A Simple Analysis on Novel Based Open Source Network Simulation Tools for Mobile Ad Hoc Networks

C. Rajan¹, K. Geetha², C. Rasi Priya³, S. Geetha⁴, A. Manikandan⁵

¹, ², ³, ⁴ Department of IT, K.S.R.C.T, Tamil Nadu, India
⁵ Department of IT, Excel College of Engineering, Tamil Nadu, India

Abstract— Simulation is cost-effective because it is used to carry out experiments without the actual hardware and provides a good compromise between complexity and accuracy of the system. The network simulators implemented in software are used for the process of simulation. The networks simulators are valuable tools which help the researchers to develop, to test and to diagnose network protocol. The performances of the networks are verified and evaluated using simulation. Different types of network simulators are available in present. It is difficult to choose an appropriate tool for the system without the complete analysis of existing tools. This paper presents the simple survey about some network simulators for Mobile Ad-Hoc Networks (MANETs). Researchers can find the efficient and reliable simulation tools for their project with the help of this survey.

Keywords— GloMoSiM; Network Simulator; NS-2; NS-3; OMNET++

I. INTRODUCTION

Establishing a network in a real time scenario is not easy in network research area. A large amount of time and cost is taken by a single test bed. So the implementation of an entire network in real world is not easily possible and also costly. The network developer can check whether the network is able to work in the real time or not, with the help of simulator. Thus the time and cost required for the functionality of a network are reduced.

In recent years, Mobile Ad-hoc Networks (MANET’s) have become more popular. It raise interest requires adapting solutions from the traditional wired networks to the wireless environment. At different stages of design, deployment and implementation, the performance evaluation of algorithms and protocols become challenging [1]. Performance analysis of newly designed algorithms and protocols are extremely desirable for efficient MANET’s deployment. Simulation is cost-effective because it is used to perform experiments without the actual hardware. Analyzing the results of simulation will be easier when compared to experimental results. It is because that the important information at critical points can be easily logged to help researchers to diagnose the network protocols. There are different network simulators are available, in which they are categorized and also explained based on the criteria like commercial or free. Network simulators which are denoted as commercial are the one which do not provide the affiliated packages or the source code to the general users for free. The general users have to pay to get the license to use the commercial simulation software. Some of the typical example simulation tools are OPNET [2] and QualNet [3]. Some of the examples for open source network simulators include NS-2 [4], NS-3 [5], OMNeT++ [6], SSFNet [7], NCTUns [8] and J-Sim [9].

NS-2 (Network Simulator version2): NS-2 is an open source, discrete event simulator. It is focused at networking research. NS-2 provides support for simulation of routing, TCP and multicast protocols over both wired and wireless networks.

NS-3 (Network Simulator version3): NS-3 is also an open source discrete-event network simulator. It primarily targets for educational and research use. NS-3 is licensed under the GNU GPLv2 license. NS-3 is also available for research and development [17].

OMNET++ (Optical Micro-Networks Plus Plus): OMNET++ is a modular, extensible and component-based C++ simulation library and framework, primarily used for building network simulators.

JSIM (Java-based simulation): It is a Java-based simulation system for building quantitative numeric models and analysing them with respect to experimental reference data.

OPNET (Optimized Network Engineering Tools): It is extensive and powerful simulation software with wide variety of possibilities to simulate entire heterogeneous networks with various protocols.

The main objective of this survey paper is to find the simulator for mobile ad hoc network which provides good balance between features. The features include accuracy, efficiency, and extendibility etc. The simulator can also be easily used by the users. These types of simulators allow the researchers to perform their work efficiently. Therefore, this survey paper also contains the overview and features of different simulators in a project area.

II. RELATED WORK

Several authors have already delivered the survey papers for different network simulators which contain its features, advantages, disadvantages, comparisons and case studies.
In [10] authors described a case study of different simulation tools for wireless Networks. In this paper the authors match up to strengths and weakness of simulators such as NS-2, GloMoSim, QualNet, OMNeT++, OPNET and J-Sim.

In [11] authors proposed a project called Integrated Risk Reduction of Information-based Infrastructure Systems (IRRIIS). The main aim of this project is to identify, compare tools and components and listing them which are suitable for decisive infrastructure simulations. The authors used the simulators such as NS-2, OMNET++, QualNet, J-Sim and OPNET Modeler.

