

# A Survey on MANET Simulation Tools

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**Abstract**—Simulation play important role in the testing and development of any network. It is very expensive to test every network protocol or any network algorithm in real network by connecting a number of routers, computers and data links. Simulation tool (Simulator) is a piece of software or hardware provides a virtual environment to network though the network is not actually present. There are many simulators present for mobile ad-hoc network. These simulators cover various aspects of this network. This paper describes the network simulators for mobile ad-hoc network to help the researchers for choosing the simulator, which will be efficient, reliable as per their requirements.

**Keywords**- ns-2, ns-3, OPNET,OMNET++.

## I. INTRODUCTION

Simulator is a very important tool for research community not only for mobile ad-hoc network but for other networks also. Simulators present an inexpensive way to evaluate any research without the use of actual hardware. Simulators provide an atmosphere in which one can check the capacity of network by creating virtual traffic, check security by doing virtual attacks and various parameters like packet delivery ration, efficiency, overhead, no. of users support, accuracy in the network can be evaluated. Any new protocol or algorithm does not test on real plate form because it requires no. of hardware, human resources, time and also because of uncertainty of results. So before implementing in real world, it is tested on simulator; if it give supposed result then it is used in real world. These network simulators are mostly GUI driven and can be easily installed on a desktop pc or a laptop [1]. These provide the graphical evaluation. Simulators are commercial or free. Free simulators are freely available to all and mainly used by students for evaluating their research. Commercial simulators are not freely available for general people. It need license and used by organizations. All simulators provide a complete toolkit to the developers that enable metrics collection and various wireless network diagnostics [2]. Toolkit contains the entire possible tools which are required for testing and evaluation of network. However simulator does not give to the point evaluation but if it is carefully modeled then it give result enough close to real result. There are many simulators available.

The rest of paper is organized as follows. Next section gives the category wise explanation of the MANET simulators. Section III provides the open issues and future scope before the paper is finally concluded in section IV.

## II. TAXONOMY OF MANET SIMULATORS

### A. NS-2

NS-2 is a discrete event simulator. It is the second version of NS. It is an open source simulator. It is widely used in academic research area. The primary version of NS was specified in 1989. The current NS project is supported by DARPA [1] [3]. Some features of ns-2 are described below:

- NS-2 is dual language simulator: one is C++ and second is OTCL. OTCL is for command interpreter.
- NS-2 is firstly used for wired network but now it is widely used for wireless network. It provides 5 layer of OSI except session and presentation layer.
- It is single threaded event driven simulator. Means it can only execute one event at a time. If many events are scheduled in ns-2, it select one of them on the basis of first come first serve.
- It can support simulation of TCP, routing over wired and wireless network.
- Extensions in ns-2 provide the more realistic simulation environment by combining both wired and wireless network.
- NS-2 comprises an energy model and it permits user to simply generate traffic.

There are some drawbacks of ns-2 due to its open source nature are described below:

- It provides limited and out of date documentation
- It is lack of tools to provide good simulation scenario
- It cannot support more than 500 nodes.
- If user code amended for any reason, ns-2 requires recompilation every time.

### B. NS-3

NS-3 is an open source and discrete event simulator. It is started in 2006. Early, it is used for educational and research purposes. It is licensed under GNU GPLv2 license; it is used for research and development purposes. The ns-3 simulator support both IP and non-IP network. It supports Wi-Fi, WiMax, LTE and various MANET routing protocol [1] [4]. Some features of ns-3 are described below:

- It is written in C++ and Python

- It performs better than NS-2 in terms of memory managements
- It is updated model provide good documentation
- It supports light weight virtual machines
- NS-3 is not updated version of ns-2, it is does not support some ns-2 API. NS-3 has some new features and is better from ns-2 and it is still under development.

NS-3 has following limitations:

- Due to Python it has limited support of visualization
- NS-3 is not backward compatible with ns-2 so it is difficult to migrate from ns-2 to ns-3

### C. OMNET++

OMNET++ is an object oriented discrete event simulation. It is publically available since 1997. OMNET++ is a public-source, and can be used under the Academic Public License that makes it free for non-profit use. OMNET++ is powerful open source simulation tool, mainly used for academic, educational and research oriented institutions for the research purpose of computer networks, distributed or parallel systems and in other fields [6][7][8]. Some features of OPNET++ are described below:

- It supports large scale network without any difficulty.
- It is written in C++.
- It provides rich class library for various module implementations.
- It supports parallel simulation execution.
- It provides containers, queues and also provides the feature of priority queue.
- It supports traffic modeling of telecommunication network.
- It provides graphical tools for result analysis.

OMNET++ has following limitations:

- It gives poor analysis of performance measures.
- It gives poor documentation.
- The mobility extension of OMNET++ is incomplete
- It does not have much variety of protocols.

### D. OPNET

OPNET is a high level event based simulator. It is first proposed in 1986 but went public in 2000. It is a commercial simulator but provides free license for educational purposes. It is mainly developed for military operations. Its interface is constructed in C and C++ [5]. Some features of OPNET are given below:

- It provides good protocol designing and testing environment in realistic scenario.

- OPENT accelerates the research and development process for designing and analyzing protocols and communication network
- It provides user friendly graphical interface.
- It is very powerful and large simulator provides various options for simulation.
- It supports grid computing for distributed simulation.

OPNET has following limitations:

- It does not provide good wireless mobility.
- It is lack of energy model.
- It provides limited support to protocols.

