Chapter 15
Hybrid Simulated-Emulated Platform – HySEP

Igor Bisio
University of Genoa, Italy

Mario Marchese
University of Genoa, Italy

Stefano Delucchi
University of Genoa, Italy

Giancarlo Portomauro
University of Genoa, Italy

Fabio Lavagetto
University of Genoa, Italy

Sandro Zappatore
University of Genoa, Italy

ABSTRACT

The main contribution of this chapter is the description of HySEP, Hybrid Simulated-Emulated Platform, developed by the authors and aimed at simulating/emulating heterogeneous networks to validate and test algorithms for traffic control and Quality of Service (QoS) assurance. Main features of HySEP are the appropriate level of accuracy and detail reached by using equipments available in most communication research laboratories, at low cost, and the easy configurability. HySEP is divided into three parts connected each others: the emulated core network; the simulated wireless access network communicating with the core network; and the real remote host. The overall platform is able to handle real traffic flows and overcomes the limitations introduced by other network simulators. HySEP is characterized by remarkable versatility and wide applicability to support the validation of different algorithms.

INTRODUCTION

The aim of this chapter is to describe the tool Hybrid Simulated-Emulated Platform (HySEP) that integrates simulated and emulated networks. HySEP enables simultaneously the test of wireless access technologies without the use of real network implementation, and the transmission of real traffic flows from/to real hosts that communicate with the simulated part of the network. Such scenario assures great advantages in the study and analysis of different network configurations using different types of real traffic flows. In particular, in this chapter, the authors present the capabilities of the tool in terms of scenarios that can be simulated and analyzed. Hybrid Simulated-Emulated Platform (HySEP) is composed of three main elements: Emulated Core Network (ECN), composed of a network of virtual machines (VMs); Simulated Access Network (SAN) which is the simulated

DOI: 10.4018/978-1-4666-8732-5.ch015

wireless access network communicating with the core network; and Real Remote Host, acting as an end point for the traffic flows generated by the nodes simulated by SAN.

This platform can assure a fundamental support to study a communication network where different access technologies such as Long Term Evolution (LTE) are available. Considering such technologies, this instrument assures a great level of detail, is able to simulate realistic scenarios. In the same time it reduces the complexity of testing different configurations and different network control algorithms with respect to a real implementation.

The set of scenarios that can be simulated is limited by the technical features (e.g. CPU limitations) of the personal computers used to implement the platform. The goal of this chapter is to show HySEP capabilities so as the limitations in the dimensions of the access network, in terms of number of users and data rate by performing scalability tests. The simulation segment of the platform is implemented by using the Network Simulation 3 (ns-3) software which assures the use of wireless technologies with a large amount of details even if requiring heavy computational resources (i.e. CPU usage). When the computational resources of PCs are insufficient, the simulation can be executed, but the synchronization with the emulated segment is compromised.

The following tests have been carried out:

- Preliminary validation tests: the correct communication between the simulated terminals and the remote host inside the emulated segment is checked by using network analysis tools, such as Wireshark and Iperf (iperf16). These tests are also useful to evidence HySEP capabilities, allowing the readers to better understand how the platform works and what can be done through it.
- Scalability tests: which are aimed at defining the limits in the size of each wireless access network that can be defined inside the simulated segment of HySEP. It is worth noting that the results are obtained by using specific PC configurations. Changing PC features can affect the numerical results.
- Vertical Handover tests: conducted to study how the heterogeneous simulated access networks can cooperate assuring the simultaneous availability of different connections to the core network. The authors developed a multi-interface node equipped with heterogeneous network interfaces to execute these tests. The implementation of this node within ns-3 is also described in this chapter.

This chapter includes the following contributes: i) a detailed description of the network simulation and emulation framework in which we highlight HySEP scope, applications, and requirements, with particular reference to the simulation segment; ii) an overview of the state of the art regarding network simulators and platforms; iii) a brief overview of the tools used to create HySEP, such as: ns-3 simulator, Direct Code Execution framework (used to integrate real applications within the ns-3 script), and Iperf and Wireshark (used to measure traffic statistics); iv) the HySEP presentation; v) a discussion about the executed tests so to evidence HySEP capabilities and operative limitations.

BACKGROUND

Objective of the Tool

The proposed HySEP tool is aimed at studying the Quality of Service (QoS) and the Quality of Experience (QoE) over an heterogeneous network composed of different access technologies such as Long Term Evolution (LTE) and Wi-Fi, and of a core network implementing the Differentiated Service (DiffServ) paradigm. In particular