



## Comparative Study of Network Simulator: NS2 and NS3

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**Abstract**— *Wireless Sensor Networks (WSNs) is built of few to several thousands of distributed interconnected sensor nodes. Deploying a complete testbed for such huge network becomes costly and time consuming. In such cases; network simulator saves lot of time and money. Simulation is used for data networking and by it helps researchers to resolve queries in time and in minimal cost. This paper describes Ns2, Ns3 network simulator which are widely used and designed to address the needs of networking research.*

**Keywords**—*Network simulator, ns2, ns3, comparison of ns2 and ns3, details of ns3*

### I. INTRODUCTION

Simulation is the imitation of some real thing or a process. Simulation is a very important modern technology. It can be applied to different science, engineering, or other application fields for different purposes. [1]. Network simulation is used in different areas; academic researchers, industrial development, to analyse, design, simulate and verify the performance of different network protocols. Simulation is a key component of network research which requires debuggability, reproducibility, parameter exploration and no dependency on existing hardware or software [2].

Computer-based simulation plays an important role in the research work to help the researchers and network designers to understand the behaviour and performance of the networks and its protocols. Network simulator allows researchers to validate new protocol and compare their work with the standards, existing protocol.

Nowadays WSN is a hot research topic. Many network details in WSNs are not finalized and standardized [3]. Wireless sensor network consists of several tiny sensors called nodes; each sensor node has several components. Each node has the ability to communicate with every other node. To build a testbed for such huge WSN it becomes very costly work. Deploying real experiments for WSN takes so much of time and it becomes a difficult task. New untested protocols cannot be applied on large scale due to no surety of successful outcome. Therefore, the new protocols or schemes are tested with the help of simulation

### II. NETWORK SIMULATOR

Network simulator is a discrete event network simulator. A network simulator is software that predicts the behaviour of a computer network. Network simulator is used to understand system behaviour accurately. In simulators, the computer network is typically modelled with devices, links, and applications to analyse the performance. Simulators provide support for the most popular technologies and networks.

#### A. Use of Network Simulator

- Network simulators provide a cost effective method for network design and validation for sensor networks facility for addition or modification to exiting network
- Network simulator must enable user to model the network topology to specify the nodes and the links between those nodes
- Model the application flow(traffic) between the nodes
- Provides network performance metrics as output
- Visualization and animation of packet flow

Table I Network Simulators

Network Simulator Types	Network Simulator Names
Commercial	OPNET, QualNet
Open source	Ns2,Ns3,OMNeT++

### III. NETWORK SIMULATOR 2

Network Simulator-2 is most widely used simulator for the research work.Ns2 is an open source discrete event network simulator. It is used for the simulation of network protocols with different network topologies. It can be supported for wired as well as wireless networks simulation. Network animator (NAM) is used for the graphical view of the network. NAM interface has facility to allow users to forward, pause, stop and play the simulation.

**A. Ns2 Architecture**

Ns2 is basically an Object Oriented TCL (OTcl) script interpreter with network simulation event scheduler, network component object libraries and network setup (plumbing) module libraries. Network simulator is used for setting up and running a network simulation and user writes a simulation program in OTcl script language. The OTcl script is used to initiate the event scheduler, setup the network topology and tell traffic source when to start and stop sending packets through event scheduler.

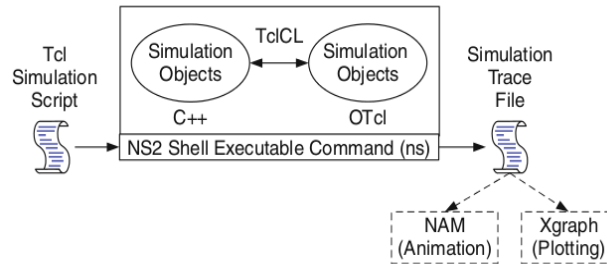


Fig. 1: Basic architecture of ns2

**B. Ns2 Merits and Demerits**

NS-2[NS-2\_wiki] having both merits and demerits. To the merits, firstly, NS-2 is an open source model, users can easily download ns2 from the internet and its saves the cost. Online tutorial and documentation is available which is beneficial for the ns2 users. The user can change and modify online document as well as updates the code easily. However, Ns2 has some demerits. Firstly, compared with other simulator NS-2 is more complex and time-consuming Secondly, NS-2 provides a poor graphical support, no Graphical User Interface (GUI) third, users must familiar with modelling technique and scripting language. Fourthly; Simulation outcome may not be consistent due to the continuing changing the code base.

