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Comparison of AODV, DSR and DSDV on Different Simulators for QoS Parameters

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Abstract: ***Proactive and reactive protocols of MANET are used to route the information over the links to the destination nodes, end-to-end and hop-to-hop. In multi-hop mobile ad hoc networks the consumption of energy at the mobile nodes end and its proper utilization is quite necessary. The nodes and other routing resources in the MANETs do not afford to waste battery power during the critical operations like rescue missions or military operations. This survey paper studies performance of MANET protocols like AODV, DSDV and DSR which were carried out by various researches, computing the various performance metrics of the Mobile Ad-hoc Networks, specifically the throughput, the packet delivery ratio and the energy consumption performed. The study covers the scenarios simulated over different simulators. The related surveys studied the scenario over OMNET++, NS-3, NS-2 and GloMoSim. GloMoSim analyzed the energy consumption scenario using MANET's scalability and nodes mobility with variable speed. OMNET++ and NS-3 also compared the performances of protocols under variable nodes mobility, pause time and nodes density in MANETs.***

Key words: AODV, DSDV, DSR, MANET, Energy Cost, Packet Delivery Ratio, Throughput, GloMoSim, NS-3, NS-2, OMNET++.

1. Introduction

Mobile Ad-hoc Network, MANET in fig 1 is a special network of mobile nodes having an infrastructure less, rapidly changing and prediction less topology. The autonomously connected mobile nodes are linked together via wireless link. Since the nodes are mobile, they can travel in any direction which in turn can frequently update communication links with other nodes. Damaged links must be update and new links must be formed frequently whenever a new node enters the network. It is also characterized by limited resources and limited security [3].

In multi-hop mobile ad hoc networks the consumption of energy at the mobile nodes end and its proper utilization is quite necessary. Energy and resource conservation becomes a prime objective of ad hoc networks. The nodes and other routing resources in the MANETs do not afford to waste battery power during the critical applications like disasters, military operations or search and rescue missions.

The technologies like simulators help in representing the real world's real time scenario in computer. It is not easy to implement the scenarios in real in present time. Also, it comes expensive and time consuming too, hence network simulators are the best substitute as for now. There are many types of network simulators on modern world which are differ from their working range. Reproducibility, mode of deployment and scalability are some of the advantageous features of the network simulators. Among many OPNET, GloMoSim, OMNeT++, NS2 and NS3 are some of the highly used simulators for the researches.

2. Network Simulators

Network simulation is a graphical user interface where a program is made to represent the situation and scenario of the nature of a network for a communication research of communicable devices like computers. A network simulator is software that predicts the behavior of a network of communicable devices. Network simulators are used because the analytical methods of intercommunication networks become too complex and cost consuming. The simulators are designed with several network equipments like nodes, channels, performance parameters to study the performance. Some of the most common network simulators are OPNET, OMNET++, GloMoSim, NS-2, NS-3, NetSim, QualNet, etc. The paper will discuss about OMNET++, GloMoSim, NS-2 and NS-3 briefly.

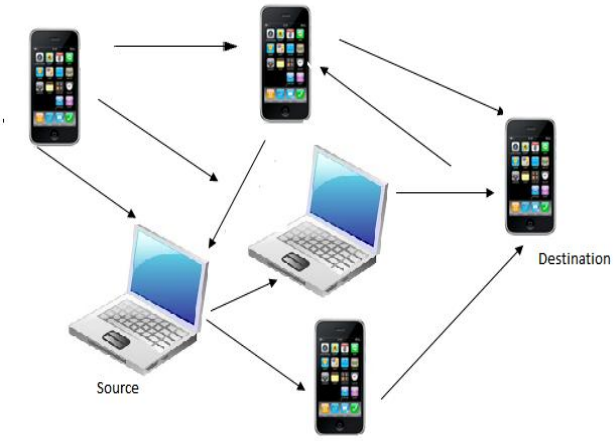

Figure 1: MANET architecture

OMNeT++ is a discrete event simulator for modeling real time scenarios of communication networks. It is an open-source network simulator which acts as a bridge between open-source research simulation and other cost consuming licensed commercial alternatives. The motivation behind OMNeT++ was to provide an open-source simulator for research at academic and commercial level. Some of the features [18] of OMNET++ includes its support for scalable network simulation, use of object oriented language C++, graphical user interface with graphical editor, an easy module development model, parallel simulation, real-time simulation, better result analysis, etc.

