Demo: Real LTE Experimentation in a Controlled Environment

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ABSTRACT
LTE, commonly known as 4G, stands for Long-Term Evolution and is a wireless communication technology standardized by 3GPP. LTE adoption has increased drastically over the last years, and today is integrated widely in a vast number of wireless devices. However, significant restrictions, such as the increased equipment cost and the acquisition of licensed spectrum, renders experimentation with real LTE equipment very difficult. Recently, iMinds w-iLab.t testbed has been extended with commercial LTE equipment and an EPC (Evolved Packet Core) software platform, offering the opportunity to orchestrate and execute real LTE experiments, hereby providing full access to the most relevant configurable LTE parameters of the network. In this paper, we describe an LTE demonstration scenario that showcases various use cases and the respective experimental settings that can be conducted on the LTE testbed.

Keywords
LTE; wireless; experimentation; testbed; replicability; controlled mobility

1. INTRODUCTION
LTE is a wireless technology, which due to its innovative architecture provides enhanced spectrum management, increased capacity (approaching the Shannon limit [1]), high user data rates and low latency. These characteristics render LTE a very appealing wireless technology currently being deployed worldwide at an increasing rate. LTE is designed to operate in licensed spectrum and as such only mobile operators owning frequency licenses have the right to deploy it. As a consequence end-to-end experimental networks using real LTE equipment are very scarce. Additionally, experimentation in a commercial operated LTE network is not recommended, because of non-replicable experimental conditions. The iMinds w-iLab.t testbed [2] has obtained a test license for LTE frequencies assigned by the BIPT[1] and has been recently extended with both LTE hardware and EPC software. Since early 2015, iMinds offers open access to a fully operational LTE test network for designing and performing end-to-end LTE experiments in a well-controlled environment. The controlled conditions of the LTE testbed offer the immense advantage of performing replicable and reliable experiments. The experimenter can modify various LTE parameters that are normally not accessible to users.

Furthermore, an experimenter can exploit other technologies supported in the w-iLab.t testbed such as Wi-Fi and Bluetooth, in order to perform multi-RAT (Radio Access Technology) experiments. Adequate monitoring tools, e.g. a spectrum analyzer, and cognitive radio platforms, such as WARPs and USRPs, the latter also available with LTE compatible front ends, can assist the monitoring and the validation of the experiments.

Various types of experiments can be performed in the testbed, for instance designing and studying interference scenarios, studying the behavior of different Modulation and Coding Scheme (MCS) profiles in the downlink (DL) or the uplink (UL), designing mobile LTE scenarios using the controlled robotic platform provided by the testbed and many more.

This paper describes an LTE demonstration scenario showcasing the DL throughput achieved using different MCS profiles, as well as how neighboring cells operating in the same frequency channel can interfere and reduce the throughput. This is a realistic scenario deserving attention by the research community, as it has to be addressed in the context of 5G dense and small cell setups.

2. DEMONSTRATION
2.1 Test setup description
The LTE experimental facility of the iMinds w-iLab.t testbed consists of both an EPC network and a Radio Access Network (RAN). The EPC software platform is provided by SiRRAN Communications and is compliant with the 8th release of the 3GPP specifications for LTE. It consists of MME, HSS, S-GW and P-GW modules and provides a web interface for monitoring and configuration. The RAN part of the LTE testbed is composed of two femtocells provided by ip.access that can operate in 3GPP

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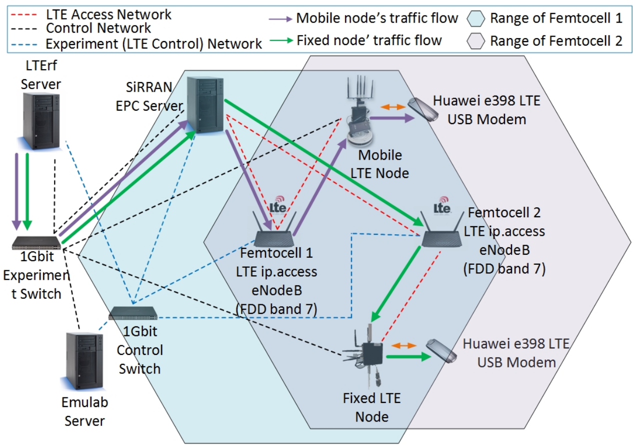

