Demo: Experimentation in Controlled and Operational LTE Settings with FLEX-MONROE

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ABSTRACT

This demo paper presents FLEX-MONROE, a platform that facilitates better understanding of current LTE Mobile Broadband (MBB) networks and enables performance improvements by allowing experimentation with controllable LTE parameters. The platform enables investigating impact of low-level network parameter tweaks in LTE infrastructure on the application performance. We argue that FLEX-MONROE is crucial to provide guidelines on improving application performance both in the current and future MBB networks.

CCS CONCEPTS

• **Networks** → **Network experimentation**; **Mobile networks**; *Network performance analysis*; • **Software and its engineering** → *Scheduling*;

KEYWORDS

Mobile Networks; Experimentation; Testbeds; Performance

1 INTRODUCTION

For mobile communication innovations, there is a need for a truly open MBB network that can offer the experience of an operational commercial network with the unique perk of controlling different network elements. In this paper, we try to address this goal by introducing FLEX-MONROE that enables experimentation with LTE networks both with commercial operational networks with MONROE [1] and in controlled settings with configurable equipment with FLEX[4].

MONROE is designed to advance understanding of MBB ecosystem from the end-user's perspective but due to lack of control over commercial networks, it cannot diagnose the root-cause of performance problems. To understand reason behind different behaviors, FLEX provides an opportunity to run similar measurements in an experimental LTE network. To demonstrate the benefits of FLEX-MONROE, we show the impact of twisting the LTE network parameters on the quality of service characteristics and application performance by taking Web browsing as a case study.

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2 FLEX-MONROE PLATFORM

In FLEX, LTE components are deployed on three wireless testbeds of FIRE [1]; in this paper we focus on the NITOS [4] indoor testbed which provides controllable RF-isolated environment consisting of over 60 nodes with two eNodeBs.

MONROE, on the other hand, consists of 150 multihomed hardware devices (both mobile and static) enabling large-scale experimentation on commercial cellular operators. Its software framework enables the orchestration of experiments along with its analysis and visualization. Authenticated users can access the platform, reserve resources and deploy their own or ready-to-use experiments[2] under a predefined quota.

The integration of MONROE in FLEX can be either hardware or software-based. For HW integration, we installed two MONROE nodes within the FLEX NITOS testbed equipped with custom FLEX SIM cards, configured with the NITOS PLMNs. For the SW integration, we generated the MONROE node software image installable in any compatible NITOS native node. To run an experiment in FLEX-MONROE the user needs to reserve resources in both FLEX and MONROE testbeds (Figure 1).

The experimenter first connects to the NITOS server using a certified slice[3]. Using the OMF Aggregate Manager service *LTErf*, the experimenter can then control the LTE base station parameters. In Table 1 we summarise a few of these configurable parameters with a short description and the range of possible values. As a final act, the experimenter

[1] https://www.ict-fire.eu/
[2] https://github.com/MONROE-PROJECT/Experiments
[3] http://nitlab.inf.uth.gr/doc/lte.html

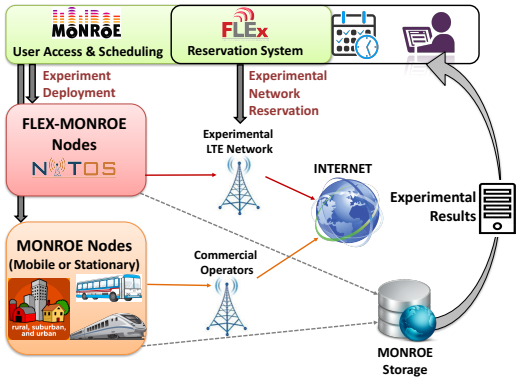

Figure 1: High level design of the FLEX-MONROE platform.

Table 1: Configurable LTE metrics in NITOS network.

Parameter	Description	Range
Power	Signal transmit power	-15dbm to -26dBm
Tx Mode	Enabled antennas	1/2
MCS DL	Downlink MCS profile	0-28
FQ Band	LTE band	7/13

can use the MONROE User Access and Scheduling system to deploy a measurement campaign and obtain measurements.

3 WEB PERFORMANCE EVALUATION

To demonstrate the measurement campaign in FLEX-MONROE platform we take web browsing as a case study. We leverage `WebWorks`[4], to investigate web performance in terms of Page Load Time (PLT). We first deploy the `WebWorks` in operational networks through MONROE platform (accessing 12 different operators) and then in a controlled environment through FLEX-MONROE nodes. `WebWorks` collects web performance metrics while visiting a target webpage using Firefox in headless mode. During web-browsing, network-side context features are retrieved from the corresponding node(s). The category of a website hints towards its content complexity [2]. We therefore analyze three popular web pages namely wikipedia.org, www.bbc.co.uk and ebay.co.uk. The measurement setup and initial analysis of our experiments are detailed in [3].

The experiments from commercial networks (Figure 2) revealed that the operators differ in their PLT performance both across websites and countries and that PLT is highly impacted by the websites' own features. Among the network parameters, we find that the number of times the RSRP value changes during an experiment has the highest impact on the PLT, followed by the LTE band and the average latency values. Analysis reveals that RSRP values away from each other by unit of 10 show slight decreasing PLT tendency and less variability with better signal quality is observed.

[4]https://github.com/MONROE-PROJECT/Experiments/tree/master/experiments/WebWorks

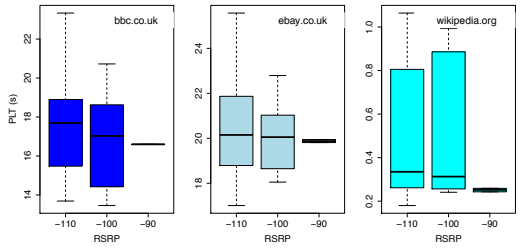

Figure 2: PLT at different signal quality levels for a particular MONROE node.

To understand whether the signal strength variation is large enough to bring greater change in corresponding PLTs of webpages, we ran further experiments. We observe that though the RSRP quality reduces with reduction in the RFSignalPower, the overall range of RSRP is quite small, varying only from -85 to -97 dBm. We conjecture that by varying the distance between the FLEX-MONROE node and the eNodeB, we may observe more notable changes in RSRP and its propagating effects on performance metrics.

4 CONCLUSIONS

In this demo, we showcased capabilities of FLEX-MONROE, a testbed that offers unified experimentation capabilities in LTE networks both in operational commercial (MONROE) and in controlled experimental (FLEX NITOS) scenarios. As a use case, we consider web QoE features with respect to network side performance parameters in LTE networks. The demo is interactive, allowing attendees to run web experiments on FLEX-MONROE and observe PLT for different websites in real-time under various settings.

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