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Demo Abstract: 5G End-to-End Open Source Network with Traffic Prioritization Mechanism

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Abstract—In this demonstration, we make use of the recent advances in network softwarization to introduce an End-to-End software-based mobile network with traffic prioritization mechanism. We focus on the Radio Access Network (RAN), where our prioritization algorithm is implemented. The proposed traffic prioritization mechanism guarantees higher throughput and lower delay for time-sensitive and critical services such as connected cars. It is also an enabler for RAN Slicing that allows for End-to-End network slicing. Our network is deployed on commodity hardware, and we prioritize the downlink flow of a connected car over downlink video streaming traffic.

Keywords—5G, RAN, slicing, prioritization, QoS

I. INTRODUCTION

According to Cisco, the number of connected devices will be more than three times the global population by 2022 [1]. This implies not only a huge increase in traffic demands both in fixed and in mobile Internet Protocol (IP) networks, but also a diversification in the provided services and their requirements. Particularly, 5G networks are expected to meet the exponentially increasing throughput demands, while guaranteeing the diverse requirements of the provided services.

In this context, the International Telecommunication Union (ITU) has specified three categories for 5G mobile network services [2]: enhanced Mobile Broadband (eMBB), ultra-Reliable and Low-Latency Communications (uRLLC), and massive Machine Type Communications (mMTC). eMBB requires throughputs up to 10 Gbit/s, uRLLC traffic is time-critical with very low delays (~ 1 ms), and mMTC traffic is characterized by low throughput and loose delay requirements.

5G Network Slicing has been introduced to flexibly and efficiently deploy diverse 5G services over a common shared network infrastructure, while guaranteeing Service Level Agreement (SLA) constraints and improving the Quality of Service (QoS). This includes resource management within the slices and resource isolation between slices [3]. In this context, answering our clients' individual traffic requirements, such as high throughput or low latency, is crucial.

In our demonstration, we show two 5G use-cases in order to illustrate future 5G deployment: (I) eMBB use-case, which is represented by a User Equipment (UE) having a video streaming session, and (II) uRLLC use-case represented by a connected car (remotely controlled

via our mobile network), which has strict requirements in terms of latency. Through this demonstration, we propose a promising flow-based approach [4] to implementing 5G Network Slices; thus, answering heterogeneous traffic requirements and providing SLA management.

II. TEST-BED ARCHITECTURE

The architecture of our experimental network is illustrated in Fig. 1. It consists of a software Evolved Packet Core (EPC) interconnected with a software RAN. We make use of the advent of Network Functions Virtualization (NFV) and Software Defined Networking (SDN) technologies that enable the deployment of software solutions on commodity hardware [5]. In fact, we are no longer obliged to adopt legacy mobile network solutions, where the constructor provides proprietary software coupled with the underlying hardware. Instead, we are able to deploy our chosen software, such as open-source software, or software provided by non-traditional constructors, on the convenient hardware.

Our enhanced NodeB (eNodeB) is therefore composed of the RAN software controlling the Universal Software Radio Peripheral (USRP) B210 card that performs radio transmissions using a log-periodic antenna.

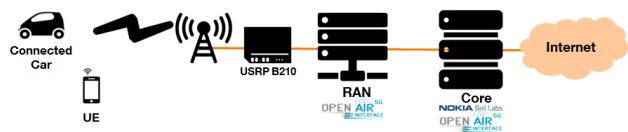


Fig. 1: Network architecture

UE are equipped with Subscriber Identity Module (SIM) cards allowing them to connect to our network once correctly provisioned within the EPC. For the sake of our demonstration, we are using two UE: a Commercial Off-The-Shelf (COTS) smartphone and a connected car equipped with a 4G dongle.

