

Network simulation tools performance comparison for wireless networks

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Abstract - Network simulation is the most useful and common methodology used to evaluate different network topologies without real world implementation. Network simulators are widely used by the research community to evaluate new theories and hypotheses. There are a number of network simulators, for instance, ns-3, GNS3, Putty, Cisco packet Tracer, Secure CRT, Wireshark and SNMP etc. Therefore, the selection of a network simulator for evaluating research work is a crucial task for researchers. The main focus of this paper is to compare the state-of-the-art, open-source network simulators based on the following parameters: mean, standard deviation, standard error, skew, median by simulating a MANET routing protocol, to identify an optimal network simulator for the research community.

Index Terms - Simulation, Network simulators, simulators comparison, MANET Routing Protocol

1.INTRODUCTION

Simulators are very important for researchers in all over the world. Finding an appropriate simulator from the pool of them isn't very easy . From the most important necessary point of view, we have studied computer network communication simulators on the basis of availability, easiness, scalability, and other important properties (user interface, data manipulation, graphical display, etc.). We have studied so far the discrete event simulators (the system behavior can be simulated by modeling the events in a system as per the order of the scenarios the user has setup), for example, ns-3, GNS3, Putty, Cisco packet Tracer, Secure CRT,Wireshark and SNMP etc.. After a detailed discussion of each simulator, we have summarized the properties in Table 1 and Table 2. As a result, any researcher are going to be ready to choose the required simulator quickly.

2.TYPES OF SIMULATIONS

2.1 GNS3:

GNS3 is employed by many thousands of network engineers worldwide to emulate, configure, test, and troubleshoot virtual and real networks. GNS3 allows you to run a little topology consisting of only a couple of devices on your laptop, to people who have many devices hosted on multiple servers or maybe hosted in the cloud.

GNS3 consists of two software components:

- The GNS3-all-in-one software (GUI)
- The GNS3 virtual machine (VM)

GNS3-all-in-one:

This is the client part of GNS3 and is the graphical user interface (GUI). You install the all-in-one software on your local PC (Windows, MAC, Linux) and make your topologies using this software. This is what you usually see the show in screenshots such as the following:

Advantages:

No limitation on the number of devices supported (the only limitation is your hardware: CPU and memory).

Supports multiple switching options (NM-ESW16 Etherswitch module, IOU/IOL Layer 2 images, VIRT IOSvL2):

Supports all VIRT images (IOSv, IOSvL2, IOS-XRv, CSR1000v, NX-OSv, ASA v)

Supports multi-vendor environments Can be run with or without hypervisors Supports both free and paid hypervisors (Virtualbox, VMware workstation, VMware player, ESXi, Fusion) Downloadable, free, pre-configured, and optimized appliances available to simplify deployment.

Disadvantages:

Cisco images got to be supplied by the user (download from Cisco.com, or purchase a VIRL license, or copy from the physical device).Not a self-contained package but requires a local installation of software (GUI).GNS3 are often suffering from your PC’s setup and limitations due to local installation (firewall and security settings, company laptop policies,etc).

