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An overview of Mobile Ad-hoc Simulation tools

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Abstract— Mobile Ad hoc NETworks (MANETs) are dynamic networks, which is populated by mobile stations. Stations in MANETs includes laptops, PDAs or mobile phones. Current types of Wireless Networks are Cellular Networks, Mobile Ad Hoc Network, Wireless Sensor Networks, Vehicle Ad-hoc Networks, and Wireless Mesh Networks. Due to advance in technologies made possibility tremendous usage of small-size and high-performance computing and communication devices like commercial laptops and personal digital assistants. Success of second generation mobile system made more interest in wireless communication. Which led more interest to two types of wireless networks: infrastructured wireless network and infrastructureless wireless network, which is also called Mobile Ad-Hoc Network (MANET). The Infrastructureless wireless network consists of a network with mobile nodes with fixed wired base stations. Simulation tools are used by researchers to debug and test the reliability and Quality of Service of network protocols and also for hardware equipment. This made simulation a very prominent step towards the deployment of wireless communication networks. Hence this paper is very useful to researchers and engineers to propose and bring out new routing protocols using simulator in Mobile Ad Hoc Networks.

Keywords—MANET, Routing, Mobility Models, Simulators, NS2.

I. MOBILE AD HOC NETWORKS

1.1 INTRODUCTION

Ad-hoc network is a local area network (LAN) which is built spontaneously as devices connect. Instead of relying on a base station to synchronize the flow of messages to each node in the network, the individual network nodes forward packets to and from each other. In Latin, ad hoc literally means "for this," meaning "for this special purpose" which is also, by extension, improvised.

Mobile Ad Hoc Networks (MANETs) are an promising type of wireless networking, in which mobile nodes associate on an extemporaneous or ad hoc basis. MANETs enables both self-forming and self-healing for peer-level communications between mobile nodes without reliance on centralized resources or fixed infrastructure.
These attributes enable MANETs to deliver noteworthy benefits in virtually any circumstances that includes a cadre of highly mobile users or platforms, a strong need to share IP-based information, and an environment in which fixed network infrastructure is impractical, impaired, or impossible. Key applications include disaster recovery, mining, transportation, defense, heavy construction, and also for special event management

1.2 HISTORY OF MANET

The life-cycle of ad-hoc networks could be classified into first, second, and the third generation. Current ad-hoc networks systems are considered as the third generation. The first generation of ad-hoc network evolved during 1970's. In 1970's, it was referred as Packet Radio Network (PRNET). The Defence Advanced Research Project Agency (DARPA) took initiatives for researching the usage of packet-switched radio communication to provide reliable communication between computers and industrial PRNET. The second generation of ad-hoc networks emerged in 1980s, when the ad-hoc network systems were more superior and implemented as a part of the SURAN (Survivable Adaptive Radio Networks) program. This network provided a packet-switched network to the mobile field in an environment and also without any mode of infrastructure. The third generation got into effect in 1990, the commercial ad-hoc networks concept arrived with note-book computers and other feasible communications equipment. At the same time, the idea of a collection of mobile nodes was proposed. Within the IETF, the MANET working group was born, and took effort to standardize the routing protocols for ad-hoc networks.

1.3 TYPES OF MANET

There are different types of MANETs including:

- InVANETs – Intelligent vehicular ad hoc networks used artificial intelligence to tackle unexpected situations like accidents and vehicle collision.
- Vehicular ad hoc networks (VANETs) – made effective communication with another vehicle or helps to communicate with roadside equipments.
- Internet Based Mobile Ad hoc Networks (iMANET) – helped to link fixed as well as mobile nodes.