A case study is done for some popular network simulators such as OMNET++, NS-2, J-Sim and ShoX. These simulators were used to evaluate a topology control protocol in a network [12]. In this paper, authors presented the comparisons and the outstanding features of each and every simulator included.

The features and descriptions of simulators NS-2, OPNET Modeler, GloMoSim, NAB, OMNET++, DIANEmu, QualNet, GTNets and SWANS [31] are presented by the authors in [13]. The author also gives some hints along with the characteristics based on the usage of each simulator.

In [14] author gives an overview about different issues in wireless sensor networks on a common basis. The author also presented a comparison table of simulators at the end of the paper based on their language and availability of the GUI support for each simulator.

A comparative study is done for simulators NS-2 and OPNET Modeler in [15]. The author compared the results of simulators with the result from a live network testbed. This survey paper will act as a guide to the researchers in their packet-level network simulations.

In [10] the author described a comparative study of Network Simulators J-Sim, NS-2, OMNET++ and ShoX. The comparison is done based on the implementation, visualization, installation and familiarization of the Network Simulators.

III. NETWORK SIMULATION TOOLS

A different variety of network simulators are available for the users. Each and every simulator has some features different from others. Fig.1 represents most commonly used network simulation tools.

A. NS-2

Network simulator-2 is developed in the year 1995 under the VINT (Virtual Inter Network Testbed) project. It is done by a joint effort of a people from University of Southern California's Information Sciences Institute, Lawrence Berkeley National Laboratory, University of California at Berkeley and Xerox Palo Alto Research Center. It includes the main sponsors National Science Foundation and the Defense Advanced Research Projects Agency [18].

Network Simulator-2 (ns-2) is an open source as well as discrete event network simulator. It was built in C++ and also it provides the simulation interface through OTcl (Object-oriented Tcl). It is the most widely and commonly used network simulator and it mainly focuses on networking research. NS-2 is used for the simulation of network protocols which includes different network topologies [4]. Simulation of both wired as well as wireless networks is possible using ns-2. A network topology is described by the users using the OTcl scripts. Simulation of that particular topology is done by the main NS program with specified parameters. The graphical view of the network is done in ns-2 with the help of network animator (NAM). The control features of NAM interface allow users to play, pause, forward and stop the simulation.
Network Simulator-2 is a discrete event simulator that provides wide-ranging support for simulation of TCP, routing, and multicast protocols over both wired as well as wireless networks. Arbitrary network topologies can be defined in ns-2 that are composed of routers, links and shared media [19]. Most of the researches in MANET routing are done based on the naturally inspired algorithms such as Ant Colony Optimization algorithm and Particle Swarm Optimization algorithm [33], [34]. NS-2 some plays a vital role in simulating networks based on those algorithmic techniques.

Fig. 2 Network Simulator -2

B. NS-3

Network Simulator-3 is also a discrete event simulator like ns-2. It targets primarily at research and educational uses. It was started in year 2006 as an open source project. Network simulator is licensed under the GNU GPLv2 license.

Network Simulator-3 (ns-3) is not an extension of ns-2, it is considered as a replacement of ns-2 [20]. Like ns-2, it does not have an OTcl API. It is written in C++ language and python. The latest version of ns-3 is ns-3.10 that supports parallel simulation and has an enhanced feature set. In addition, ns-3 network simulations can be implemented in pure C++, while some parts of the simulation can also be written using Python [21].

Ns-3 supports both simulation and emulation using sockets. It also generates pcap traces that can help in debugging. To analyze network traffic, standard tools like Wireshark [22] can be used to read trace files. Ns-3 provides a realistic environment and its source code is well organized [23].

Fig. 3 Network Simulator -3

C. OMNET++

OMNET++ [24] has been available to the public since September 1997 and currently has a large number of users. Unlike ns-2 and ns-3, OMNET++ is not only designed for network simulations. It can also be used for modeling of multiprocessors, distributed hardware systems and performance evaluation of complex software systems. However, OMNET++ is most commonly used for computer networks simulation. OMNET++ is a general discrete event, component-based (modular) open architecture simulation framework.