GloMoSim is network simulator built using PARSEC a C-based language. It is mobile communication system simulator which can simulate network models scalable up to hundred thousand nodes in parallel simulation. GloMoSim is a large simulation library for wireless networks like wireless sensor networks, mobile ad hoc networks and satellite networks. The size of the network can vary with respect to the scenarios like random mobility of the nodes within the network hence connectivity can also change dynamically. It is capable of simulating and analyzing for digital communication in military and commercial purposes. Monitoring, vehicular ad hoc networks, mesh networks and wireless sensor networks are some of its most common applications.

NS-2 [19] is a network simulator written in object-oriented C++ and OTcl. Ns2 is an open source discrete event network simulator. It simulates many different types of wireless, local area networks and wide area networks specially IP networks. NS-2 includes support for the modules of the models and protocols. The NS-2 simulation environment presents the various characteristics of sensor networks which can be built with almost same set of protocols characterizing the one available in the actual world and evaluating their performances. Energy constraints and node mobility are among the additional support. Also, it provides scalability to the network scenario which is hard to achieve in the practical world. It helps in studying network protocols, network traffic and routing management of protocols like TCP, UDP, Telnet, FTP, VBR, CBR, etc. It also develops tools for result display and converts topologies to its own format.

NS-3 [20] is an open sourced discrete-event network simulator licensed under the GNU GPLv2 license, scripting in Python and coded in C++ and is mostly used in research and development and educational work. and is available for research and development. There is no relationship between NS-3 and NS-2. NS-3 is not an enhancement of NS-2. It was written from the beginning. It has a well organized source code and provides realistic scenario of the real world environment. Its features include modular, documented core, aligned with real-time systems, etc.

3. Classification of the ad hoc routing protocols

MANET routing protocols are classified into three main categories. The different routing protocols for various categories of unicast routing protocols are summarized in table 1.
The routing protocols in MANET are classified into:

- Reactive routing protocols
- Proactive routing protocols
- Hybrid routing protocols

Table 1: MANET routing protocols

Reactive Routing Protocol	AODV, DSR, TORA
Proactive Routing Protocol	DSDV, WRP, OLSR
Hybrid Routing Protocol	ZRP, SHARP

Reactive protocols are On-Demand routing protocols for MANET [12]. Reactive protocols do not maintain or update routing information in the routing tables. Using these protocols, the source node initiates the route search whenever it is demanded to send the data packets to the destination node. The reactive protocols have low congestion overhead, less frequent topological change and bandwidth efficient. AODV, DSR and TORA are some of the reactive routing protocols.

The Ad hoc On-Demand Distance Vector (AODV) routing protocol [4] is used by the mobile nodes in the Mobile Ad hoc Networks to determine the routes of other existing nodes within the network. AODV possess features like multihop, self-starting routing among the communicating nodes in the MANET. In AODV, nodes quickly routes new destinations. It does not maintain routes for the inactive nodes and acknowledge the damaged links and variation in network infrastructure in periodic basis.

Dynamic Source Routing (DSR) routing protocol is a protocol for MANETs. It finds a route on-demand similar to AODV, when a source node seeks a route to transmit a node to the destination node within the network. In a frequently changing topology it adapts to routing changes quickly and possesses low routing when topology change is less frequent. Route Discovery and Route Maintenance are the two mechanisms used by DSR to discover and maintain the route for the source.

