

Investigation of Network Simulation Tools and Comparison Study: NS3 vs NS2

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Abstract - Establishing and implementation of a whole network in real time scenario is very difficult. It is too much time consuming and costly to deploy a complete test bed component containing multiple networks (computers, routers and data links) to validate and verify a certain network protocol or a specific network algorithm for wired and wireless network. A widespread methodology is used for verifying, testing and analyzing the results of network based on network simulation. A network simulation is a technique where the program models the behavior of a network either by calculating the interaction between the different network entities (hosts, packets, etc.) using mathematical formulas, or actually capturing and playing back observations from a production network. The network simulation is performed by network simulation tool is referred to as network simulator. A network simulator is a piece of software or hardware that predicts the behavior of a network without an actual network being present. During the past years, varieties of network simulation tools have been developed in the field of communication. In this paper, network simulation tools namely NS3, NS2, OMNet++, NetSim, OPNET, REAL, J-Sim, QualNet have been compared and a comparison study between two simulators namely NS3 and NS2 has been conducted.

Index Terms – J-Sim, Network Simulator, NetSim, NS2, NS3, OMNet++, OPNET, QuealNet, REAL, Simulation.

This paper is presented at International Conference on Recent Trends in Computer and information Technology Research on 25th& 26th September (2015) conducted by B. S. Anangpuria Instituteof Technology & Management, Village-Alampur, Ballabgarh-Sohna Road,Faridabad.

1. INTRODUCTION

Networking community is largely depending on simulation to evaluate the behaviour and performance of network protocols for various networks [1]. Simulators are good option to negotiation the cost and complexity and gives precise results. The simulator can use for different field of technology like science, engineering, and other application fields for different purposes. It is computer assisted simulation model based on hypothetical and real-life objects or activities on a computer for verifying studied to see how the system working and functioning.

A network simulation is a technique where a program models the behaviour of a network either by calculating the between the different network interaction entities (hardware/software) using mathematical formulas for capturing and playing back observations from a production network [2]. The network simulation is performing by network simulation tool which is referred as network simulator. A network simulator is a part of software or hardware that predicts the behaviour of a network, exclusive of an actual network being present [2]. Network simulators are used by people from different areas for different purposes (design, simulate, verify, and analyze the performance of different networks protocols) [3].

Establishing and implementation of a whole network in real time scenario is very difficult. To deploy a complete test bed which containing multiple networked (computers, routers and data links) to validate and verify a certain modelled network protocol or a specific network algorithm for wired and wireless network is time consuming and costly. With the help of network simulators, the real world networks can try to model. After that the features of the modelled network can be changed and the corresponding results can be analyzed. When a simulation program is used in conjunction with live applications and services in order to observe is referred as network emulation [2].

The rest of paper is organized as follow: the second section is the investigation and classification of various simulation tools, the third section is the comparison study of NS3 and NS2 simulator and finally concluded in last section.



. SIMULATION TOOLS INVESTIGATION

During the last years, varieties of network simulation tools have been developed in the field of communication engineering. We reviewed the network simulation tools, namely, NS3, NS2, OMNet++, NetSim, OPNET, REAL, J-Sim, QualNet.

2.1. NS3

NS3[4][5] is a discrete event network simulator, primarily focus for research and educational use. NS3 is free software under the GNU GPLv2 license, which is publicly available for use. NS3 encourages the development of simulation models which are sufficiently realistic to allow NS3 to be used as a real-time network emulator which can be interconnect with the real world and which allows many existing real-world protocol implementations to be reused within NS3. The NS3 simulation core supports research on both IP and non-IP network. Majority of its users mainly focus on wireless/IP simulations which involve models for layers 1 and 2 and variety of static or dynamic routing protocols such as OLSR and AODV for IP-based applications.

NS3 also supports a real-time scheduler that facilitates a number of "simulation-in-the-loop" use cases for interacting with actual systems. For instance, users can send and receive NS3 generated packets on real network devices, and NS3 can work as an interconnection framework between virtual machines.

2.2. NS2

NS2[6] is discrete event [7] network simulator which composed of C++ code, which is used to model the behaviour of the simulation nodes, and OTcl scripts that handle the simulation and specify the network topology. This design choice was originally made to avoid unnecessary recompilations if changes are made to the simulation set-up. The frequent recompilation of programs was indeed time-consuming and slowed down the research cycle when the first version (Back in 1996) of NS2 was released.