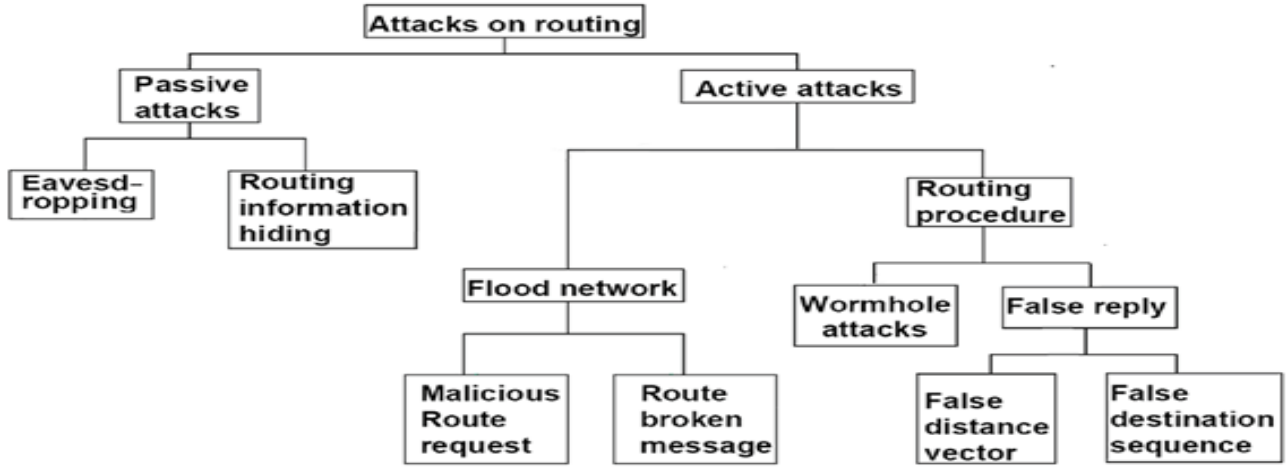
1.4 CHARACTERISTICS OF MANET

- In MANET, each node will act as both host and as router. That is it is independent in behavior.
- Multi-hop radio relaying- the MANETs are capable of multi-hop routing, When a source node and destination node for a message is out of the specified radio range,
- Distributed nature of operation for security, routing and host configuration. Here it lacked centralized firewall.
- The network topology is dynamic in nature as the nodes can join or leave the network anytime.
- Mobile nodes are with less memory power and also with light weight features.
- The reliability, efficiency, stability and capacity of wireless links are often rejected, when it compared with wired links. This shows the irregular link bandwidth of wireless links.
- Mobile and unprompted behavior which requires less human intervention to configure the network.
- All nodes usually have identical features with similar responsibilities and capabilities and thus forms a completely symmetric environment.
- Provides high user density and large level of user mobility.
- Nodal connectivity is irregular.

1.5 MANET CHALLENGES

A Manet environment has to overcome certain issues and inefficiency. It includes:

- The wireless link characteristics are time-varying in nature: There are transmission impediments like fading, path loss, blockage and interference that adds to the vulnerable behavior of wireless channels. The consistency of wireless transmission is resisted by different factors.
- Limited range of wireless transmission – The limited radio band results in reduced data rates compared to the wireless networks. Hence best usage of bandwidth is necessary by keeping low overhead as possible.
- Packet losses due to errors in transmission – MANETs experience higher packet loss during hidden terminals that results in collisions, wireless channel issues (high bit error rate (BER)), interference, breakage happens frequently in paths caused by mobility of nodes, increased collisions happens in the presence of hidden terminals and uni-directional links.
- Route changes due to mobility- Frequently path gets disconnected due to the dynamic nature of network topology.
- Frequent network partitions- Partition of networks happens due to the random movement of nodes. This mostly affects the intermediate nodes.



The application of this wireless network is limited due to the mobile and ad hoc nature. Similarly, which prevents the use of firewall in MANETs as it lacks centralized operation. It also come across multitude of security threats just like wired networks. The threats includes spoofing, passive eavesdropping and denial of service , etc., The attacks are usually categorized on the basis of employed techniques and the consequences.

