Study and Analysis of Various Simulation Tools for Network Security Algorithms

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Abstract— The simulator plays vital role for developer to check whether the network security algorithm is able to work in real time. It is very costly and not easily achievable task to implement and establish network security algorithm in real world. As a result cost of testing functionality of network security algorithm as well as the time taken has been reduced and thus implementations are made easy. In our research paper the features of six currently used simulators NS2, NS3, OMNet++, OPNET, Scilab, and MATLAB are analyzed. Our analysis of these selected simulation tools for network security algorithm would be beneficial to make use of suitable simulation for research work.

Key words: NS2, NS3, OPNET, OMNeT++, MATLAB, Scilab

I. INTRODUCTION

One of the most significant technologies of the modern world is Simulation. To study Simulation it can be speculative and a real life objects on a computer. The network security algorithm is also simulated on the computer. There are two options to calculate the conduct of network securities, one is seizing and playing back observation from production network and the second is interconnection of network entities through mathematical formula.

For Network security algorithms different types of simulators can be grouped as Network Simulators and Numerical Computational Packages which is further divided in to Open Source and Commercial simulators.

A. Network Simulator:

By researcher [1] network simulator is a tool that is widely used to construct large and complex networks. It is important in enhancing the networking process as it uses mathematical equations to calculate the conduct of network. Network symbols and their relationship help in calculating the network conduct. It helps in formulating and implementing the different types of topologies. Researchers use this to study and examine the formulae that are practically hard to test. It is specifically of use in testing new networking protocols in a stringent situation and can be reusable too. There are vast and wide areas that extensively use network simulator to test the efficiency of performance of diverse network protocols. The comparison of these types of simulators as based on:

- Application that use text as their operative mode.
- Where nodes and their interconnection are specified.
- Where the variation of starting and ending rang is wide.
- Where the protocol used is specified in detail as to how the network congestion as managed.

B. Numerical Computational Packages:

By [2] to analyze, to create and to implement algorithms for solving numerically the problems of continuous mathematics, numerical analysis plays a vital role in the area of computer science and mathematics. For implementing numerical analysis C, C++ and Java are the most important programming languages. The most popular way to do numerical computing a commercial package is well known. For numerical computations in engineering, statistics, mathematics and other fields MATLAB is highly preferable commercial package.

There are different simulators with different features. By [1], [3] and [4] some of the generally used network simulator and Numerical Analysis Simulator are as per table given below. In this paper we will analyze six currently used simulators NS2, NS3, OMNet++, OPNET, Scilab, and MATLAB which reflects recent development status.

Sr. No.	Types of Simulator		Name of Simulator
1.	Network Simulator	Open Source	NS2, NS3, OMNeT++, REAL, J-Sim
		Commercial	OPNET, QualNet, NetSim
2.	Numerical Computational Packages	Open Source	Scilab, GNU Octave, FreeMat
		Commercial	MATLAB

Table 1: Categorization of General Simulators

II. OUTLINE OF SOME OF THE GENERAL SIMULATION TOOLS

- NS2 - By [5] it is the most popular open source discrete event simulators targeted at networking research work. For the graphical view of the network in NS2 Network animator is used.
- NS3 - By [6] it is primarily used for research and educational purpose and is also an open source discrete event network simulator. By using sockets it supports both simulation and emulation. It has well organized source code and gives a realistic environment.