The motivation behind the development of OMNET++ was to produce a powerful open-source discrete event simulation tool. That can be used by academic, educational and research-oriented commercial institutions for the
simulation of computer networks, distributed and parallel systems [25]. OMNET++ distributions are available for both UNIX and Windows-based systems. It was developed using component-oriented approach that promotes structured and reusable models. In addition, OMNET++ has extensive graphical user interface (GUI) and intelligence support [26].

Fig. 4 OMNET++

D. GLOMOSIM

Global Mobile Information System Simulator (GloMoSiM) is a simulation environment used for large scale wireless networks. GloMoSiM uses parallel discrete-event simulation based on Parsec [27]. And also GloMoSiM uses the Parsec compiler to compile the simulation of protocols [28].

GloMoSiM is capable of simulating a network that contains thousands of nodes and heterogeneous communication links, for instance multicast and asymmetric links. In addition, GloMoSiM supports traditional Internet protocols, direct satellite communication, multi-hop wireless communication. GloMoSiM is designed purely for wireless networks. It is a library based sequential and parallel simulator [28].

GloMoSiM has a scalable simulation library that is based on the Parsec simulation environment [29]. GloMoSiM is developed as a set of library modules. Each module in GloMoSiM simulates a specific wireless communication protocol in the protocol stack [30].

Fig. 5 Global Mobile Information System Simulator.

E. NCTUNS

NCTUns [8] network simulator, which is a high-fidelity and extensible network simulator. It is capable of simulating both wired and wireless IP networks. NCTUns stands for National Chiao Tung University network simulator. The predecessor of the NCTUns is the Harvard network simulator [16], which was authored by S.Y. Wang in 1999. NCTUns simulator was developed S.Y. Wang, because the Harvard network simulator has several limitations and drawbacks that need to be overcome and solved. It also does not have some functions and features.

The NCTUns has a fully-integrated GUI environment by which a user can easily perform simulation studies. NCTUns contains the performance monitor which easily and graphically displays the plots of some monitored performance metrics such as a link's utilization or a TCP connection's achieved throughput. Simulating Single-hop networks, simulating multi-hop networks and Tunnel Network Interface are the main features of NCTUns [32].
TABLE I COMPARISON TABLE

<table>
<thead>
<tr>
<th>S. No</th>
<th>Network Simulators</th>
<th>License</th>
<th>Interface</th>
<th>GUI</th>
<th>Scalability</th>
<th>Simulation Technique</th>
<th>Document &amp; User Support</th>
<th>Available Modules</th>
<th>Emulation Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>NS-3</td>
<td>Open Source</td>
<td>C++, Python</td>
<td>Limit ed</td>
<td>Large - Scale</td>
<td>Discrete Event Simulation</td>
<td>Excellent</td>
<td>IP &amp; Non-IP based networks</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>OMNET++</td>
<td>Open Source</td>
<td>C++, NED</td>
<td>Yes</td>
<td>Large</td>
<td>Discrete Event Simulation</td>
<td>Medium</td>
<td>Wired, Wireless and Ad Hoc networks</td>
<td>Limited Support</td>
</tr>
<tr>
<td>4</td>
<td>GLOMO SIM</td>
<td>Open Source</td>
<td>C</td>
<td>Limit ed</td>
<td>Large</td>
<td>Discrete Event Simulation</td>
<td>Poor</td>
<td>Wired, Wireless and Ad Hoc networks</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>NCTUNs</td>
<td>Open Source</td>
<td>C</td>
<td>Yes</td>
<td>Medium</td>
<td>Discrete Event Simulation</td>
<td>Good</td>
<td>Wired, Wireless and Ad Hoc networks</td>
<td>Yes</td>
</tr>
</tbody>
</table>

IV. CONCLUSIONS

In this survey paper, the performances of five network simulators are described. It is concluded that large scale network simulations are easily carried out by NS-3, GloMoSiM and OMNET++ simulators. The fastest simulator among the given five simulators is NS-3. It demonstrates the best performance when compared with the other simulators, even though it is still under development. The best choices for Mobile Ad-Hoc Networks are NS-2 and OMNET++. All range of protocols in all layers is widely supported by NS-2. And also the specific MANET routing protocols are provided by NS-2. OMNET++ is better for development, because it supports the powerful GUI and also hierarchical modeling. Another good and strong scalability power simulator is GloMoSiM. It is useful for the wireless network which contains the large number of nodes.

REFERENCES


[31] SWANS: http://jist.ece.cornell.edu/