Proactive protocols of mobile ad-hoc networks use routing information from the routing tables to direct the packet from source to destination. Hence proactive routing is also called Table-Driven routing. A continuous routing update is carried upon by every node in the network to maintain correct routing information specially the routes about every other node in the network. Though proactive protocols provide reliability but traffic overhead is more as the routing information is transmitted throughout the network on regular basis in order to maintain routing table consistently [12]. Some of the proactive routing protocols are DSDV, WRP, OLSR, GRP, etc.

Destination-Sequenced Distance-Vector Routing (DSDV) routing protocol is a table-driven routing protocol for MANETs with advancement in the conventional Bellman–Ford algorithm. Each mobile node in MANET maintains a routing table with the addresses of all the available destination nodes, address of the next hop node towards the destination, sequence number and other parameters. These metrics makes it transmit the packets reliably between the communicating nodes of the MANET.

Hybrid Protocols utilize the combined features Table-Driven and On-Demand routing protocols. These protocols take the advantage of best features of both the above mentioned protocols. These protocols allow the nodes with close proximity to work together, thus increasing scalability and reducing route discovery [14]. To route to the nodes within a specific geographical zone, table-driven routing approach is used. On demand approach is used for the nodes existing outside the specific zone. Hence hybrid routing protocols combine the advantageous features of both reactive and proactive protocols to maintain inter-zone information and intra-zone information respectively. ZRP, SHARP are some of the hybrid routing protocol.

4. Literature Survey

C. E. Perkins and E. M. Royer in paper [4] proposed for repairing the failed links using the loop-free route in AODV. The algorithm is suited for scalable large ad hoc networks. The scenario was performed for dense networks in [10] using the simulator OMNET++.

Johansson Per, Tony Larsson, Nicklas Hedman, Bartosz Mielczarek and Mikael Degermark in [1] analyzed the performance of reactive and proactive routing protocols (AODV, DSDV, DSR), simulated with NS-2. It is found that AODV and DSR outburst DSDV under almost every evaluation parameter.

Atta urRehman Khan, Sardar M. Bilal, Mazliza Othman in [5], in MANETs have compared various network simulators in terms of CPU utilization, memory usage, scalability and computational time. The study proved that NS-3 works fastest by means of computation time.

Node lifetime and link lifetime are combined in route lifetime-prediction algorithm [8]. It is depicted in terms of (energy state of nodes) residual energy, energy drain rate and the relative mobility estimation rate. The nodes which can be alive for the longer period of time will be selected.

5. The goal of the survey

The aim is to study some of the simulators and evaluation of the scenarios to analyze the performances of routing protocols in terms of throughput, packet delivery ratio, energy cost and average end-to-end delay to determine the optimal path. Comparison was made on OMNET++ and NS-3, GloMoSim, and NS-2 network simulators.

6. Protocols Simulation and Analysis

In MANETs, the performance of various routing protocols will be measured using performance parameters like throughput, routing overhead, energy consumption, packet delivery ratio, end-to-end delay, and some more. This survey studied some scenarios simulated on GloMoSim, OMNET++, NS-2 and NS-3 simulators. In the current survey we are focusing more on AODV, DSR and DSDV analyzed under the performance parameters.

6.1 Performance Evaluation Parameters

- Throughput: throughput is the number of total packets delivered per unit time.
- Packet delivery ratio: it is defined as the ratio of the number of packets successfully delivered to the destination to the number of packets generated by the source.
- End-to-end delay: time taken for a packet to transmitted over the networks from source to destination.
- Routing Overhead: The total number of routing controlled packets generated by routing protocols [11].
- Average Energy Cost: is the amount of energy (battery power) consumed by the nodes (in joules) while transmitting the node in the network.
- Path optimality: it is the difference between numbers of hops taken by a packet to reach its destination and the size of the existing shortest path.