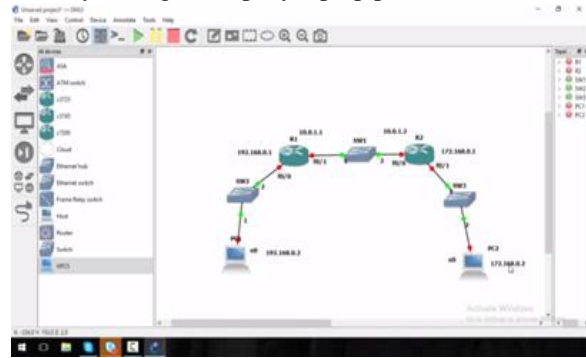


Figure1: Connecting two nodes with Routers

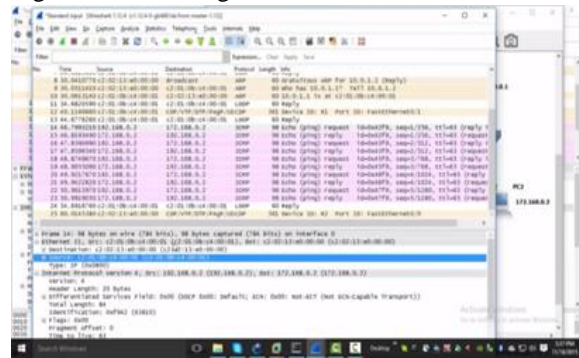
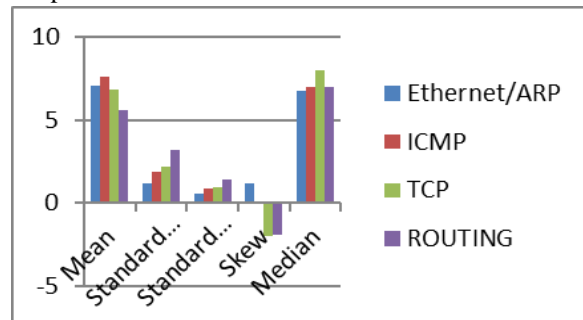


Figure2: Performance of network

Table1: Results from the experiments

	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	7.1	1.2	0.54	1.17	6.75
ICMP	7.6	1.9	0.87	-0.08	7
TCP	6.8	2.2	0.96	-2.03	8
ROUTING	5.6	3.2	1.43	-1.96	7

Graph:



2.2 Cisco Packet Tracer:

Cisco Packet Tracer is a politician Cisco product for Cisco Academy students that simulates Cisco networks. It doesn’t emulate Cisco hardware or support real images from Cisco or other vendors.

Advantages:

- Easy to line up
- Supports Cisco router, switch, and PC simulations
- Sufficient for CCNA studies
- Simulates multiple devices and protocols (routers, switches, wireless, RADIUS, etc...)
- Free (requires registration at Cisco’s NetAcad website)

Disadvantages:

- Proprietary code - not open source
- Only simulates Cisco devices (Not running true Cisco images)
- No multivendor support
- Cannot integrate with real physical devices
- You can only use the IOS commands implemented by the developers. Not every conceivable command available on a platform simulated in Packet Tracer are going to be present to be used

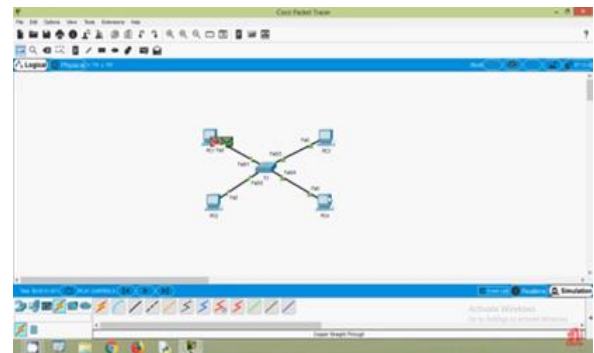


Figure3: connecting nodes with Hub in packet tracer.