- OMNET++ - By [7] it is a powerful component-based, open architecture and has a modular framework of discrete event simulator for building network simulators.
- REAL - By [8] it is network simulator which provides users with a way of specifying packet-switched data networks. It is for analyzing congestion control schemes and potent behavior of flow in packet-switched data networks. Programming language C is used in this simulator.
- J-Sim – By [9] it is component based software architecture which supports an application development environment. It is for forming measurable numeric models as well evaluating them with regards to experiment evidences of data. It is java based simulation system and also support web based simulation. Java and Tcl are programming languages.
- OPNET - By [10] it is slightly different from other network simulator. It is immense and effective simulation tool to simulate heterogeneous networks with varied protocols with extensive possibilities. Its environment supports the distributed systems and modeling of communication networks.
- QualNet - By [11] it is highly authentic network simulator for enormous, distributed applications and heterogeneous networks that execute on wired, wireless and combined platform of network and networking device performance. QualNet follows a procedural paradigm and uses C/C++ programming language while implementing new protocol. It can run on distributed machines, as it uses the parallel simulation situation for fundamental operations in complicated systems.
- NetSim - By [12] it simulates Cisco networking hardware and software Systems. It is designed to help the user to learn Cisco IOS command structure. NetSim will support computer based amalgamated work. As compare with other network simulator NetSim provides more adaptability and support. It is deliberated for use within the various divergent defense systems.
- Scilab - By [13] it is one of the open source option to MATLAB. It is high level numerically oriented programming language and is cross platform numerical computational package. MATLAB code can be converted in Scilab that has similarity in syntax.
- Scilab can be used for numerical optimization, statistical analysis, fluid dynamics simulations, simulation of explicit and implicit dynamical system and image enhancement.
- GNU Octave - By [14] it is basically deliberate for numerical computations and is high level elucidating language. For data visualization and manipulation GNU Octave provides large-scale graphics capabilities. It is capable for performing numerical experiments and for numerical solution of nonlinear and linear problems. Though generally is used through interactive command line interface, is also used to write non-interactive programs. Most programs are simply portable because Octave language is entirely similar to MATLAB.
- FreeMat - BY [15] it is open source numerical computing package similar to MATLAB, GNU Octave and IDL from Research Systems. It has a free framework for scientific prototyping, prompt engineering and data processing. Additionally it is to support some IDL Functionality and many MATLB Functions, FreeMat features a codeless interface to external FORTRAN, C and C++ Code. It has 3D and plotting envision capabilities.
- MATLAB - By [16] it is high level language for numerical calculation, visualization and programming. As compared with conventional programming languages like C/C++ or Java, MATLAB enables to explore multiple approaches and quickly conclude to a solution. MATLAB can be used for develop algorithms, analyze data and create models and applications.

III. STUDY OF SELECTED SIMULATION TOOLS

A. NS2:

By [5] and [17] it is extensively used in academic research with its packages supplied by different non benefited groups. It is basically established on REAL network simulator. It gives support for simulation of routing, simulation of multicast protocols and simulation TCP over wired and wireless networks.

The programming language it uses is C++ and OTcl. OTcl is a Tcl script language as well Object oriented extensions. C++ language is well organized for design implementation but for graphically and visually it is not very efficient. So the amalgamation of these two C++ and OTcl languages is very efficient. C++ is utilized for implement detailed protocol and OTcl is for users to restraint the simulation scheme as well plan the events. OTcl is slow-going but it can be swapped very rapidly that's why it is ideal for simulation configuration. NS gives glue to create objects and variables appears on these both languages.

NS2 is accessible on platforms of Windows, Free BSD and UNIX. Small scale networks are simulated on bases of NS2. The benefits of NS2 are its low cost, easy testing of complicated structures, quick procurement of results. The utmost drawback is that real time system is a complex to model and has issues of measurability. The features of NS2 are:

- An object-oriented
- Event scheduler

In NS2, by invoking suitable network components the event scheduler retains the record of simulation time as well sets all the events in event concatenation. Before taking further action on packet all the network component utilize the event scheduler by providing an incident for the packet and waiting for the incident to be free.

B. NS3:

By [6] and [18] NS3 is designed to substitute the well liked NS2 in present-day, yet NS3 is not a revised version of NS2. NS3 has not backward compatibility with NS2 but it is a new simulator accessible for research and development and is licensed under the GNU GPLv2. The fundamental of NS3

is written in C++ with Python scripting interface. Also various progressive C++ design patterns are used. The start of simulation and simulation topology are defined by the libraries which are built by NS3 can be statically or dynamically linked with C++. C++ is used for implementation of simulation and C++ is wrapped by Python. NS3 supports Linux x86 and x86_64, FreeBSD x86 and x86_64, Mac OS X Intel platforms and also lightly supports Visual Studio 2012 and Windows Cygwin 1.7 platforms. The features of NS3 are:

- Modular and documented core.
- Attribute system and has update models.
- Support inclusion of more open-source networking software.
- It uses lightweight virtual machines.
- It minimizes the requirement of rewriting models for simulation.
- It designs protocol entities which are to be closer to real computers.
- Without reconstructing the simulation core it tries to enable customization of the output by evolving a tracing and statistics gathering structure.
- It has Virtualization, test bed integration and Software integration.

