



A Survey of Simulation Tool(s) for Mobile Ad-Hoc Networks

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Abstract: Mobile Ad-hoc Networks have gained tremendous popularity among the research fraternity. Lot of research is going on in the area of Mobile Ad-hoc Networks throughout the length and breadth of world. Most of the research is conducted by employing the simulation technique. These days, a number of simulation tool, that may be employed, are available. Most common among these are Network Simulator (ns2), MATLAB, OPNET etc. Out of these ns2 is most widely used. In this work a study on this tool in terms of its features, applicability to mobile ad-hoc networks and procedure for implementation etc are studied.

Keywords: Mobile Ad-hoc Networks; Network Simulator; ISM.

I. INTRODUCTION

“A Mobile Ad-hoc Network [1] is a collection of autonomous nodes or terminals that communicate with each other by forming multi-hop networks and maintaining connectivity in decentralized manner.” Mobile Ad-hoc Networks have been found to be very useful in emergency search and rescue operations. The reason behind this is the small time required to deploy them. Moreover their deployment cost is small. These days there is an increasing interest among the computer science fraternity in Mobile Ad Hoc Networks.

This interest has been kicked off by the common availability of wireless communication devices (including Laptops, Palmtops & PDAs) that can connect to each other using license free Industrial-Scientific-Military (ISM) band concentrated at 2.4 GHz. The underlying assumptions behind the research on these networks is that the cheap short range to medium range radio transceivers working in ISM band will become very common. Two such technologies (namely WiFi & Bluetooth) are already available in the market. The amount of interest in Mobile Ad Hoc Networks research can be gauged from the fact that a working group for Mobile Ad Hoc Networks has been formed within the Internet Engineering Task Force (IETF).

The charter of this task force includes developing of a framework to provide IP based services over Mobile Ad Hoc Networks. The IEEE has also played its part by releasing IEEE 802.11 standard [2] for wireless LANs.

Current research in Mobile Ad Hoc Networks is focused on developing a real time practical environment. According to a study more than 75% research on MANETs is based on Simulation. So, the best suited computer simulation tools for MANETs need to be employed. In this paper most widely used simulator for mobile ad hoc networks, namely ns2, has been studied in terms of its relevance for the study on mobile ad hoc networks.

II. MOBILE ADHOC NETWORKS

Since inception during 1970s wireless networks have become increasingly popular owing to their capabilities of communication and information access regardless of the location. These days specifically those wireless networks in which nodes are mobile, are gaining attention of research fraternity. There are two variations of mobile wireless networks. First type of such networks is infrastructure based networks having fixed and wired gateways. Typical application for this type of network includes Wireless Local Area Networks (WLAN). The second type of mobile wireless networks is commonly known as Mobile Ad Hoc NETWORKS, also referred as MANETs.

All nodes in the Mobile Ad Hoc Network are capable of dynamic movement. This means that the topology of these networks keeps on changing. Mobile Ad Hoc Networks do not have fixed routers. All nodes in such networks can act as routers

Some important characteristics of the Mobile Ad Hoc networks are:

A. Range Limitations:

The area range covered by a device is very small. The range covered by a device in Mobile Ad Hoc network depends on the underlying technology. For example if Bluetooth technology is used then range can be 10 mtr to 100mtr.

B. Unreliable Media:

The media that is used to transfer data in Mobile Ad Hoc Networks is highly unreliable. There is every chance that the data received contains some errors.

C. Dynamic Topology:

This is the most important feature of MANETs, as the devices are moving so the topology of the network keeps on changing.

D. Interference from Outside Source:

One limitation for wireless media is that they are prone on disturbances from outside.

E. Willingness:

Inability of a device to 'hear' every other device within a network. In Mobile Ad Hoc networks a device which is not willing to take part in the network may set itself as hidden. There is no code of conduct that would ensure that all available nodes must act as routers, if required. Sometimes the presence of the device in neighbourhood may not be detected due to the limitations of the Wireless media.

F. Power Available:

This is a determining factor for the performance of a Mobile Ad Hoc Network. As the devices are on the run the power available to them fall short and they may not be willing to take part to save the power.

G. Security Issues:

Everything is available to everyone, one just have to crack the information. This is the worst point about the wireless networks themselves.