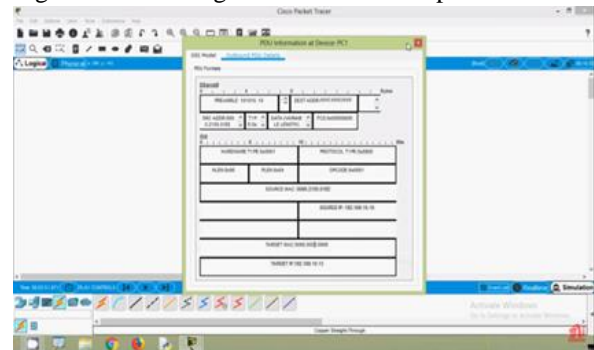


Figure4: Performance of the network

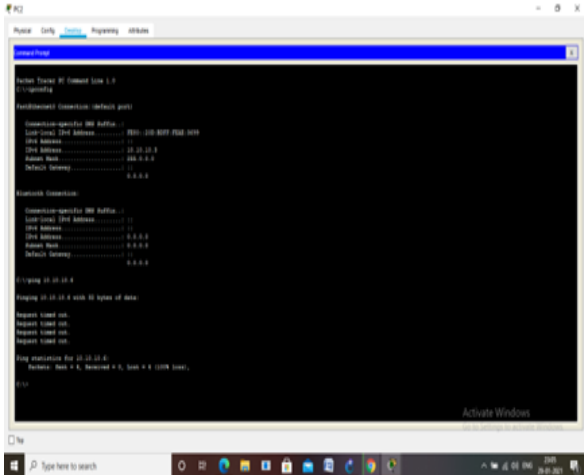


Figure 4,5: Network Performance

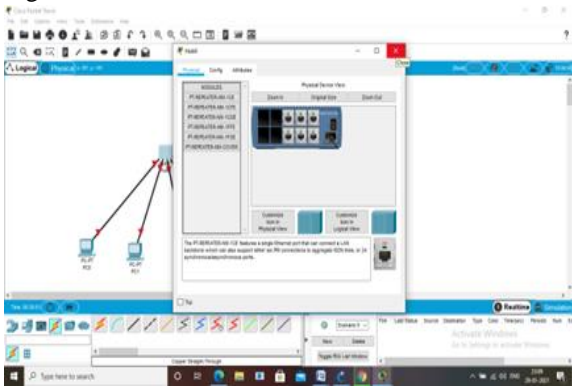
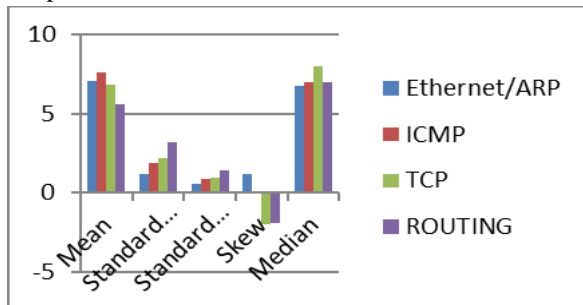


Figure6: Hub Interface

Table2: Results from the Experiments

Experiment	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	6.9	1.0	0.34	1.12	6.25
ICMP	7.1	1.5	0.75	-0.06	6.58
TCP	6.3	1.1	0.82	-2.02	7.35
ROUTING	5.4	2.5	1.20	-1.76	7

Graph:



2.3Putty:

PuTTY supports many variations on the secure link-attached terminal, and provides user control over the

SSH encryption key and protocol version, alternate ciphers like AES, 3DES, RC4, Blowfish, DES, and Public-key authentication. PuTTY uses own format of key files – PPK (protected by Message Authentication Code). PuTTY supports SSO through GSSAPI, including user provided GSSAPI DLLs. It can also emulate control sequences from xterm, VT220, VT102 or ECMA-48 emulation, and allows local, remote, or dynamic port forwarding with SSH (including X11 forwarding). The network communication layer supports IPv6, and therefore the SSH protocol supports the zlib@openssh.com delayed compression scheme. It also can be used with local interface connections. PuTTY comes bundled with command-line SCP and SFTP clients, called "pscp" and "psftp" respectively, and plink, a command-line connection tool, used for non-interactive sessions.

