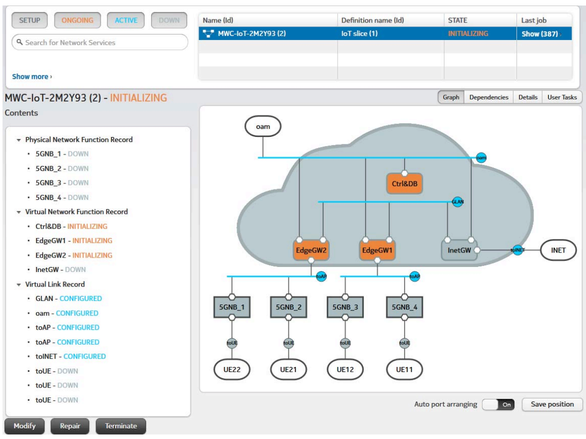

Figure 2: Orchestration of network resources.

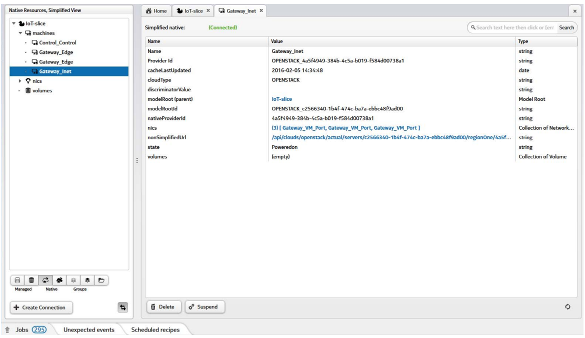

Figure 3: Cloud Application Manager.

IV. Conclusion

The demo illustrates that it is possible to create a 5G network slice automatically within a few minutes, with individual statistics and billing. We show that network slicing allows to create an individual programmable network architecture for thousands of use cases, subscriber types, and apps. Thus, network slicing can be used by network operators to provide Network as a Service (NaaS), which gives new opportunities for different verticals. In future, we will extend the network slicing concept to include also the radio access. We will further split the network elements into services and integrate the location awareness of these.

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