C. OMNeT++:

By [7] and [19] OMNeT++ is also a public-source, discrete event, component-based, network simulator with GUI support same as NS2 and NS3. The roots of simulation can be installed amongst all categories of various users' applications due to its modular architecture. Generally it is used for simulation but also it is used for queuing network simulations as well in other areas.

It uses C++ programming language for its modules. It supports Linux, Mac-OS and UNIX platforms. The features of OMNET++ are:

- It depicts a structural approach.
- Simulation models are evolved completely independently and they follow their own release cycles.
- The modules can be merged in different ways and are reusable.
- For writing different simulations it gives an infrastructure.
- Tools are there to facilitate and manage simulations.
- For simulations there are runtime user interfaces.
- To create simulation components simulation kernel and utility classes are used.

D. OPNET:

By [10] and [20] it is studied that by performing discrete event simulations behavior and as well the execution of designed systems can be evaluated. It uses C programming language but recently released version support C++. For users benefit user friendly charts, graphs, statistics and animation can be created by OPNET. It supports C, C++, OPNET modeler software platforms. OPNET has three main inbuilt functions.

Sr. No.	Inbuilt Function	Description
1.	Modeling	To create all kinds of models of protocols it provides intuitive graphical Environment.
2.	Simulating	To address a wide range of studies it uses three different advanced simulation technologies.
3.	Analysis	Result of simulation and data can be easily evaluated and exhibited

Table 2: OPNET inbuilt Characteristics

Features of OPNET are:

- It is Object-oriented modeling.
- It has hierarchical modeling environment.
- It is fast discrete event simulation engine.
- It has component library with source code.
- It has graphical user interface.
- It supports wireless simulation.
- It has 32-bit and 64-bit parallel simulation kernel.
- It supports grid computing.
- It has open interface for integrating external component libraries.

E. Scilab:

By [13] and [21] it is programming language with splendid collection of numerical algorithms that covers numerous features of scientific computing problems. Users can solve their particular problems because they can develop their own modules. Scilab language allows dynamically compiling and linking other languages such as FORTRAN and C. It provides versions for Windows, Linux and Mac OS. Key features of Scilab are:

- It has Differentiable and non-differentiable optimization.
- It supports exceeding one occurrence without adjustment on performance.
- To handle matrices syntax is its ability.
- It has Open programming environment.
- It supports a character string data type which, in particular, allows the on-line creation of functions.
- Generally it allows to get faster development processes
- User-defined data types can be defined with possibly overloaded operations.
- It provides many graphical features.

F. MATLAB:

By [16] it is high level language for application development, for numerical computation and visualization. It is used for diverse applications such as control systems, test and measurement, communications and signal processing, video and image processing, computational finance and computational biology. It is the language of technical computing and used by engineers and scientists in industry and academician. The key features of MATLAB are:

- It has functions for amalgamate MATLAB based algorithms with external languages and applications like Microsoft Excel, Java, C and .NET.
- It has tools for establish applications with custom graphical interfaces.
- It has development tools for maintainability, improving code quality and maximizing performance.
- It has inbuilt graphics for visualizing data.
- It has inbuilt tools for creating custom plots.
- It has Interactive environment for design, problem solving and iterative exploration.
- From MATLAB, the code written in .NET, C, C++ and Java can be called without deviation.
- By using the MATLAB engine library, MATLAB code can be called from C, C++, or FORTRAN applications.

MATLAB comprises of varied tools for efficient algorithm development, which consists of:

Sr. No.	MATLAB Tools	Description
1.	Command Window	It interactively enters data, executes commands and programs and displays results.
2.	MATLAB Editor	It has features of editing and debugging.
3.	Code Analyzer	It checks code of problem automatically and suggests modifications to optimum performance and maintainability.
4.	MATLAB Profiler	It quantifies the performance of MATLAB programs and recognize areas of code to modify for improvement.