III. SIMULATION OF MANETS

It is not always possible to create natural research environment due to the inherent limitations of research work. In such situations simulation plays an important role. For the purpose of simulating Mobile Ad hoc Networks discrete-event simulation is employed. Kurkowskiet. al[3]., in their studies have pointed out that most used discrete simulators for MANETs are:

- A. Network Simulator 2 (NS2)[4]:** Around 44% of Simulation Research is using this tool.
- B. MATLAB:** Around 4% of Simulation Research is using this tool.
- C. CSIM:** Around 2.5% of Simulation Research is using this tool.
- D. OPNET:** Around 6% of Simulation Research is using this tool.
- E. QualNet:** Around 6% of Simulation Research is using this tool.
- F. GoMoSlim:** Around 10% of Simulation Research is using this tool.

Apart from these tools around 40% of the researchers prefer to design their own tools. These results were generated by the authors on the basis of premier conferences for the MANET community, i.e., the Proceedings of the ACM International Symposium on Mobile Ad-hoc Networking and Computing (MobiHoc) from 2000-2005.

The authors have clearly established that among various simulation tools for Mobile Ad Hoc Networks Network Simulator(NS2) is most employed. The importance of NS2 as simulation tool can be attributed to a number of reasons like:

- A. First and foremost, NS2 is open source freely available Network Simulator.
- B. A full fledge community is working on the fast development of the tool. Various updates and patches are available time to time on the Internet itself.
- C. A number of Forums are working to help the users of the tools in overcoming their problems.

- D. A number of tools to evaluate simulation results are available.
- E. Last but not the least it is found to be very suitable for simulating the MANETs, as the results observed from the Simulation have found to be practically acceptable.

IV. FEATURES OF NS2

Network Simulator arrived in 1989 as a variant of the prevailing REAL network simulator. By 1995 Network Simulator gained support from DARPA, the VINT (Virtual Inter Network Testbed) project at LBL, Xerox PARC, UCB, and USC/ISI. These days Network Simulator is developed in collaboration between a number of different researchers and institutions, including SAMAN, CONSER and ICIR. It is currently maintained by volunteers.

Network Simulator (NS-2) is a discrete event network simulator. It is popularly used in the simulation of routing and multicast protocols. These days it is heavily used in MobileAd-hoc Network research. NS-2 supports an array of popular network protocols, offering simulation results for wired and wireless networks alike. It is very popular as it can be easily extended. Number of online help on NS-2 is also available. NS-2 is available free of cost under the version 2 of the GNU General Public License. Some salient features of NS-2 specific to implementation of Mobile Ad-hoc Networks are given below:

A. Propagation Model:

The Friss-Space model is used for short distances and the approximated Two Ray Ground model is used for long distances. The shadowing model is employed to characterize the probabilistic multiple path fading during radio propagation.

B. MAC Layer:

The IEEE 802.11 Distributed Coordination Function (DCF) is implemented including Request-to-Send (RTS) / Clear-to-Send (CTS) / DATA / ACK four-way handshake for unicasting packets.

C. Network Layer:

All major Ad Hoc routing protocols like DSDV[5], AODV[6], DSR[7] & TORA are implemented.

D. Transport Layer:

Both UDP & TCP are supported. These are extended through the availability of other protocol ste including RTP, RTCP etc.

E. Application Layer:

Most of the major applications are supported like HTTP, FTP etc.

F. Evaluation Tools used with NS2:

A number of freely available analysis tools were employed; most important of them are NAM, xgraph, gnuplot etc. Microsoft Excel was used to generate the charts from various data coming out of simulation

V. SIMULATION OF MANETS USING NS2

One of the major reasons behind using NS-2 for simulation of Mobile Ad hoc Networks is convince of implementation, as the NS-2 architecture closely follows the

OSI model. NS-2 has been implemented using two programming languages in C++ and OTcl[8]. This combination offers is a compromise between performance and ease of use. The ns-2 package provides a compiled class hierarchy of objects written in C++ and an interpreted class hierarchy of objects written in OTcl related to the compiled ones. Mobile Ad-hoc Networks may be implemented using

NS2 by creating own protocol through adding a combination of C++ and OTcl code to NS-2's source base. Then one can write the OTcl script for implementing the simulation. Finally after running the simulation output produced in form of trace files may be analyzed to make inferences The C++ code also describes which parameters and methods are to be made available for OTcl scripting.

