Implementing new OpenFlow features in ns-3 network simulator

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Abstract
We are witnessing a rapid growth in communication, and current networks are becoming larger and more complex. Many works point to the use of Software-Defined Networking (SDN) and the OpenFlow protocol as enabling technologies to overcome current limitations. As the use of software-based simulation is a straightforward option for researchers in this area, the main contribution of this work is the validation and enhancement of the OpenFlow module for the well-known ns-3 network simulator.

Key words: Software-Defined Networking, OpenFlow Protocol, ns-3 Network Simulator.

Introduction
The Software-Defined Networking (SDN) is receiving great attention from the academia and industry. The SDN decouples the system that makes decisions about where traffic is sent (the software controller) from the underlying systems that forward traffic to the selected destination (the hardware data plane). OpenFlow is the first standard interface designed specifically for SDN, providing high-performance, granular traffic control across multiple network devices. Since software-based evaluation is a common approach used by research to fast experimentation purposes, this work focuses on enhancing the well-known ns-3 network simulator with cutting-edge OpenFlow technology. The ns-3 is a free software widely used by researchers. The project objectives include new features implementation, documentation improvements and some novel test cases.

Results and Discussion
The authors identified that the existing module was very outdated, and many new major OpenFlow features were introduced since its development. So, an entire new OpenFlow module was developed in parallel to this project: the ofswitch13 module. The ofswitch13 interconnects the ns-3 simulator to the external library, to create both an OpenFlow 1.3 switch device and an OpenFlow 1.3 controller interface, as illustrated in Image 1. With this module it is possible to interconnect simulated ns-3 nodes to send and receive traffic using the existing Ethernet device models. This project improved the new module with a set of novel example scenarios, which can be used by new users as a starting point for coding new simulations. Also, some test cases were proposed to validate the ofswitch13 implementation, and the module documentation was written in accordance to ns-3 design guidelines. The module is under releasing process, and there is a webpage with more information about the project.

Conclusions
The ofswitch13 module was designed to enhance the ns-3 with SDN technology support. The new module was enhanced with new examples and test cases throughout this project. The results lead to a publication at an international conference, and the module release processes is an ongoing work.

Acknowledgement
The authors would like to thank CNPq – Brazil, for the financial support (process 118198/2014-9).

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