Table 3: MATLAB Tools

In research paper [22] they surveyed for new progress in the field of network simulation and they did a performance comparison study by executing similar simulation setup in five simulators, namely NS2, NS3, OMNet++, SimPy and JiST/SWANS. Their results disclose large differences as stated by both memory usage and run-time performance. They find the simulator which majorly depends on the specific use case is difficult in use. But if scalability is the main concern NS3, OMNeT++ and JiST are smart choices.

By Technical report [23] MATLAB is extensively used Commercial Numerical Computational Package. With numerous of similar features Scilab, GNU Octave and FreeMat are alternative free numerical computational packages which is available for Winows, Linux and Mac OS X operating systems. They compare the results they receive from Scilab, GNU Octave and FreeMat with MATLAB results. They conclude that:

- GNU Octave is the most suitable with MATLAB due to its numerical abilities, the similarity of its syntax and also it has free parallel computing extensions.
- Linear system in Scilab has limitation in the size
- FreeMat has limited three-dimensional graphics capabilities.

While studying technical report [24] Scilab contains all the fundamental features needed for a scientific computational program. In present days use of Scilab is limited to open source users and the developer group. Scilab does not contain clear-cut listing of functions, extensive search and tutorials but it has caliber to gives a serious warning to proprietary software like MATLAB. The online help in Scilab is limited as compared to MATLAB.

Sr. No.	Parameter	MATLAB	Scilab
1.	System Requirement	Very high for the best performance.	Functions are effective with minimum requirements.
2.	GUI	Large scale GUI and it contains all essential features.	The GUI requires many more features.
3.	Loading Time	It is extremely slow moving.	It is very fast moving.
4.	Control System execution	The number of functions available is very high.	The obtainable functions are inadequate.
5.	Image Processing execution	Some of the readymade functions are not available.	Readymade functions are available

Table 4: Comparisons between MATLAB and SCILAB

By Research paper [25] they have been discussed advantages and disadvantages of internal structure, information about each of simulator abilities, for NS2, OMNeT++, OPNET, QualNet and J-Sim simulators. Also they analyzed conditions wherein simulators can be utilizes for their best need. Finally, they conclude about making the apt choice of network simulator established on the needs of researchers. NS2, OMNet++ and OPNET simulators have network visualization tool, availability of analysis tool and features of interaction with real systems as well of creating trace files. Additionally OPNet have features of Communication with other modules and Fast simulation capabilities.

The focal point of research paper [26] is performance comparison of four network simulators, NS2, NS3, OMNet++ and GloMoSim based on the parameters of memory usage, CPU utilization, scalability and computational time by simulating a mobile ad hoc network routing protocol to identify an excellent network simulator for the research group. On the basis of simulation result they conclude that:

- NS3, OMNet++ and GloMoSim are able for simulate large scale network.
- NS3 is the fastest simulator in terms of computation time among NS2, NS3, OMNet++ and GloMoSim simulators.

- NS2 completely utilize the CPU, but when other applications are executed in parallel NS2 is able to reduce CPU utilization.
- NS3 shows the best execution amongst the above mentioned simulator.

By researcher [27] they presented extensively used wireless network simulators like OPNET, NS-2, NS-3, OMNeT++, NetSim, QualNet, REAL and J-Sim, etc. obtainable in present day with their features such as availability, types, network impairments, support and interface for network protocol. From their survey, it is found that till present day no one of the researcher or author utilizes the potential of all the most well-liked general purpose simulators jointly for one application, so that a common scrutiny application.

Simulators	Features			
	User Support	GUI	Mobility	Learning Time
NS2	Excellent	Limited	Yes	Long
NS3	Excellent	Limited	Yes	Short
OMNet++	Good	Good	No	Moderate
OPNET	Excellent	Excellent	Yes	Long

Table 5: Comparison between Features of NS-2, NS-3, OMNeT++ and OPNET

By researcher [28] they show how to use NS2simulation for scheming wireless networks and utilizing cryptography algorithm as to secure information. They used NS2 for the simulation of selected illustrative examples of wireless networks. In NS2 simulator they performed end user performance of wireless network consisting 35 nodes. To secure information of package transfer in communications, they used RC5 Cryptography algorithm. For future work they concluded that it is possible to transfer more secure information among nodes with the combination of two types of cryptography algorithm.