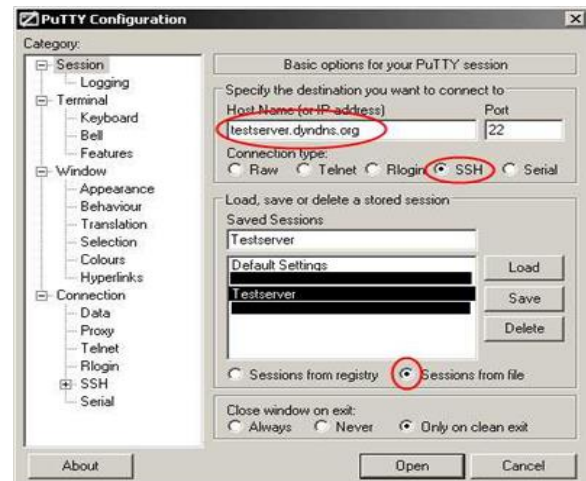


Figure7:Putty Interface

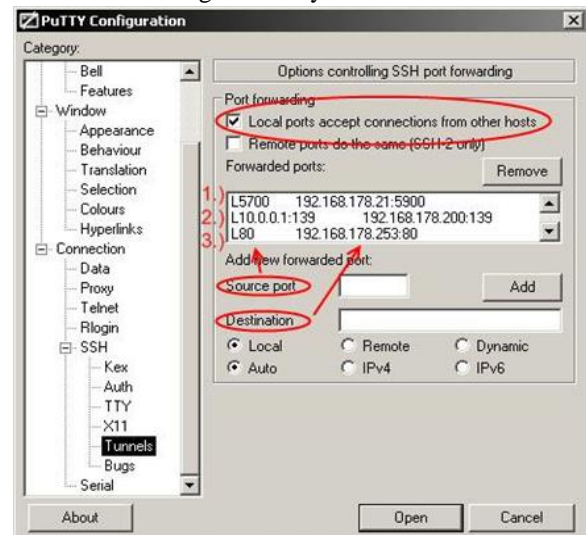


Figure8: Putty Configuration

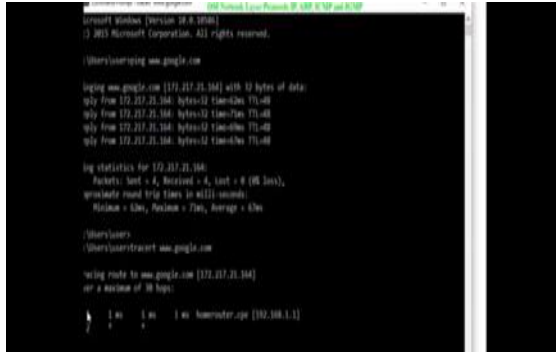
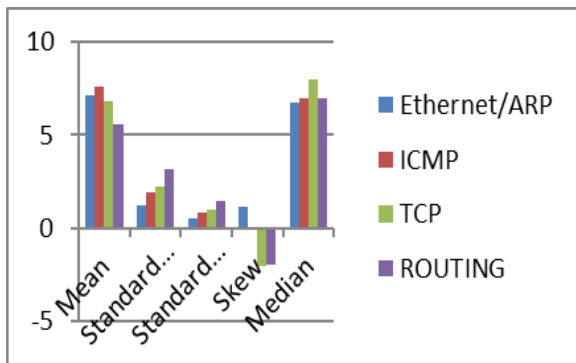


Figure9: Network performance in PuTTY

Table3: Results

Experiment	Assesments				
	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	5.9	0.9	0.25	1.2	6.15
ICMP	6.1	1.1	0.65	-0.05	6.4
TCP	5.9	0.9	0.80	-2.01	7.2
ROUTING	5	2.1	1.10	-1.71	6.9



2.4 Secure CRT:

SecureCRT may be a GUI-based Telnet client and terminal emulator originally called CRT. it had been first released within the autumn of 1995 by VanDyke Software.[3][4] Originally released as a premium version of CRT with support for SSH encryption, SecureCRT later absorbed the CRT product entirely. The program is a component of a line of networking software that has SecureFX, a file transfer client with SSL capability, and VShell, an SSH server. SecureCRT and SecureFX are often started from within one another and use a combined host information list. A separately sold pack of command-line tools (e.g., SCP, modeled after the Unix command of an equivalent name) to be used with VShell is additionally sold by the corporate. All offerings are commercial ware.

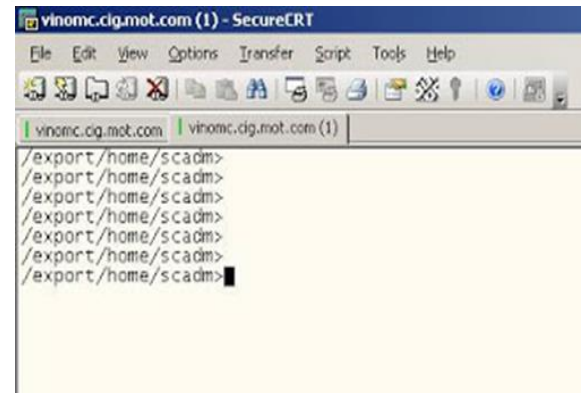
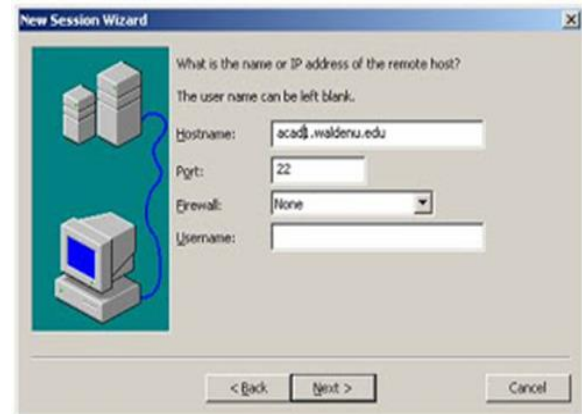
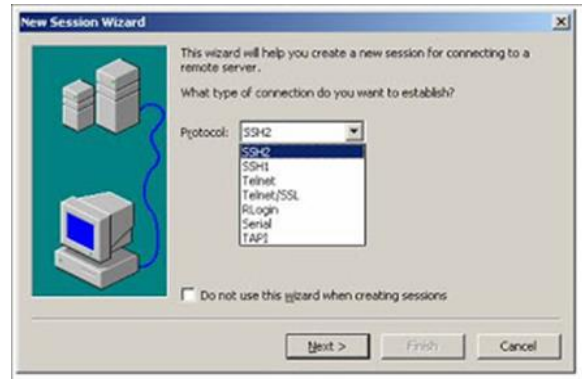