**C. Ns2 release (ns-2.32 to ns2.35)**

Table II Ns2 release

ns-2.32:Mar 2007:	Ns-2.33:Mar 2008:	ns-2.34:Jun 2009:	ns-2.35:Nov 2011:
-Enable TK 2 contributed by Pedro Vale Estrela	- Wireless shadow bug fix	-Import Tmix traffic generator tool	-Added new SCTP patch
-Several changes to SCTP module	-Added dynamic libraries patch to SIGNET group University of Padova	-Bug fix for 802.11, MAC-802.11Ext	-support for NR-SACK non-renegable selective acknowledgement
-Change validation to gzip	-Added 802.11Ext models from Mercedes Benz/Karlsruhe team	-Add AOMDV(on demand multipath distance)	-Fixes for Tmix traffic
	-Added ns2 TCP Linux patch	-Bug fix for wireless PhyExt	-One way TCP implementation

**IV. NETWORK SIMULATOR 3**

Ns3 is also an open sourced discrete-event network simulator which is mostly used in research and educational work. Ns3 is licensed under the GNU GPLv2 license and is available for research and development. Ns3 is a new simulator, written from scratch not really an evolution of Ns2. It also generates pcap traces that can help in debugging. To analyze network traffic, standard tools like Wireshark can be used to read trace files. Ns-3 provides a realistic environment and its source code is well organized.

**A. Comparison between ns2 and ns3**

Table III Comparison of ns2 and ns3

Criteria	Ns2	Ns3
Released at	1996	2008
Supported by	DARPA, VINT, SAMAN, NSF & CONSER	NSF & INRIA
Based on	NS-1 & REAL simulator	NS-2, GTNets, YANS
Built in	C++	C++
Scripting	OTcl	Python
Simulation output	NAM	NS-3-viz,pyviz,nam

- Programming Languages: Ns2 is implemented using a combination of oTCL (object Tool Command Language) and C++ while Ns3 is implemented entirely in C++ and support of python for scripting and visualization.
- Memory Management: Ns2 requires basic manual C++ memory management function. Because Ns3 is implemented in C++, all normal C++ memory management functions are available.

- Performance: Ns3 performance is better than Ns2
- Simulation outcome: Ns2 come with the package NAM (Network Animator) it's a tcl based animation system. In Ns3 having python based visualization package Furthermore, Ns3 don't have all the modules that ns2 has, but some modules are ported from ns2 to ns3.

**B. Details of Ns3**

Project started in mid of 2006 and still under heavy development. Funded partners are University of Washington, INRIA, Sophia Antipolis and Georgia Tech University (Atlanta). Ns3 is a new simulator, written from scratch. It is extension of ns2. Ns3 is written completely in C++ and Python bindings for public API's provided. Simulation program are C++ executable. Ns3 uses the "waf" build system.

**Features of Ns3**

- Open source licensing (GNU GPLv2) and development model.
- Packet can be saved in PCAP file and Wireshark tool is used to read the PCAP file
- Scalability features
  - Packets can have virtual zero byte
    - Some packet can have virtual zero bytes for such virtual zero byte memory is not allocated
  - Node optional features
    - Memory does not get allocated for nodes that don't need it.
    - User can choose the model which is needed. For wired network there is no need of mobility model
  - New features can be added
- Cross-layer features
  - Packet Tags
    - Each packet is attached with a small unit of information.
  - Tracing
    - Tracing facility for getting output.

**C. Ns3 release (ns-3.4 to ns-3.7)**

Table IV Ns3 release

ns-3.20: Jun 2014:	ns-3.21: Sep 2014:	ns-3.22: Feb 2015:	ns3.23: May 2015:
-Support for IEEE802.15.4	-Support for frequency reuse algorithm	-Frame aggregation mechanism for IEEE802.11n	-support for 2-level frame aggregation for IEEE802.11n
-Added IPv6 routing protocol mode	-Support for TCP timestamp and Window scale options	-Support for vehicular wireless networks(VANET)	-Several bugs and limitations of 802.11 models have been fixed
-Many bug fix and small improvement made	-Improvement to the energy modelling of Wifi(sleep mode) Packet socket application helper added		-Several aspects of the mesh module are used.

**D. Software Organization of Ns3**

- The source code of ns3 is organized in the src directory. Figure shows upper level modules are depend on lower level modules, bottom up approach.
- Core of the simulator contains all protocol, hardware and environmental models. The simulation core is implemented in src/core.
- Packets basic object in network simulator and are implemented in src/network. Ns3 programs may access the entire API directly or may make use of a so called helper API that provides convenient wrappers or encapsulation of low level API calls.