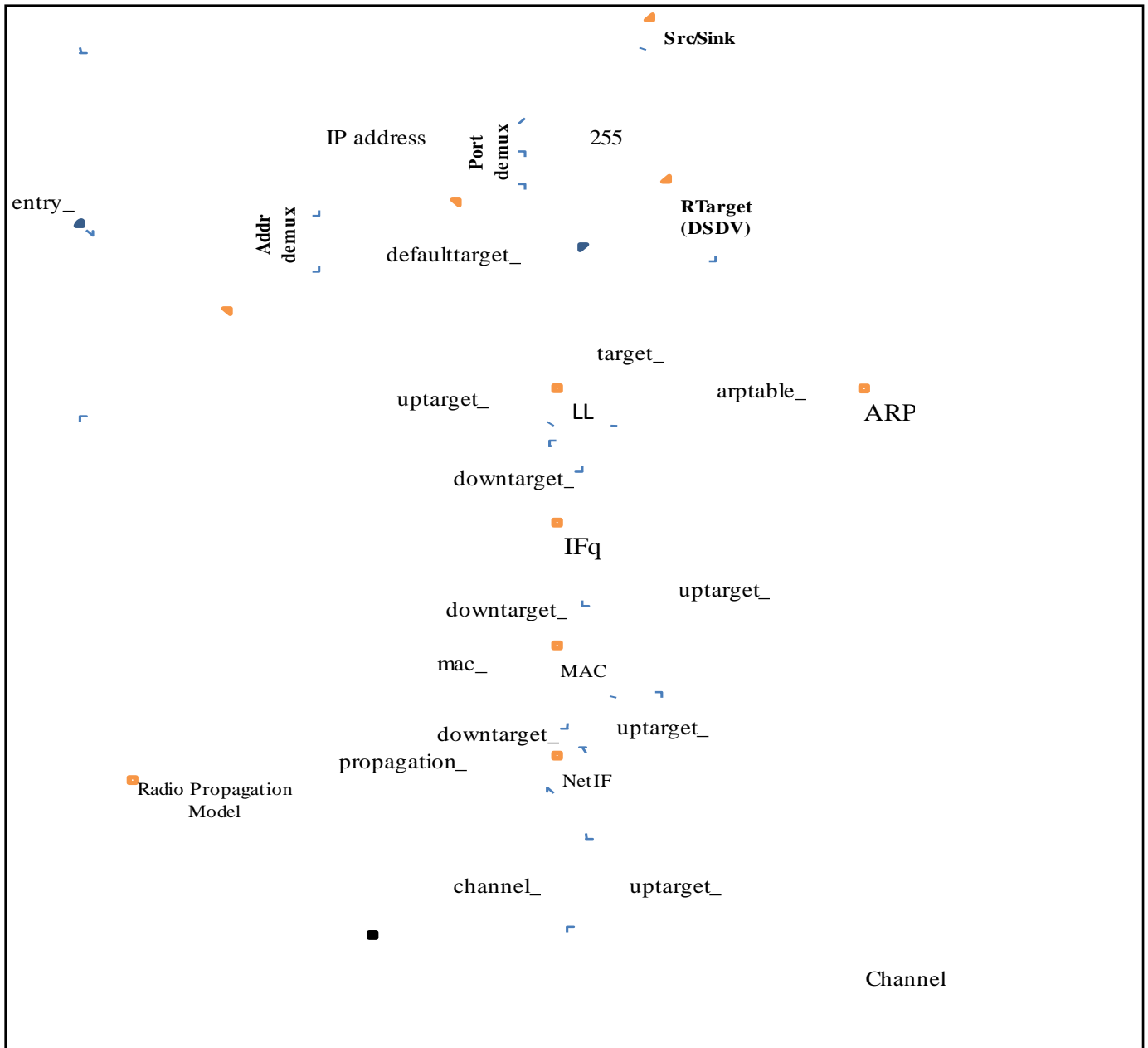


Figure 1: MobileNode Class in NS2 (source : ns2 Documentation)

Mobile Ad-hoc Networks are implemented in NS-2 through the basic class namely MobileNode. This class in itself extends the Node class. Various extension made through this class into the Node class are:

- A. Ability to communicate through wireless media and mobility
- B. Receive and Transmit signals using an antenna, etc.

A major difference among the node of a wired network and node of wireless network comes in form of links which are not there in case of wireless networks. Overall the

MobileNode object is a split object i.e. as its mobility features like node movement are implemented in C++ while plumbing of network component within itself like classifiers have been implemented in OTcl.

Figure1.[9] represents the implementation of MobileNode class in NS-2. As depicted in the diagram the MobileNode stack consists of Link Layer assisted by an Address Resolution Protocol (ARP) module, An Interface Priority Queue for maintaining packets, MAC Layer & Network Interface at Physical Layer Level in terms of Radio Propagation Model.

VI. CONCLUSIONS

It was observed that NS-2 is presently the most widely used simulation tool for conducting research on mobile ad hoc networks. This can be attributed to the fact that NS-2 comes fully equipped with a number of commonly used protocols. It is based on the OSI model. NS-2 is object oriented and hence easily extensible. In this work implementation of Mobile Ad-hoc Networks in NS-2 using the MobileNode was studied.

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