Figure 10,11,12: Secure CRT Interface

Table4:

Experiment	Assesments				
	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	5.6	0.7	0.28	1.1	6.05
ICMP	5.9	0.9	0.60	-0.05	6.2
TCP	5.7	0.7	0.75	-2.00	7.0
ROUTING	4.5	2.0	1.3	-1.65	7

2.5 Simple Network Management Protocol (SNMP) :

Simple Network Management Protocol (SNMP) is an application-layer protocol defined by the web Architecture Board (IAB) in RFC1157 for exchanging management information between network devices.

it's a neighborhood of the Transmission Control Protocol/Internet Protocol (TCP/IP) protocol suite. SNMP is one among the widely accepted network protocols to manage and monitor network elements. Most of the professional-grade network elements accompany bundled SNMP agent. These agents need to be enabled and configured to speak with the network monitoring tools or network management system (NMS).

SNMP Agent:

The agent may be a program that's packaged within the network element. Enabling the agent allows it to gather the management information database from the device locally and makes it available to the SNMP manager when it's queried for. These agents might be standard (e.g. Net-SNMP) or specific to a vendor (e.g. HP insight agent)

SNMP agent's key functions

- Collects management information about its local environment
- Stores and retrieves management information as defined within the MIB.
- Signals an occasion to the manager.
- Acts as a proxy for a few non-SNMP manageable network node.

Basic SNMP Communication Diagram

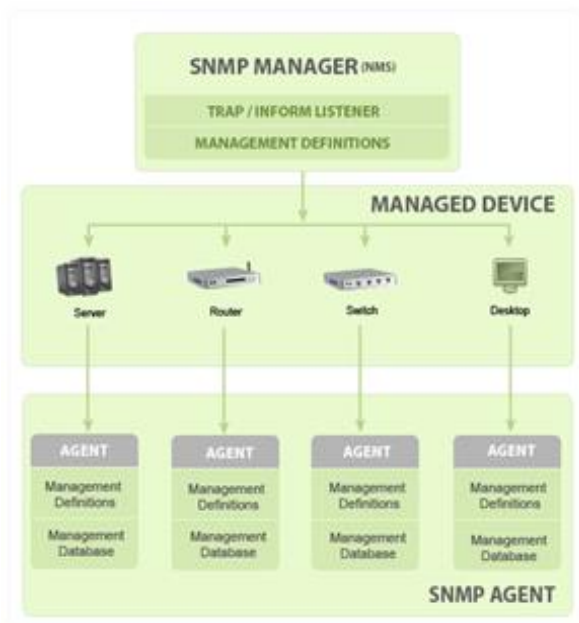


Figure 12 : SNMP Communication Diagram

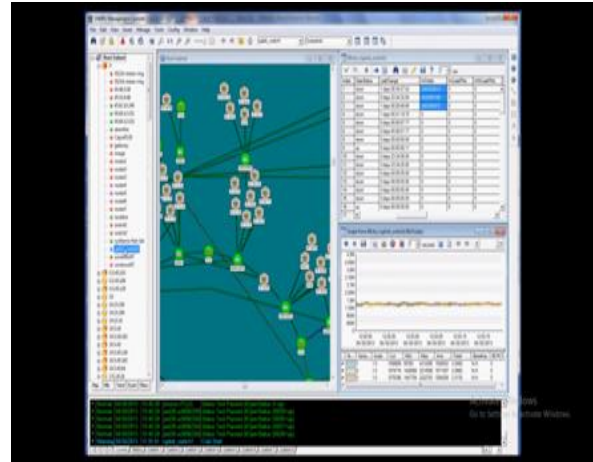
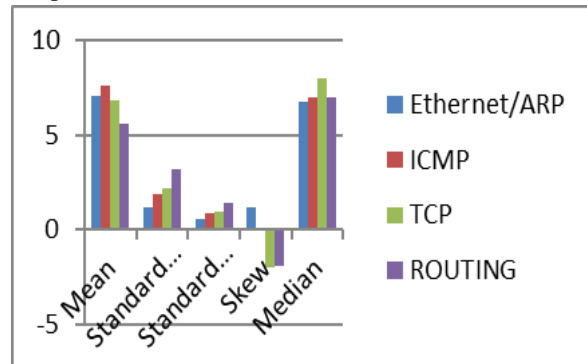