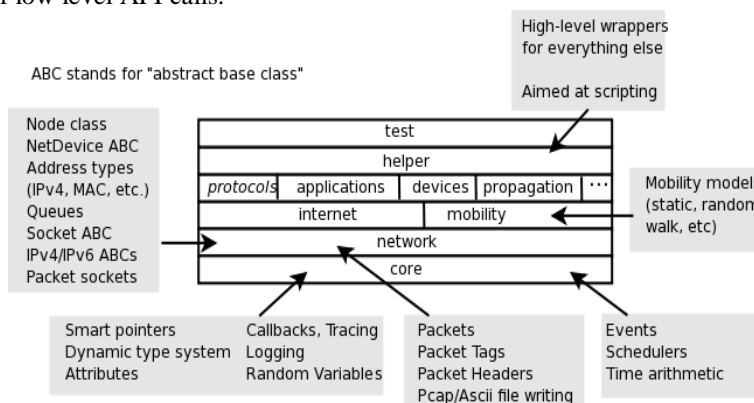


Fig. 2 Software organization of ns3

E. Basic Model of Ns3

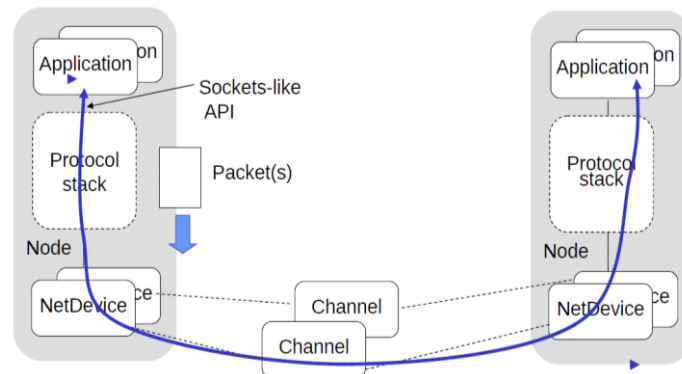


Fig. 3 Basic Model of ns3

Key objects in simulator are Nodes, Packets and Channels. Node contains all applications protocol stacks and NetDevices.

- Node - The motherboard of computer system, RAM, CPU and IO interface. Node class provides methods to represent and manage computer devices in simulation. Node contains all application protocol stacks and NetDevices. Nodes are architected for multiple interfaces.
- Application - A packet generator which can run on a Node and communicate with a set of network stacks. The application class provides methods to manage user version of user-level application in simulation.
- NetDevices - A network card which can be plugged in an IO interface of node. NetDevices are strongly bound to Channels of a matching type. NetDevice class provides methods to manage connections to Node and Channel objects.
- Channel – A physical connector between a set of NetDevices objects. The channel class provide method to manage communication sub network objects and connect nodes to them.
- Packet - Each network packet contains a byte buffer, a list of tags and metadata.
  - Buffer: serialized representation of header and trailer.
  - Tag: set arbitrary, flow monitor
  - Metadata: Describe the types of headers and trailers to add a new header and write Serialize () and Deserialize () methods.
- Socket - The interface between an application and network stack. Ns-3 provides two types of sockets APIs, first one is nativens-3 API and second one uses the services of the native API to provide a POSIX-like AP

F. Models of Ns3

The simulator keeps updating the rapid growth in wireless networking, many variants like IEEE 802.11 networking, emerging IEEE standards such as WiMax (802.16), and cellular data services (GPRS, CDMA). Additional models beyond wireless are also needed; Figure shows the models used in the current ns-2, and ns3.

Table V Models of ns3

Layers	Existing core ns-2 capability	Existing ns-3
Application Layer	Ping, vat, telnet, FTP, multicast FTP, HTTP, probabilistic and trace-driven traffic generators, webcache	OnOffApplication, asynchronous sockets API, packet sockets
Transport Layer	TCP(many variants), UDP, SCTP, XCP, TFRC, RAP, RTP Multicast: PGM, SRM, RLM, PLM	UDP, TCP
Network Layer	Unicast: IP, MobileIP, generic dist vector and link state, IPinIP, source routing, Nixvector Multicast SRM, generic centralized MANET: AODV, DSR, DSDV, TORA, IMEP	Unicast IPv4, global static routing Multicast static routing MANRT:OLSR
Link Layer	ARP, HDLC, GAF, MPLS, LDP, Diffserv Queuing: DropTail, RED, RIO, WFQ, SRR, Semantic Packet Queue, REM, Priority, VQ MACs: CSMA, 802.11b, 802.15.4(WPAN), Satellite Aloha	PointToPoint,CSMA.802.11 MAC low and high and rate control algorithm
Physical Layer	TwoWay, Shadowing, OmniAntennas, EnergyModel, Satellite Repeater	802.11aFriis propagation loss model, log distance propagation loss model, basic wired(loss, delay)

V. CONCLUSION

Despite ns-2's popularity, there is a critical need for a new project simulator to perform core refactoring, integration, software documentation maintenance, and extension of the simulator. Ns3 supports coupling, interoperability, good

memory management, debugging of split language object, coding in C++ and object oriented concepts. It also supports models which supported by Ns2 and it works for wireless networks. The Network Simulator-3 (ns-3) is rapidly developing into a flexible and easy-to-use tool suitable for wireless network simulation. These features makes Ns3; replacement of Ns2.

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