2.3. OMNet++

OMNeT++ [8] is a discrete event [9] extensible, modular, component-based C++ simulation library and framework. The domain-specific functionality for sensor networks [10], wireless ad-hoc networks, peer-to-peer network, Internet protocols, optical switch and storage area network [11] are supported. OMNeT++ is an eclipse based IDE graphical runtime environment [9]. The extensions are handle real-time simulation, network emulation, alternative programming (Java, C#, C), and database integration.

2.4. NetSim

NetSim[12] is a one more discrete event simulator which was developed by Tetcos. It is mainly used for network lab experimentation. It supports major technologies like wireless (LAN, Wi-Max, MANET, WSN, Wi-Fi), MPLS, QoS, VoIP, TCP, IP, etc. It serves as the interface between user's code and NetSim's protocol libraries and simulation kernel. NetSim protocol libraries are available in open C code for alteration. It also support the debugging ability with breakpoints and checkpoints during simulation through that user can perform single-step, step-in, step over observation [13].

2.5. OPNET

OPNET comes with GUI for the topology design. It allows for practical simulation of networks, with performance data collection and display modules [16]. It is high-fidelity discrete event simulation models for technologies like IPv6, LTE, MPLS, UMTS, 802.16 (WiMax). It facilitate simulation, analysis and design of networks, protocols, devices, and applications (terrain modeling, system-in-the-loop, 3D network visualizer, app transaction xpert models application transactions) [14][15].

2.6. REAL

Mainly, the REAL is intended for studying the dynamic behaviour of flow and congestion control schemes in packet switching network. It provides users with a way of specifying such networks and to observe their behaviour. It has approximate thirty modules which are written in C. It can emulate the several well-known flow control protocols and fives scheduling. The simulator takes as an input of scenario with topology, protocols, and workload and control parameters. It creates as an output statistics like the amount of packets sent by each source, the queuing delay at each queuing point, and the number of dropped and retransmitted packets. The GUI allows users to rapidly build simulation scenarios with drag and draw interfaces [17].

2.7. J-Sim

J-Sim [18] is an object oriented based library for discrete-time process-oriented simulation. The main application area is queuing network simulation. J-Sim is in Java language. It also supports Perl, Tcl, or Python scripting interface for integration [19], [20].

2.8. QuelNet

QualNet [21] is about planning, testing and training tool that imitates the behavior of actual network. It provides a



complete atmosphere for designing protocol, creating and animating network scenario, and analyzing performance. It is a GUI based tool for designing and visualization. In design mode, can set up various connection of network, subnets, define mobility patterns of wireless of network nodes using intuitive, click and drag operation. Use can customize the QualNet's protocol, application layer traffic and services which run for the network. In visualize mode, user can perform in-depth visualization and analysis of a network scenario and can generate dynamic graphs [22].

The above network simulation tools are classified and compared based on different criteria: commercial or free, type

supporting platform etc. in Table I.

3. NS3 VS NS2

NS3 is built in C++ with library to link statically or dynamically. C++ wrapped by Python scripting language which is optional in NS2. Python script use for simulation and emulation of NS3 modules. C++ is speedy to run but slower to modify for protocol execution. While the OTcl runs much slower but can be changed very speedily and interactively for simulation and configuration of protocol in NS2. Hence NS2 required much resource and lots of tools to make network

	Interface					T				[
Simulator	G U I	C L I	Analyzer	Emul- ation	Open Source	Comm- ercial	Programming Language	Platform (OS)	Latest version	Vendor & Available Site
NS3	×	\checkmark	NetAnim		\checkmark	×	C++, Python	Windows, Linux, Mac OS, Free BSD	NS3.23 (May 2015)	http://www.nsnam.org/ns-3- 13/download/
NS2	×	\checkmark	NAM		\checkmark	×	C++, Otcl	Windows, Linux, Mac OS, Free BSD	NS2.35 (Nov 2011)	http://www.isi.edu/nsnam/n s/ns-build.html
OMNeT++	\checkmark	×	\checkmark	\checkmark	\checkmark	×	C++	Windows, Linux, Mac OS	OMNeT ++ 4.6 (Feb 2014)	Omnest http://www.omnetpp.org/co mponent/docman /cat_view/17-downloads/1- omnet-releases
NetSim	\checkmark	×	\checkmark	Net- Patrol	×	\checkmark	C,C++, Java	Windows	NetSim 8.3	TETCOS http://tetcos.com/netsim_ge n.html
OPNET (Riverbed)		×	\checkmark	\checkmark	×	\checkmark	C, C++,	Windows	Version 9.1	OPNET Technologies Inc. http://www.opnet.com/univ ersity_program/it guru_academic_edition/
REAL	\checkmark	\checkmark	-	×	\checkmark	×	C (CLI), Java (GUI)	Sun OS, Linux, Windows	Real5.0	S. Keshav Cornell University http://www.cs.cornell.edu/s keshav/real/overv iew.html
J-Sim		\checkmark	\checkmark	Partial	\checkmark	×	Java, TCL	Windows, Linux,	Version 2.15 (Oct. 2014)	https://sites.google.com/site/ jsimofficial/dow nloads
QualNet	\checkmark	\checkmark	\checkmark	\checkmark	×	\checkmark	C++	Windows, Linux	-	Scalable Network Technologies Inc. http://web.scalable- networks.com/content/qualn et

