Demonstration of a Custom LTE Emulation-based Test Environment

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ABSTRACT

Notwithstanding the value of Long Term Evolution (LTE) towards an improved user experience in next-generation networks, its associated high complexity is known to place computational and time burdens on testing tasks involving real-world platforms. Simulation is currently the tool most widely used to tackle this issue. LENA, for instance, is an open source simulator based on ns-3 that allows the design, evaluation, and validation of LTE networks. Despite of modeling the main LTE elements and interfaces, one limitation of LENA is that it does *not* support the use of external traffic entities in conjunction with the simulation. In this presentation, we will demonstrate an ns-3 LENA LTE framework customized for use in emulation-based test environments. To validate our emulation results, it is possible to use as benchmark a testbed that differs from the aforementioned test environment in that the ns-3 server running the simulated network is replaced with a network made up of real-world platforms. This comparison and the results are described with details in [1]. Initial validation results, based on limited tests using an industry-standard VoIP test tool, demonstrate that ns-3 LTE models can deliver voice quality and latency as good as an experimental testbed using actual LTE equipment over a range of signal-to-noise ratios. Similar conclusions are also drawn for throughput, thus confirming the suitability of our emulation approach as a viable means to predict performance in real LTE networks. The good agreement of our experimental results is possible not only because the *same* functionality is implemented in *both* experiments but due to the use of the *same* traffic generation tools in the simulated *and* real-world LTE networks – not possible in standard LENA simulation. The proposed demonstration will include only the emulation-based test environment, not the real-world LTE platform scenario, and is focused on the voice quality and latency evaluation, based on mean opinion score measurements.

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1. DEMONSTRATION

Since the release 8 of its Long Term Evolution (LTE) standard [2], the Third Generation Partnership Project (3GPP) has specified functionalities of utmost importance to the development of next-generation networks.

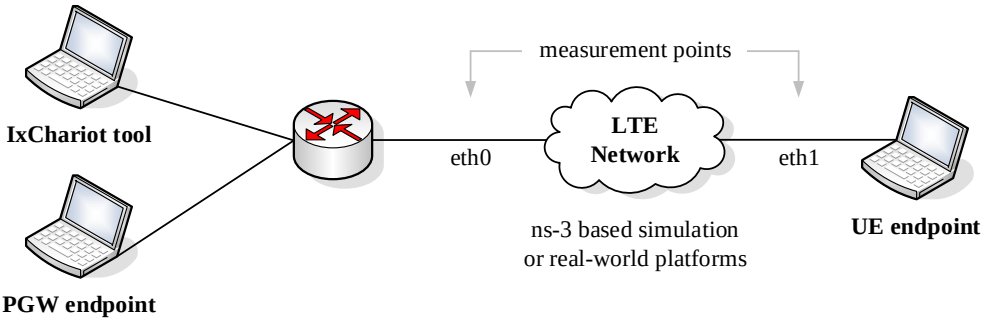
The high complexity of LTE poses computational and time burdens on testing tasks involving real-world platforms, *e.g.* 3GPP tests of conformance, performance, mobility, and QoS with respect to different services. Simulation is the tool most widely used to circumvent this limitation, although the use of implementation and emulation in research has been ramping up recently as alternatives to pure simulation. Implementation means that the experiment runs a fully functioning protocol stack on top of a real-world platform, whereas emulation is a term used to denote experiments that result from a combination of simulation and implementation [3].

In the context of LTE, most simulators found in the literature tend to rely on built-in traffic generation processes (see *e.g.* [4] and [5]). This is also the case with LENA [6], a recently introduced ns-3 module whose use has been leveraged within the community in view of the LTE functionalities, protocols, and interfaces it implements. However, and despite of modeling evolved packet core (EPC) network, evolved node B (eNodeB), user equipment (UE), and respective protocol stacks, one limitation of LENA is that it does *not* support the use of external traffic entities in conjunction with the LTE simulation. A consequence of that is the impossibility to employ hypertext transfer protocol, Skype, YouTube, or any other real-world traffic entity – source or sink – external to the simulation.

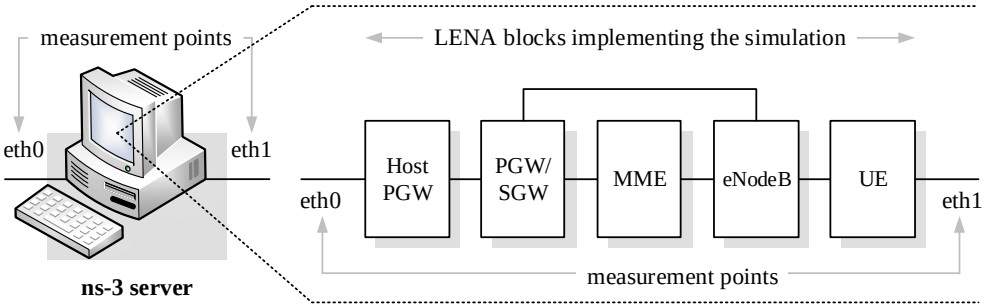
In this presentation, we will demonstrate an ns-3 LENA LTE framework scenario customized for use in an emulation-based test environment that allows a wider variety of real-world applications to be run over the simulated links.

The *internal* interfaces created within our custom LENA are associated with the *external* Ethernet interfaces of the ns-3 server running the simulation. This allows one to physically connect the ns-3 server to other computers running elements of the industry-standard testing tool IxChariot [7]. Having this (and other modifications required for passing real data through the simulated LTE entities) in place, we assess the performance of the emulator in terms of voice quality and latency.

The demonstration scenario proposed in this document is depicted in Figure 1. As can be seen from the figure, this common architecture consists of a server, a *generic* LTE network, and two client endpoints. The IxChariot [7] server is



(a) General architecture.



(b) Simulated LTE network.

Figure 1: Pictorial descriptions of the demonstration. The measurement architecture depicted in (a). The demonstration replaces the LTE network with an ns-3 server running LENA blocks as shown in (b).

used to monitor and measure the traffic that flows through the LTE network, as well as to calculate the MOS of each one of these data flows. IxChariot communicates directly with the packet data network gateway (PGW) endpoint and indirectly, via LTE network, with the UE endpoint. As the names suggest, PGW and UE endpoints are respectively connected to the host PGW network interface (eth0) and the UE's network interface (eth1) of the LTE network. In the proposed emulation setup, shown in Figure 1(a), the goal is to assess voice quality and latency. The IxChariot endpoints generate VoIP traffic in this case.

We refer to the LTE network as generic, actually experiment-dependent, as it could assume the form of a custom ns-3/LENA-based emulator or a practical testbed made up of real-world platforms depending on the experiment considered.

Our emulator relies on standard ns-3/LENA scenarios with just few customizations, being thus quite simple. Assuming some prior knowledge of ns-3/LENA is available we refer the interested reader to [8] for details of the ns-3/LENA architecture and to [9] for its specific documentation. The demonstration consider the recently standardized Band 31 (450-470 MHz), with frequency division duplexing, 5 MHz operation channels, adaptive modulation, and round robin scheduling. The ns-3 server is equipped with an Intel Core i7-2600 quad core processor with 3.4 GHz, 8 GB of random access memory, and two physical Ethernet interfaces, and runs Linux Ubuntu 12.04 as operational system. The Linux "top" command is used to monitor CPU utilization, process statistics, and memory utilization, so we can ascertain that the ns-3 server running the emulation is handling the workload during the measurements.

2. REFERENCES

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