In [11] the comparison between various proactive and reactive protocols of mobile ad hoc networks has been made. The performances of AODV, DSR, DSDV, OLSR, ZRP, and WARP protocols are studied over NS-3 and OMNET++ network simulators, though, as mentioned above, this survey is focusing on AODV, DSR and DSDV. The performance is analyzed for the scenarios with variable network densities. In NS-3, at variable network density AODV has better packet delivery ratio than DSDV and DSR. While comparing the throughput in NS-3, DSR possesses better throughput than AODV and AODV was determined to be better than DSDV. Again, DSDV has lower average end-to-end delay than AODV and DSR. In OMNET++ simulation environment, with variable network density, AODV and DSR both have higher packet delivery ratio than DSDV. While comparing the throughput in OMNET++, AODV possesses better throughput than any other reactive and proactive routing protocol. Here, the result to be monitored is that in NS-3, DSR has better throughput than all whereas in OMNET++ the throughput of AODV is better than all the protocols. Although, in either scenario reactive routing protocols has better throughput than proactive routing protocol. DSDV has lower average end-to-end delay than AODV and DSR.

To maximize the lifetime of the nodes the energy conservation algorithm was proposed and simulated over NS-2 [9]. AODV, DSR and ZRP has been analyzed by [9], though the survey has been performed over AODV and DSR only. The algorithm distributes the rotating sleep period equally to the nodes thus reducing the energy consumption. Aggregate throughput and routing load are key measures of interest when assessing protocol performance. Applying different pause time (different time intervals) results in better throughput and better packet delivery ratio and low energy cost per packet for DSR in comparison with AODV. With different node mobility (different speed for mobile nodes with constant distance in meter per second) results in better throughput and better packet delivery ratio and low energy cost per packet for DSR in comparison with AODV. Under random node mobility scenario results in better throughput and better packet delivery ratio and low energy cost per packet for DSR in comparison with AODV. Though AODV results in a better performance DSR under some parameters in some scenarios for certain instances, still DSR has an upper hand and has performed well in all the simulations.

In [3] the scenario simulated on GloMoSim [6] simulator over DSDV and AODV under varying scalability of the MANET and mobility of the nodes with variable speed. In the analysis under scalability scenario, the throughput of AODV was better than DSDV in various network sizes except the densest network where DSDV possesses higher throughput than AODV. In average energy consumption scenario, DSDV has been constant with battery power consumption with variable network sizes whereas AODV consumed more energy in the same scenario.

Under the scenario of node maximum speed (number of nodes and pause time are kept constant), AODV has comparatively much better throughput than DSDV, but energy consumption by DSDV was low in comparison to AODV under same scenario. Under the scenario of node minimum speed (number of nodes and pause time are kept constant), again AODV has comparatively better throughput than DSDV, but energy consumption by DSDV was lower in comparison to AODV under same scenario. The DSDV protocol has consumed approximately same amount of energy in terms of average battery power for the different size of networks examined, whereas the energy consumption in AODV was highly variable for different MANETs sizes. Although DSDV consumed relatively lower average battery power for almost all sized networks. On the other hand, AODV was only better for larger MANETs.

7. Conclusion

This survey paper studied AODV, DSDV and DSR routing protocols of MANET with OMNET++, GloMoSim, NS-3 and NS-2 network simulators analyzing under various parameters like throughput, packet delivery ratio, end-to-end delay, energy cost, etc. Each simulator has its own areas of relative weakness compared to the other candidate set. The results of the reactive and proactive routing protocols were same for both NS-3 and OMNET++ but the values varies abruptly. NS-3 produces better result. OMNET++ has a better Graphical User Interface.

The survey also analyzed the synchronization of the optimized power depletion while maintaining the effective throughput. The scenario was simulated over NS-2 for AODV, DSR and ZRP. DSR enhances performance well under different pause time, energy consumption, Node mobility, random mobility and different node density.

Another analysis was based on variable scalability and mobility of the nodes of ad hoc networks studied for AODV and DSDV. The performance was monitored under GloMoSim academic simulator. DSDV has consumed less energy. In future, study could be put on comparing various MANET routing protocols with different open source network simulators.

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