Demonstrating the Optimal Placement of Virtualized Cellular Network Functions in Case of Large Crowd Events

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1. INTRODUCTION

This demonstration shows how Network Function Virtualisation (NFV) [1] can be used by a network provider to dynamically provide required mobile core network functions in case of a large "Mega" event like a soccer game or a music festival. Economical reasons may not justify the installation or continuous maintenance of expensive dedicated hardware which is necessary to cope with the high load generated by visitors of such an event only in some parts of the network and only for a short time.

The Evolved Packet Core (EPC) in nowadays' mobile LTE networks consists of several, specialized components: first pure control-plane elements like Mobility Management Entities (MME) which can be installed on virtualized IT hardware in the cloud already today and second gateways which are a mixture of control- and user-plane. This demonstration focuses on the Serving Gateway (SGW) which switches GTP (GPRS Tunneling Protocol) tunnels in a LTE network. In such an LTE network with \( \approx 10 \) mio. subscribers about 10 SGW devices are in use.

On the way to a successful deployment of NFV-based EPC components, several challenges have to be met. This includes the deployment, interconnection and configuration of LTE components in the cloud. As such, entities that instantiates and orchestrate the virtualized functions are required.

The presented demonstration shows a scenario of NFV-based dynamic capacity addition to a LTE mobile network, indicated in Figure 1. By incorporating the new demands added by the increased access capacity, virtualized SGW instances are launched at the optimal locations in the network, by re-programming SDN enabled network elements (NE+). Figure 1(a) shows the normal configuration of the LTE network including the statically located SGW devices as well as further NE+ that can be reprogrammed as a virtual SGW if necessary. For reasons of better readability, normal non-reprogrammable network elements (NE) and base stations are not displayed. Figure 1(b) shows a configuration with dynamic capacity addition. Large crowd events indicated by stars of different size lead to an increase of the access capacity. By reprogramming some of the NE+, this additional capacity demand can be handled. Depending on the number, size and location of the events, an adequate number of NE+ has to be selected and reprogrammed.

2. DYNAMIC CAPACITY ADDITION

Figure 2 indicates the different steps of the dynamic capacity addition and gives an overview on the involved com-
components. First, the SGW placement has to be optimized. In this demo, this step is conducted by the POCO tool [2, 3]. POCO allows for the consideration of trade-offs between different metrics, such as the number of additional SGWs, the maximum latency to the gateways, or load balancing on the SGWs. As second and third step, the dynamically added applications are deployed, interconnected, monitored and configured. This is done by NOKIA’s Cloud Application Manager (CAM) [4] in collaboration with OpenStack. For the network operation and the triggering of CAM and POCO an NOKIA orchestration tool called Network Utilization Controller (NUC) is used. Finally, to assure the correctness of the deployment and to avoid malicious behavior a security check on the setup is conducted.

Figure 2: Steps of dynamic capacity addition.

3. SCENARIO AND DEMO PRESENTATION

In the presented demonstration, the use case of a "Mega" event, like a soccer game or music festival is demonstrated. Two persons Ann and Ben are living in a so-called home area and are subscribers in a LTE network. Together with many others, Ann is traveling to the event area, a stadium, while Ben stays in the home area. This is also indicated by the different locations of the icons representing Ann and Ben in Figure 1. Figure 3 provides a closer look to the considered scenario including the normal situation Figure 3(a) and the event situation Figure 3(b).

Figure 3: Demonstration scenario.

The home area is a typical LTE network incl. base stations, an evolved packet core etc. and several datacenters. For the management of the operator cloud (data centers) OpenStack is used. The mobile network operator is aware of the situation that subscribers in the event area will extensively share pictures/videos and will do video calls and thus the network usage is going to increase. Therefore, the operator will activate additional base stations that are installed in the event area but inactive during normal days. Additionally base stations, e.g. mounted on vans can be set up and connected through the network available around the event area. They are connected to a fixed network and at least one data center. Both can be already used for other use cases. The activated base stations will be visible in the operation center of the operator. POCO calculates the optimal location for a necessary new serving gateway. Possible locations are places with installed SDN-enabled (Layer2/3 and GTP switching) network elements. The SGW will be activated using CAM by installing a SDN GTP controller and a SGW application in a datacenter best located to the network element location.

After deployment, configuration and activation of the network element the event area is ready for the "Mega" event, as illustrated by Figure 3(b). Then all visitors incl. Ann enter the stadium, the "Mega" event starts and Ann has a video call with Ben who is still in the home area. After the end of the "Mega" event all visitors leave the event area incl. Ann and the operator releases the deployed resources.

All LTE network components are realized by a LTE emulator. Only the SGW is not part of the emulator. It is an SDN based gateway consisting of Ethernet/IP/GTP enabled NE, SDN Ethernet/IP/GTP controllers and a SGW application. The LTE emulator uses a 3GPP conform user and control plane communication where also the SGW is integrated. Also base stations and user equipment is part of the emulator. The components are realized in software and are installed on two servers in the cloud environment of Deutsche Telekom. The cloud is managed by OpenStack and the CAM is used for the application management. To show the video call two tablets are connected via a Wifi access point to the user equipment (endpoints) of the emulator and Wifi traffic is translated into 3GPP conform traffic. CAM, NUC and POCO have own graphical user interfaces that are integrated into a demo control GUI.

4. ACKNOWLEDGMENTS

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5. REFERENCES