II. SIMULATION TOOLS INVESTIGATION

So far there are 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 it is for researchers, engineers and educational use. NS3 is free software under the GNU GPLv2 license, which is available openly for use. NS3 encourages the development of simulation models which are adequately 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 the researchers with both IP and non-IP network. More focus is on wireless/IP simulations which involve models for layers 1 and 2 with variety of static or dynamic routing protocols such as OLSR and AODV for IP-based applications.

NS3 also supports a real-time scheduler with full fledged facilities for a number of "simulation-in-the-loop" use cases for interacting with actual systems. For instance, users can receive and send NS3 generated packets on real network devices, and NS3 a also 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 avoids unnecessary recompilations, even if changes are made to the simulation set-up. The frequent recompilation of programs consumed more time and simultaneously 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] modular, extensible, component-based on C++ simulation library and framework. The domain-specific functionality for sensor networks [10], Internet protocols, optical switch, wireless ad-hoc networks, peer-to-peer network and storage area network [11] are supported. OMNeT++ is an eclipse based IDE graphical runtime environment [9]. The extensions can handle network emulation, alternative programming (Java, C#, C), real-time simulation and database integration.

2.4. NetSim

NetSim[12] is a discrete event simulator 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 openly in the form of C code for alteration. It provides full support to the debug 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 practically proves the simulation of networks, with performance data collection and display modules [16]. It provides high-fidelity discrete event simulation models for technologies like MPLS, UMTS, 802.16 (WiMax), IPv6, LTE. It provides simulation, analysis and design of networks, 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 meant 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 study 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. The output is with statistics report which includes 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 quickly 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. It is mainly implemented in application area with queuing network simulation. J-Sim is in Java language. It supports scripting with Perl, Tcl, or Python interface for integration [19], [20].

2.8. QuelNet

QualNet [21] is about planning, testing and training tool that imitates the behavior of real network. It provides a complete atmosphere for creating and animating network scenario, designing protocol, and analyzing performance. It is a GUI

based tool for designing and visualization. In design mode, its possible to 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. The user can visualize in-depth and analysis the state with the option of visualize mode. This can generate dynamic graphs [22].

The above network simulation tools are categorized based on different criteria: commercial or free, type of interface (GUI and/or CLI), whether it support real time traffic/emulation mode, supporting programming language, supporting platform etc. in Table I.

Table 1 Classification of Simulator Tools

Simulator	Interface			Emul-ation	Open Source	Comm-ercial	Programming Language	Platform (OS)	Latest version
	GUI	CLI	Analyzer						
NS3	×	√	NetAnim	√	√	×	C++, Python	Windows, Linux, Mac OS, Free BSD	NS3.23 (May 2015)
NS2	×	√	NAM	√	√	×	C++, Otcl	Windows, Linux, Mac OS, Free BSD	NS2.35 (Nov 2011)
pMNeT++	√	×	√	√	√	×	C++	Windows, Linux, Mac OS	OMNeT ++ 4.6 (Feb 2014)
NetSim	√	×	√	Net-Patrol	×	√	C,C++, Java	Windows	NetSim 8.3
OPNET (Riverbed)	√	×	√	√	×	√	C, C++,	Windows	Version 9.1
REAL	√	√	-	×	√	×	C (CLI), Java (GUI)	Sun OS, Linux, Windows	Real5.0
J-Sim	√	√	√	Partial	√	×	Java, TCL	Windows, Linux,	Version 2.15 (Oct. 2014)
QualNet	√	√	√	√	×	√	C++	Windows, Linux	-

III. CONCLUSION

There are many network simulators which are presented in the field of communication. Among them NS2, NS3 and OMNeT++ are most frequently used for simulation. Due to the rich set of models for NS2, still needs to be ported from NS2 to NS3. OMNeT++ can be considered as feasible option. Furthermore, OMNeT++ is loaded with enough GUI interface and an abstract modeling language. NS2 and NS3 are also abstract modeling language with CLI based source code for the development of the whole simulation. As compare to OPENet++, the NS2 and NS3 contributes more and community even though they are not supporting the GUI mode. However, based on comparative study, it shows that NS3 may better than NS2 in features.

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