Table 1 Classification of Simulation Tools

of interface (GUI and/or CLI), does it support real time traffic/emulation mode, supporting programming language,

scenarios. Note that NS2 source codes created on NS2 is not



Startad 1995 2006 Trist release 2008 Type Freeware & Open source Freeware & Open source Finded by DARPA VITS SAMAN & NSF CONSER NSF CISE & INRIA Based on NSI & REAL simulator NSE, CISE & INRIA Carrent support Volunteers, USC SI & Sourceforge NSF, INRIA, CT, WashU & volunteers. Architecture OTel which Introduced overhead with large simulations. Python Namagement NSZ requires basic manual C++ memory management functions such as new. delete, malloc, and free are still available. Simulation Total simulation time is large in NS2 The total computation time required to run a simulation scales better in NS3 than NS2. Simulation Total simulations Total simulations NM H for distributed simulations Simulation Total simulations MPI for distributed simulations NS3 is not backwards-compatible with NS2 is compatible with NS3 is. C ++ code may use Scalability Sequential simulations contributed of meddes and contributed in models and contributed models in Components of NS2, contract regions in the medde and comparison with NS2 is normal mate-data. Contributed Applect consists of 2 distinct regions; one for beaders. MPI for distributed sintubility on models and cont		Table 2 NS3 v	
First release 1996 2008 Type Pressure & Open source Pressure & Open source Funded by DARPA VINTSAMAN & NSF CONSER NSF CISE & INRIA Based on NS1 & RELA Simulator NS2 Current support Volunteers, USC BI & Sourceforge NSF. INRIA, CT, WashU & volunteers Archhecture C++ & Opin and Pyton scripting OT I & C++ Scripting OT I & C++ C++ & Opin and Pyton scripting Scripting OT I & Volunteers, USC BI & Sourceforge NST, WALA, CT, WashU & volunteers Memory NST inacions Python scripting OT I & Volunteers Volunteers Volunteers Memory NST ignification time is large in NS2 The total computation time required to run a simulation scales better in NS3 is not backwards-compatible with NS2 Scatability Sequential simulation MS is not backwards-compatible with NS2 Compatible Parket consists of 2 a single binding scontaining meta-data. Outer Statistics A packet consists of 2 a single binding scontaining meta-data. The second stores payload data. Corbit of stratistics is scourease strate multicast. Statistic metalos anatana. <td></td> <td>NS2</td> <td>NS3</td>		NS2	NS3
Type Freeware & Open source Freeware & Open source Finded by DARPA VITSAMAN & NS FCONSER NST CISE & INFIA Based on NSI & REAL simulator NS2. GTNers, YANS Current support OTEL shick Slit & Sourceforge NST. F. INFIA, GT. WashU & voluniters: Architecture OTEL shick Slit & Sourceforge NST. F. INFIA, GT. WashU & voluniters: Visualization NAM Rod-siz, privit, NarAnim, Memory Inccisons management Increases Inccisons Total shinch Introduced overhead with large simulations. Python Simulation Total shinch Introduced overhead with Size in INS2 In Stall	Started	1995	2006
Fundaed by DARPA VINT, SAMAN & NSF CONSER NSF CISE & INRIA Based on NSI & RELA-Simulator NS2, CITNes, VANS Current support Volunteers, USC NI & Bourceforge NSF, INRIA, CT, WashU & volunteers Architecture C++ & optional Phyton scripting Serigting OTel & C++ C++ & optional Phyton scripting Memory NS7 equires basic manual C++ memory management functions nanagement functions such as new, delete, malloc, and free are still available. Memory NS2 requires basic manual C++ memory management functions such as new, delete, malloc, and free are still available. Simulation Total simulation time is large in NS2 The total computation time required to run a simulations scales better in NS3 than NS2. Compatible Partially NS2 is compatible with NS3 i.e. C++ code may use in NS3 is not backwards-compatible with NS2 NS 3 is not backwards-compatible with NS2 Scalability Sequential simulations MPI for distributed simulations A packet consists of 2 single buffer of bytes, and optionally a collection of small tage containing meta-data. Tork DEP, SCP, TRCP, TRCR, CAP, RTP, Multicast: POH. TCF UDP, SCP, NCP, TRCR, CAP, RTP, Multicast: SEM, Topology Input Readers Transport Transport TCP, UDP, SCP, NCP, TRCR, CAP, RTP, Multicast: SEM, GMPMLD, static (Dijkstru) minast, static mu	First release	1996	2008
Based on Current support. NS2. GTPMst, YANS Current support. Volunteers. UCS ISI & Sourceforge NS7. KTPMS, YANS Current support. OTEl which Introduced overhead with large simulations. Python C++ & optional Phyton scripting. Scripting OTEl which Introduced overhead with large simulations. Python NS3. Yet Anim. Memory NS2 reguines basic manual C++ memory management functions NS3. Yet Anim. Memory Total which Introduced overhead with Size C++ code may use in NS3 The total computation time required to run a simulation scales better in NS3. Simulation Total simulation time is large in NS2. The total computation time required to run a simulation scales better in NS3. Scalability Seguential simulations MPI for distributed simulations Packets A packet consists of 2 distinct regions; one for headers, and components of NS2. Application Pring via, telnet, FIP, multicast, probabilistic and trace-driven codes Nore is very limited number of models and components of NS2. Transport TCP, UPP, SCTP, TSPC, TSPC, TRP, CRAP, RTP, Multicast; SPM, MANET: AONY, DSR, DSDV, TORA, DMEP, Queuing: Diffserv, RED, WFQ, DropTail TCP variants (Diffsrbru uneisst, sterie multicast, DSDV, Globaltink state), Nix vector, DSR, VANET, Click, MANET: Disk, AODV. Network Unicast: IP, MP, DV,	Туре	Freeware & Open source	Freeware & Open source
Current support Volunteers USC ISI & Sourceforge NSF, INRIA, GT, WashU, & Volunteers Architecture C1+4: & optional MPyton scripting OTCI & C-+4: & optional MPyton scripting Seripting OTCI & C++4: & optional MPyton scripting Mennory NS2 requires basic manual C++ memory management ns-3-iz, pryvix, NetAnim, Mennory NS2 requires basic manual C++ memory management ns-3-iz, pryvix, NetAnim, Simulation Total simulation time is large in NS2 ns-3-iz, pryvix, NetAnim, Simulation Total simulation time is large in NS2 ns-NS1 ham NS2 Compatible Partially NS2 is compatible with NS3 is. C++ code may use NS 3 is not backwards-compatible with NS2 Scalability Sequential simulations contributed to the models and Conformation of small region on the NS2 Application Ping, vat, tehnet, FTP, multicast, probabilistic and trace-driven Sockets-like APJ P2P, traffic generator, Ping, Echo, Packet sink, Taffic gen., webcahe Transport TCP, UDP, SCTP, XCP, TRPC, RAP, RTP, Multicast: PKM, TCP variants, BD, DDCP, additional high speed Transport TCP, UDP, SCTP, XCP, TRPC, RAP, RTP, Multicast: SRM, GMP/MLJ, Natcic ObjexR, NDR, NDR, NDR, NDR, NDR, NDR, NDR, ND	Funded by	DARPA VINT, SAMAN & NSF CONSER	NSF CISE & INRIA
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Table 2 NS3 vs NS2