Figure 13: Network performance in SNMP

Table5: Results

Experiment	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	5.1	0.5	0.21	0.9	6.0
ICMP	5.4	0.6	0.55	-0.04	6.1
TCP	5.3	0.5	0.66	-2.00	6.8
ROUTING	4.3	1.9	1.2	-1.56	6.2

Graph:



2.6 NS-3 :

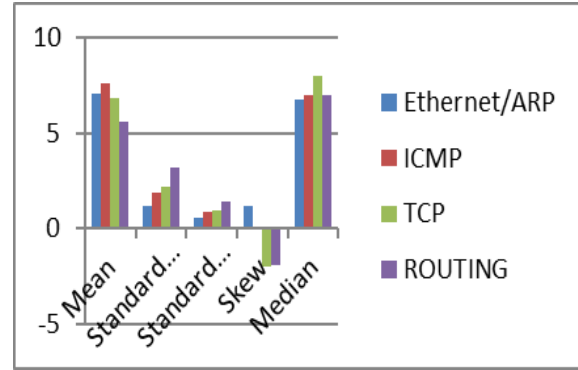
ns-3 has been developed to provide an open, extensible network simulation platform, for networking research and education. In brief, ns-3 provides models of how packet data networks work and perform, and provides a simulation engine for users to conduct simulation experiments. Some of the reasons to use ns-3 include to perform studies that are more difficult or not possible to perform with real systems, to study system behavior in a highly controlled, reproducible environment, and to learn about how networks work. Users will note that the available model set in ns-3 focuses on modeling how Internet protocols and

networks work, but ns-3 is not limited to Internet systems; several users are using ns-3 to model non-Internet-based systems.

Many simulation tools exist for network simulation studies. Below are a few distinguishing features of ns-3 in contrast to other tools.

ns-3 is designed as a set of libraries that can be combined together and also with other external software libraries. While some simulation platforms provide users with a single, integrated graphical user interface environment in which all tasks are carried out, ns-3 is more modular in this regard. Several external animators and data analysis and visualization tools can be used with ns-3. However, users should expect to work at the command line and with C++ and/or Python software development tools.

ns-3 is primarily used on Linux or macOS systems, although support exists for BSD systems and also for Windows frameworks that can build Linux code, such as Windows Subsystem for Linux, or Cygwin. Native Windows Visual Studio is not presently supported although a developer is working on future support. Windows users may also use a Linux virtual machine. ns-3 is not an officially supported software product of any company. Support for ns-3 is done on a best-effort basis on the ns-3-users forum.



Wireshark:

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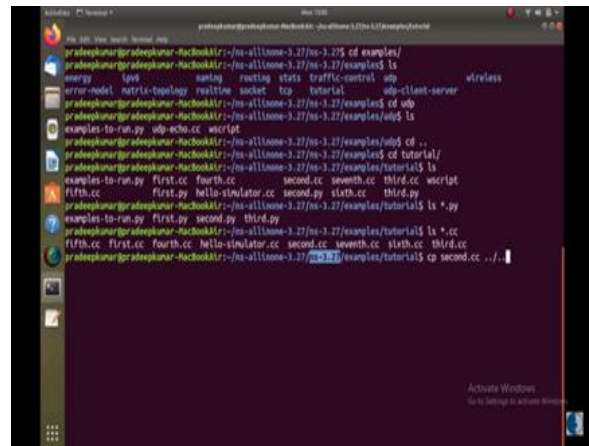


Figure14:Network performance in NS3

Table6: Results

Experiment	Assesments				
	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	4.51	0.2	0.11	0.8	5.9
ICMP	5.8	0.4	0.5	-0.03	5.8
TCP	4.9	0.4	0.6	-2.03	5.7
ROUTING	5.2	1.7	1.5	-1.46	5.8