### E. GloMoSim

GloMoSim is a scalable discrete event simulator. It provides support to both wired and wireless network. It has layered approach like OSI model. Its library is developed using PERSEC language which is C based parallel simulation language. It supports large variety of wireless protocols. It is a free simulator and do not need any licensing [9]. Some features of OPNET++ are described below:

- It is very scalable and provides simulation of thousands of nodes.
- Its library is developed in PERSEC.
- It supports wireless network protocols.
- It has parallel environment which distinguish it from other simulators.
- It provides simulation of very large network and can reduce execution time of simulation
- Due to PERSEC, it can execute different asynchronous simulation protocols.

GloMoSim has following limitations:

- It requires separate installation of PERSCE.
- It provides poor documentation.
- It is not up to date simulator.

### F. QualNet and EXATA/cyber

QualNet is a commercial adaptation of GloMoSim used by Scalable Network Technologies (SNT) for defense projects named BCNIS, JTRS and Startcom Cyber. SNT developed various versions of simulator: QualNet, EXATA, and EXATA/cyber [6] [10]. Some Features of QualNet is given below:

- It has Java based user interface.
- It provides comparative performance evaluation of protocols at each layer.
- It provides rapid prototype of layers.
- It has built in measurements of layers.

- It has graphical tools for various evaluations.
- It has animation tools.
- It provides very helpful documentation.
- The manufacturer claims that QualNet scales up to “10s of thousands of nodes”.

QualNet has following limitations:

- It is very expensive so cannot used commonly
- It have slow interface.
- Its installation is very difficult on LINUX.

### G. JIST/SWANS

First version of JIST/SWAN is released in 2005. JIST is a high performance java based discrete simulator. It is abbreviated as java in simulation time. It is written in java and compiled using java compiler. SWANS is scalable wireless network simulator built atop the JIST platform. It has similar

capabilities with ns-2 and GloMoSim but can simulate a large network [6] [11]. Some of features of JIST/SWANS are given below:

- It can simulate large network.
- Due to Java, it is very powerful simulator.
- Simulation Code which wants to run on JIST should not need in domain specific language.

JIST/SWANS have following limitations:

- It is comparatively lack of features from OMNET++.
- There is no development of JIST/SWANS since 2005 so it cannot compete with new simulators which are up to date.

By considering the importance of different simulators; parameters of these simulators are summarized in TABLE I.

TABLE I. PARAMETERS AND ISSUES OF MANET SIMULATORS

| Simulator               | License                                    | Languages Involved | Network   | Issues   |
|-------------------------|--|--------------------|---|--|
| ns-2                    | Open Source                                | C++, OTCL          | Wired,Wirless,Ad-hoc network                      | Poor documentation, change in code need recompilation every time, lack of tools, can not simulate large network. |
| NS-3                    | Open Source, licensed under GNU GPLv2      | C++, Python        | Wired, Wireless, Ad-hoc network                   | Limited support of visualization and can not backwad compatible with ns-2.                                       |
| OMNET++                 | Open Source, Academic public Licensed      | C++, NED           | Wired,Wirless, Ad-hoc network                     | Poor documentation,poor performance measures, lack of variety of protocols.                                      |
| OPNET                   | Commercial, Free under educational License | C, C++             | Wireless ,Ad-hoc network                          | Lack of good wireless mobility, lack of energy model, limited support to protocols.                              |
| Glomosim                | Free                                       | C, PERSEC          | Wireless sensor network, Ad-hoc network           | Poor documentation and need separate intallation of PERSEC.  |
| QUALNET and EXATA/cyber | Commercial                                 | JAVA               | Wired,Wirless, Ad-hoc network                     | Expensive, slow interface and difficult to install on LINUX.   |
| JIST/SWANS              | Commercial                                 | JAVA,Tcl           | Wireless sensor network, Vehicular ad-hoc network | Does not develop since 2005 so cannott compete with new simulators which are upto date.                          |

### III. OPEN ISSUES AND FUTURE SCOPE

Important features and capabilities of MANET simulators have been discussed in previous section. Considering the importance of simulators of MANET, the features of simulators, open issues and future scope has been presented here:

All the simulators have their own powerful features like NS-2 provides energy model, ns-3 is very good for documentation, OMNET++ have very rich class library, OPNET is easy to use, GloMoSim is very scalable, QualNet provides animation tools and JIST is very powerful simulator. But still there are some open issues as some simulators like NS-2 and NS-3 are very difficult to use. GloMoSim, OMNET++ and NS-2 are not good for documentation. Some

simulators are work on only commands or programming rather than GUI which is somehow difficult. OMNET++ and OMNET do not cover all the protocols. Commercial version of various simulators is very expensive and some simulators are very difficult to install and not up to date.

It can be hoped that these issues will be solved in future or any new simulator which will overcome these problems will be developed. In future newly developed or improved simulator will be easy to install and user friendly, it will provide good documentation and will not be expensive, it will based on GUI which will make it easy to customize any project, it will cover all the aspects of a network and will be up to date.

## CONCLUSION

MANET is an active area of research. Researchers have already done much work on MANET, but research work on various aspects of this network still remaining. Simulator provides an economical way to evaluate the outcome of newly developed protocol or any algorithm; otherwise it will be very expensive to test all on real platform. Simulators are used to calculate the accuracy, throughput, scalability, latency traffic ratio etc. parameters of a protocol. Different simulators have been developed in the recent past with powerful features that cover different aspects of MANET. Important features of simulators had been discussed in the paper to identify accurate simulator for testing and designing protocols in MANET as per the requirement. In this comparative study of simulators the important issues that need immediate attention for researches are summarized. Important features, capabilities and issues in simulators have been extracted that will prove helpful for the active researchers to identify the simulator as per the specific requirements.

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