capable to be reused for actual execution while the NS3 allows the users to work on source code for implementation and can reuse in real execution [23].

Two discrete event simulators NS3 and NS2 are compared based on platform, language, architecture, layers, memory, visualization, simulation time etc. The main comparisons between NS3 and NS2 are demonstrated in Table II [24].

4. CONCLUSION

Many network simulators are presented in the field of communication. Among them NS2, NS3 and OMNeT++ are frequently used for simulation. As the rich set of models for NS2, still needs to be ported from NS2 to NS3. OMNeT++ can be considered as viable alternative. Furthermore, OMNeT++ provides a rich GUI interface and an abstract modeling language. NS2 and NS3 are also abstract modeling language and CLI based source code for the development of the whole simulation. As compare to OPENet++, the NS2 and NS3 have greater contributors and community even if these simulators are not supporting the GUI mode. However, based on comparative study, it shows that NS3 may better than NS2 in features.

In conclusion, the issue of which simulator to use is a difficult and the answer is mainly dependent on the exact use-case. However, if scalability is the main criteria, NS3 and OMNeT++ are smart options. Hope this review shows to be a good reference source for community who feel difficult to choose the suitable network simulators for their work.

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Journal of Network Communications and Emerging Technologies (JNCET) <u>www.jncet.org</u> Volume 5, Special Issue 2, December (2015)

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