A. Traffic Prioritization Scenario

In [4], authors present a cross-layer design for an IP-centric QoS model. In this IP-centric model, all the flows belonging to a given user are transported on his unique multi-QoS bearer. QoS is further managed at packet level (flow prioritisation), according to the Differentiated

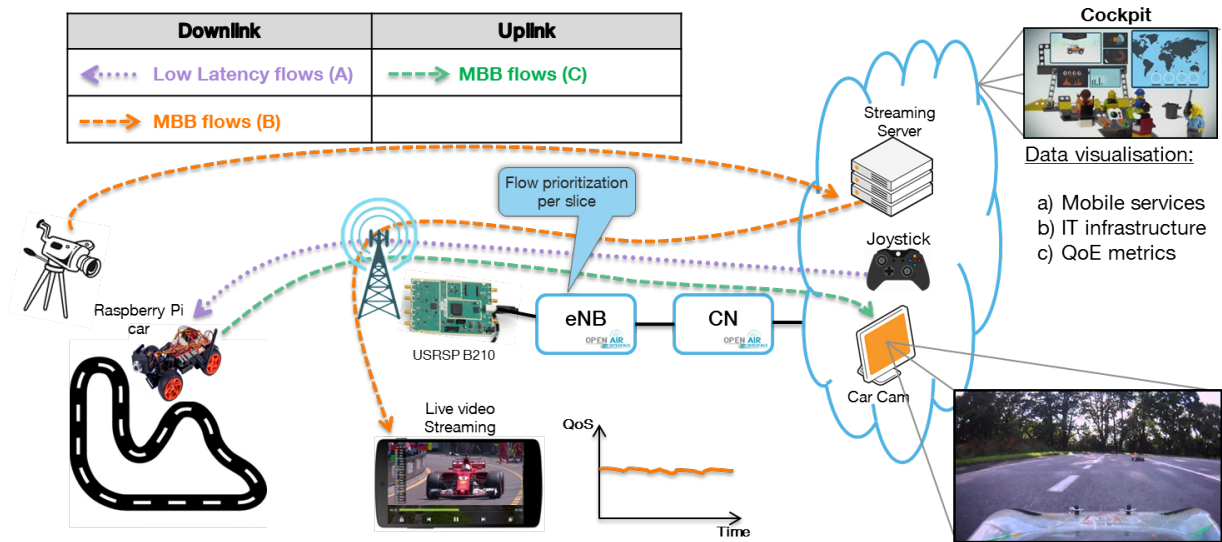


Fig. 2: Demonstration setup

Services Code Point (DSCP) field for example. A set of priority queues per UE should further be implemented in the eNodeB.

In our test-bed we have implemented the proposed Inter-bearer arrangements, in which the radio scheduler takes into account the traffic mix waiting for transmission of each UE when radio resources are allocated. In this case, the scheduling algorithm should know the state of each queue in the eNodeB and weighting the allocation of radio resources according to the prioritized traffic volume.

III. DEMONSTRATION DESCRIPTION

Our prototype test-bed and its use cases are illustrated in an online video [6] that summarizes our indoor lab tests and outdoor field trial. The network infrastructure of this test-bed is composed by a software eNodeB based on OpenAirInterface (OAI)¹ which we have modified in order to integrate our Flow-prioritization algorithm [4] and an Evolved Packet Core (EPC) based on LTEBOX which is a set of software components that provides MME, SGW, PGW and xGW (SGW + PGW) functions provided by Nokia Bell Labs.

On top of our network infrastructure, two services in downlink and one in uplink are performed as shown in Figure 2. We define a Low Latency service (purple flow) comprising the control messages sent to the car [7] (Pi Smart Video Car + 4G dongle) and a Broadband service (orange flow), which is a video streaming session, performed by a smartphone. The mentioned video streaming is a live transmission of the demo through a public video streaming platform.

In uplink, a video from the car camera is received in the monitoring center, which is used to remotely drive the connected car through a racing circuit.

In this demo, we show how a flow-based mechanism can be used to meet 5G requirements, which is illustrated through the latency between the driver actions and the car video delay. When our flow prioritization mechanism is active, an accurate driving is performed; otherwise, the accuracy between car control actions and car video is poor. We also evaluate and obtain feedback on flow-based mechanism performance in terms of latency and throughput, which quantitatively illustrates the advantages of our mechanism.

IV. FIELD TRIAL

Our lab demonstration is also performed with over-the-air transmission *i.e.*, with USRP X310 card connected to a power amplifier and an over-the-air antenna. Transmissions are made on LTE Band 38 (Time Division Duplex, 2.6 GHz frequency, and 5 MHz frequency band). Our connected devices are Motorola Moto X Play (TDD smartphone) for the video streaming service, and Pi Smart Video Car (connected via Huawei E3276s 4G Dongle) for the time-critical service. This field trial is done in Rennes, France, in collaboration with b-com².

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