Chapter 1
OMNeT++ Framework for Simulation of Centralized and Distributed Algorithms in Multi-Hop Networks

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ABSTRACT

Theoretical applications and practical network algorithms are not very cost-effective, and most of the algorithms in the commercial market are implemented in the cutting-edge devices. Open-source network simulators have gained importance in recent years due to the necessity to implement network algorithms in more realistic scenarios with reasonable costs, especially for educational purposes and scientific researches. Although there have been various simulation tools, NS2 and NS3, OMNeT++ is more suitable to demonstrate network algorithms because it is convenient for the model establishment, modularization, expandability, etc. OMNeT++ network simulator is selected as a testbed in order to verify the correctness of the network algorithms. The study focuses on the algorithms based on centralized and distributed approaches for multi-hop networks in OMNeT++. Two network algorithms, the shortest path algorithm and flooding-based asynchronous spanning tree algorithm, were examined in OMNeT++. The implementation, analysis, and visualization of these algorithms have also been addressed.

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INTRODUCTION

Simulators are the common name for the tools used for implementing, testing and monitoring real-life situations in a virtual environment. Recently, simulators have been used in various scientific fields in order to obtain experimental results using limited resources. In addition to the limited resources such as time, money and labor, it is possible to test and implement difficult or impossible cases by means of simulators. Thanks to these tools, experimental studies and proofs-of-concept (PoCs) are conducted in virtual environments rather than the physical world. Real-life applications can also be performed based on the results obtained. This is also valid in the IT sector, and especially in computer networks.

Computer networks are structures consisting of many different nodes and various network elements (router, switch, etc.). These structures being in communication with each other can be found at different scales. There may be networks consisting of a small number of nodes, as well as networks spreading to the cities, countries, continents and even the planets. Establishing a real-test environment in experiments and researches in this field brings a major burden in the industry in terms of time and cost. Moreover, it may not be possible to access the environment where the network is planned to be installed or there may be situations where intervention is not possible after a real installation. Furthermore, it may be much more convenient to test the performance of a proposed algorithm in computer networks of different sizes using simulators, instead of working on real networks.

There are various tools used for Network Simulation. While some of these tools are free of charge, some of them are only free of charge for educational and academic purposes for commercial activities. Some of them are fully paid as well. In addition, each of these simulation tools focuses on different features of the networks and provides a more convenient environment for certain areas and analyses. Therefore, when choosing a simulation environment, the most suitable one will be selected according to the purpose of the environment. OMNeT++ (Varga, 2019), used in this chapter, and also other popular network simulators will be briefly introduced.

THE COMPARISON OF NETWORK SIMULATORS

In recent years various comparisons between network simulators are done (Weingartner et al., 2009; Chaudhary et al., 2012; Xian et al., 2008). We are briefly defining some of the most popular network simulators and we are giving comparison between them shown in Table 1 (Kabir et al, 2014).

NS2 (Network Simulator v2): NS2 which is a discrete event simulator with a focus on network research is used for simulating TCP, routing and multicast protocols over wireless and wired networks (Issariyakul and Hossain, 2009).

NS3 (Network Simulator v3): NS-3 which is a free software for simulating Internet systems is publicly available for research, development and educational purposes. Various virtual nodes can be created by using NS3 (Riley and Henderson, 2010). Various auxiliary classes, devices, internet stacks or applications can be installed on the previously created nodes. Connections between nodes such as PointToPoint, Wireless, CSMA can be simulated by means of NS3. C++ or Python languages are used to code the simulation.

Opnet: Opnet Network Simulator which is an event-based high-level network simulation tooloffers a large number of project scenarios (Chang X., 1999).