Figure 1: LTE Demo's architecture

bands 7 and 13, and 28 Huawei LTE USB dongles that can support 2x2 MIMO. Eight of these dongles are attached to fixed nodes distributed in the testbed, while the other 20 are mounted on mobile nodes. The different LTE software modules and femtocells provide an API that allows configuration of their parameters through scripts. Moreover, configuration can also be achieved via OMF [3], using the LTErf service [4] developed by the UTH team [5]. The configuration of LTE testbed resources with OMF aligns the LTE experimentation with the de facto testbeds' philosophy.

2.2 Experiment scenario

In our scenario, we examine the LTE DL throughput that can be achieved between the server hosting the LTErf service and a UE, using different MCS profiles. We further analyze how interference from a neighboring cell can affect this throughput. The UE is mounted on a mobile node that moves around following a predefined route. The interferer node is fixed. The LTE network consists of the EPC and 2 femtocells, while the LTErf server is used to configure the femtocells and initialize the traffic. Both femtocells are configured to operate in the same frequency and are placed closely together, so that their cell ranges overlap. Both nodes are in the range of the two femtocells, but are attached to a different femtocell. This way, transmission from/to the femtocells will interfere with each other. Figure 1 illustrates the described scenario.

2.3 Execution and results

The mobile LTE node is attached to femtocell 1 and the fixed (interferer) node to femtocell 2. Femtocell 1 is configured to use the 18th MCS DL profile and femtocell 2 is configured to use the 27th. When the experiment starts, the mobile node starts following the predefined route and the LTErf server initializes DL UDP traffic towards the mobile node using a data rate of 60 Mbps. As the node moves around, the received throughput is measured and is represented on a graph. Then, the traffic stops, femtocell 1 changes to the 27th MCS DL profile and the server hosting the LTErf service again sends LTE traffic. Meanwhile, the

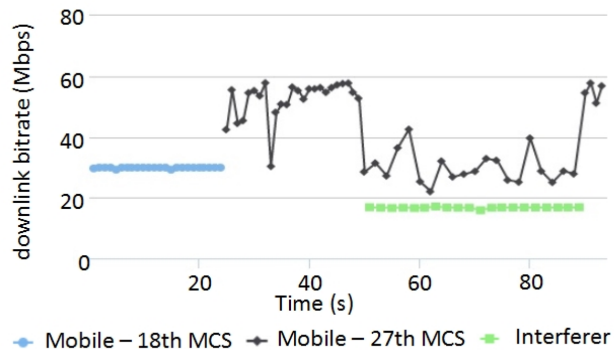

Figure 2: Downlink throughput using different MCS profiles and the degradation caused by interference

received throughput measurement continues. After a while, the LTErf server concurrently starts a second data stream to the fixed node. This causes interference leading to throughput degradation, as shown in Figure 2. The blue and black graphs denote the DL throughput using the 18th and the 27th MCS profile respectively. The graphs show that the higher MCS profile achieves higher throughput, but is more sensitive to the node's movement. As Figure 2 shows, after the first 50 seconds the controlled interference is introduced, resulting in a decreased throughput. Finally, the throughput increases again when the interference stops.

3. CONCLUSION

This paper presents the iMinds w-iLab.t LTE testbed and emphasizes its newest features offering LTE experimentation using commercial LTE equipment. We demonstrated a relevant scenario showcasing how an experimenter can use the LTE testbed with the standardized experimentation tool OMF to study the behavior of different MCS profiles and the impact of interference on the DL throughput.

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