IV. SELECTION OF SIMULATORS

By researcher [29] they used different encryption algorithm without delay during processing of each packet instead of single encryption algorithm. By simulation studies on NS2 through simulating BLOWFISH, RC2, DES and AES algorithms on GARUDA Grid Network Topology, the performance has been measured. They conclude that utilization of cryptography algorithm at the application layer has clear impact on the network performance. Also it has been exhibited that haphazard changing of encryption algorithm while transferring the data has favorable effect on performance. The effort required to break the code by any interceding hacker will be changed by haphazard change of encryption algorithm and this will theoretically strengthen the security.

By researcher [30] they have evolved simulation scripts for WPA (Wi-Fi Protected Access) and WEP (Wired Equivalent security algorithms. These algorithms have been successfully used to simulate WLANs. The consequence of these security algorithms are measured by using NS2 simulator on different parameters like packet delivery part and end to end deferment by using these scripts. They have done analysis that WEP provides larger end to end delay as compared WPA. They concluded that WPA has a finer execution in relation to packet delivery part and end to end deferment.

The motive of research paper [31] is to present how to utilize cryptographic algorithm for securing information and use of NS2 for designing a secure network. They compared the results from different encryption algorithms. The paper defines how to add a brand new protocol for NS2 as it does not support any security features.

While studying research paper [32] and [33] some results were assessed and studied by comparing all the symmetric encryption methods. To show which algorithm performs better in network they have done analysis of AES, DES and Blowfish algorithm in other simulators like NS2, NS3, OPNET and MATLAB etc. For cryptographic applications in network, these simulators will give better results.

By researcher [34] they have created a wireless network in OMNET++ simulator which contains a server as a Base Station (BS) and 5 hosts as Subscriber Stations (SS). Also based on the security parameters like, type of message (transmit or receive), SS (subscriber station) ID, bandwidth request and communication band, they have simulated AES based security model using OMNET++.

While studying researcher paper [35] they suggested an encryption algorithm to attain the end-to-end security for an IP Multimedia Subsystem with minimum time delay. OPNET simulator is utilized to assess the suggested inter domain security gateways of IP Multimedia Subsystem architecture with encryption algorithms. Also end to end delay generated by both Advanced Encryption Standard (AES) and Triple Data Encryption Standards (3DES) algorithm is reckoned by simulating them in OPNET. The simulation result displays that Advanced Encryption Standard Cipher Block Chaining (AES-CBC) encryption algorithm gives a more secure period with minimum time delay.

By researcher [36] they implement different security algorithm for increase the performance of mobile ad hoc network (MANET) Network. They have considered DSA, RSA and MD5 algorithm for checking load, response time, reliability and throughput of Ad-hoc networks with execution of these algorithms. For checking out the performance and reliability of the network, they start with different scenario in OPNET simulator. In simulations, they consider of sensing area of 100 m*1000m, each is with arranged 10 mobile nodes at random. Also they define the two blade servers and database server for testing their research connected with 15 nodes Local Area Network (LAN).

By Researcher Paper [37] they developed the concept of RSA algorithm in brief. Also they design and analyze the performance of their improved implementation. In this research paper an effective execution of RSA is displayed by utilizing different tools from MATLAB toolbox.

While studying Researcher Paper [38] In MATLAB they have described design and simulation of AES-128 algorithm for image encryption, which is completely appropriated for the matrix based data structure of AES algorithm. The gray level image file is taken for execution of AES in MATLAB. In this research three image files of different sizes in pixels are considered prior encryption, post encryption and post decryption. The main benefit of executing with MATLAB is the comprehensibility, more than speed of execution.

V. CONCLUSION

Our paper provides analysis of simulation tools namely: NS2, NS3, OMNet++, OPNET, Scilab and MATLAB for network security algorithms. We observed that combination of the capability of commonly used simulator tools is not used for network security algorithm.

After analyzing above mentioned simulators and researchers work on these simulators we reached to a conclusion that NS2 is extensively used for network security algorithms.

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