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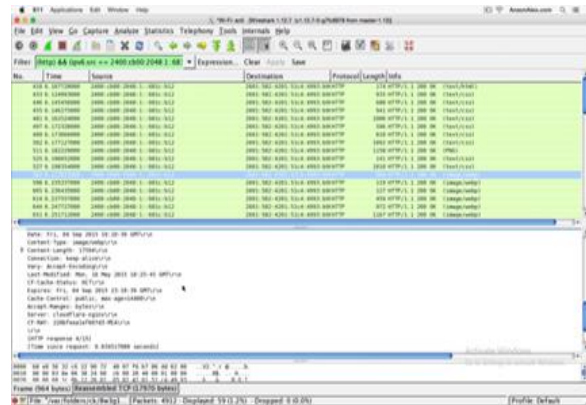


Figure15:Network performance in Wireshark

For each configuration, the download throughput (mbit/s), the upload throughput(mbit/s) the response time (ms) and the jitter (ms) are measured.

Bandwidth: commonly measured in bits/second is the maximum rate that information can be transferred

Throughput: is the actual rate that information is transferred

Latency: the delay between the sender and the receiver decoding it, this is mainly a function of the signals travel time, and processing time at any nodes the information traverses

Jitter: variation in packet delay at the receiver of the information

Table7: Result from the experiments

Experiment	Assesments				
	Mean	Standard Deviation	Standard error	Skew	Median
Ethernet/ARP	4.1	0.1	0.25	0.6	5.2
ICMP	5.0	0.2	0.8	-0.02	5.3
TCP	5.4	0.2	0.4	-1.03	5.5
ROUTING	4.5	1.2	1.3	-1.25	5.2

Graph:

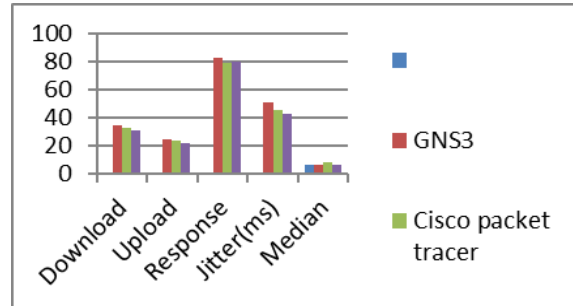


Table 8: Comparison of Network Simulators:

S. No	Name of the simulator	License Type	Language	Supported Operating System	GUI Support	Download (mbits/s)	Upload (mbits/s)	Response Time(ms)	Jitter (ms)
1	GNS3	Open source	P4 programming Language	Linux,FreeBSD, Mac OS X, Win-dows XP & Windows 7,10.	Yes	34.4	24.5	83	51.5
2	Cisco packet tracer	Open source	C++ and Java	Linux,FreeBSD, Mac OS X, Win-dows XP, Windows Vista & Windows 7,10.	Yes	32.5	23.5	79	45.8
3	Putty	Open source	C++	Linux,FreeBSD, Mac OS X, Win-dows XP,& Windows 7,10.	No	31.2	22.2	80	43.2

3.CONCLUSION

In this paper we have investigated different network simulating tools and found that Analysis tool for state estimation is available in, GNS3, Cisco Packet Tracer, Microsoft Visio, Ns3, Simple network Manage All the simulators discussed in the paper supports network visualization tools and can modify scenarios. Trace files are created by all the simulators discussed in the paper. Wireshark and Putty communicates with other simulators whereas Ns-2 and JSim do not. Fast simulation capabilities are only supported by GNS3 and Cisco Packet Tracer. Ns2 consumes more amount of memory and Ns-3 consumes lowest amount of memory when compared to other simulator as the number of nodes increases. Wireshark and Putty are commercial simulators and are capable to simulate larger networks.

4	Secure CRT	Open source	C++ and Java	Linux,FreeBSD, Mac OS X, Windows Vista & Windows 7,10.	Yes	30.1	21.6	81	46.1
6	Wiresahark	Open source	C++	Linux,FreeBSD, Mac OS X & Windows 7,10.	Yes	32.1	20.8	76	48.5
7	SNMP Agent Simulator	Open source	C,C++ and Java	Linux,FreeBSD, Mac OS X, Win-dows XP & Windows 7,10.	Yes	32.7	23.8	78	49.5
8	NS3	Open source	C++and Optional Python Bindings	Linux,FreeBSD, Mac OS X, & Windows 7,10.	Yes	28.5	20.3	77	47.5

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