A 5G multi-Slice cell capacity framework

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Introduction

The different types of services to be supported by 5G networks have vastly heterogeneous traffic characteristics, quality of service requirements and even energy consumption associated (ITU-IMT2020). The unified management of these services in Layer 2, particularly designing the algorithms related to scheduling, access control, interference management and power control, is a daunting task. Although several mechanisms have been standardized in 5G to consider these services' requirements (e.g. Flexible Radio Frame Structure, mMIMO, Flexible HARQ, Network Slicing), the standard does not define how they should be used. Equipment providers will be faced thus with the challenge of designing the algorithms mentioned above. Operators will have to evaluate and choose among several possibilities. In this context, a tool which allows to generate different types of scenarios in 5G networks and to easily test different scheduling algorithms is essential. In this work we present Py5cheSim, a flexible and open-source simulator based on Python and specially oriented to simulate cell capacity in 3GPP 5G networks and beyond. To the best of our knowledge, Py5cheSim is the first simulator that supports Network Slicing at the Radio Access Network.

System Characteristics

Py5cheSim implements RAN Slicing as a core feature using a two-level scheduler composed of an Intra Slice Scheduler and an Inter Slice Scheduler. The first one is oriented to solve resource allocation between different UEs of the same Slice, and the second to allocate resources between the different Slices. Each Slice has a set of requirements and a configuration. Configuration is set automatically depending on Slice requirements in terms of delay, band, the number of UEs to serve, traffic profile, UE capabilities, and availability. For each Slice, numerology/SCS/TTI, duplexing mode, scheduler algorithm to use, signaling load, and allocated PRBs (Physical Resource Blocks) are set at the initializing of the simulator. Slice allocated PRBs can change according to interSlice scheduler decision with a configurable granularity.

Py5cheSim supports multiple numerologies, FDD and TDD frame (depending on the cell band set for the simulation), uplink and downlink bearers, and a basic implementation of Carrier Aggregation and Single-User/ Multi-User MIMO functionalities. Transport Block Size calculation, which depends on both the number of allocated PRBs and the MCS is based on 3GPP Technical Specifications. It also supports different traffic profiles configuration by groups of UEs that can emulate the different 5G services.

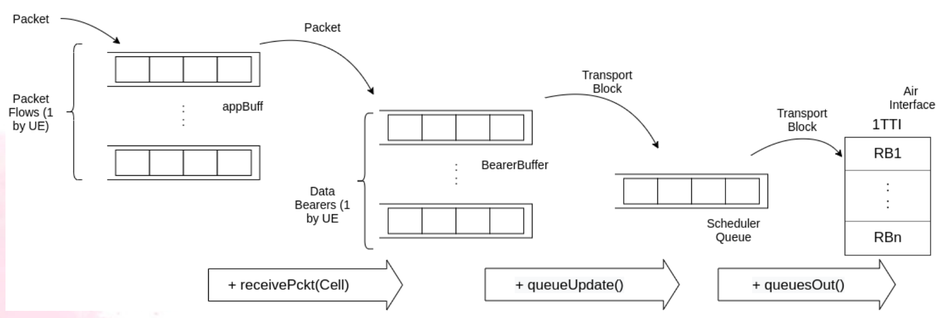

Fig.1. Intra Slice Scheduler Queues operative.

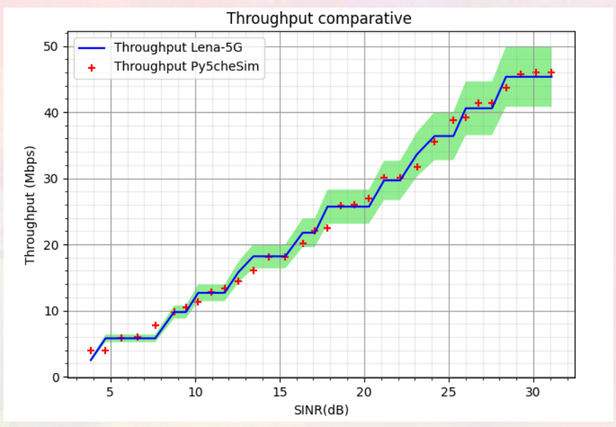

Fig.2. Throughput of Py5cheSim vs 5G-LENA.

Conclusions

Py5cheSim is a new discrete event Python simulator focused on cell capacity analysis. Its validation and calibration process has been a comprehensive check verifying in a wide variety of scenarios.

We are working on a second version of the simulator improving some features and including others. In particular we are working on a associated library to simplify the development and testing of new 5G scheduler algorithms (inter and intra Slice).

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