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Performance Evaluation of Routing Protocols in MANET

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Abstract

Mobile Ad Hoc Networks (MANETs) use many different routing protocols to route data packets between the nodes. Efficient routing mechanism is a challenging task for group oriented computing in Mobile Ad Hoc Networks (MANETs). A MANET is a wireless mobile network that is self-forming, self-maintained and self-healing. In MANET's network nodes stay connected even as the network topology changes. The ability of MANETs to support adequate Quality of Service (QoS) for group communication is limited by the ability of the underlying ad-hoc routing protocols to provide consistent behavior despite the dynamic properties of mobile computing devices. A number of ad hoc routing protocols have been developed during the time, but none of these is able to produce efficient routing of packets in large number of nodes due to their own limitations. This Paper presents the performance of two routing protocols OLSR(Optimized link state routing protocol) and DSR(Dynamic source routing protocol) using metrics throughput, packets delivery ratio and End-to-end delay. The performance evaluation of routing protocols is done by using two different traffics i.e. TCP and UDP. Our Simulation tool will be NS-2.

Keywords: *MANET, OLSR, DSR, TCP, UDP.*

1. Introduction

Ad-Hoc is a decentralized wireless network. The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks.

Need of Ad-Hoc Network: Setting up of fixed access points and backbone infrastructure is not always viable. It means infrastructure may not be present in disaster area or war zone. A mobile ad-hoc network is a collection of mobile nodes forming an ad-hoc network without the assistance of any centralized structures.[1] These networks introduced a new art of network establishment and can be well suited for an environment where either the infrastructure is lost or where deploy an infrastructure is not very cost effective. In mobile ad hoc networks, two nodes communicate directly or via a multi-hop route with the cooperation of other nodes. The different types of the MANET's are VANET's (Vehicular ad hoc networks) and IMANET (Internet based mobile ad hoc networks). [2]

The features of the MANET are:

1) Each node acts as both host and a router.
2) It supports the Multi-hop routing.
3) Nodes can join or leave the network anytime.
4) The control and management operations are distributed among the nodes.

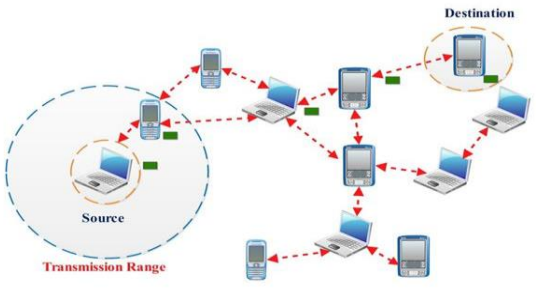

Figure 1: MANET Network

MANET Routing Protocols

There are number of routing protocols in MANET's and the routing protocols in MANET's are classified into four types:

Proactive Routing Protocols

This type of protocols maintains a routing table that's why these protocols are called table driven routing protocols.[3] The address of the nodes are periodically updated in the routing tables of all nodes throughout the network. These protocols maintain different number of routing tables varying from protocol to protocol. The different types of the proactive routing protocols are OLSR (Optimized Link State Routing Protocol), DBF ((Distributed Bellman-Ford Routing), GSR (Global State Routing), WRP (Wireless Routing Protocol), ZRP (Zone Routing Protocol), STAR (Source Tree Adaptive Routing), DSDV (Dynamic Destination-Sequenced Distance-Vector Routing Protocol).

Reactive Routing PROTOCOLS

This type of protocols do not have any pre-determined routing table, it is otherwise called On Demand Routing Protocols. In this type of protocols nodes initiate a route discovery process throughout the network, only when it wants to send packets to its destination.[4]The route discovery is done by using flooding of route request packets. The different types of the reactive routing protocols are DSR(Dynamic Source Routing), DDR(Dial on Demand Routing), TORA(Temporarily Ordered Routing Algorithm), RDMAR(Relative Distance Micro-Discovery.

Hybrid Routing

This type of protocols combines the advantages of proactive and reactive routing. The routing is initially established with proactive routing and then serves reactive routing for additionally activated nodes by flooding. Hybrid protocol is suitable for large networks where large numbers of nodes are present. In this large network is divided into set of zones where routing inside the zone is performed by using reactive approach and outside the zone routing is done using reactive approach.[5] The different types of the hybrid routing protocols are ZRP(Zone Routing Protocol) and SHARP (Sharp Hybrid Adaptive Routing Protocol).

Hierarchical Routing

It is similar to hybrid protocol but the choice of proactive and of reactive routing depends on the hierarchic level in which a node resides.

2. Simulation Environment

It is very difficult to estimate the performance of a proposed network in real life and as a result, many network simulators have been proposed to design and simulate the networks in many perspectives.[6] In this paper, the simulation of OLSR and DSR routing protocols is done by using network simulator (NS-2) software due to its simplicity. NS-2 is simply an event-driven simulation tool that has useful in studying the dynamic nature of communication networks. It is written using two languages:
1) OTCL (Object Oriented Tool Command Language)
2) C++ language
NS-2 uses OTCL to create and configure a network. C++ defines the internal mechanism of the simulation objects. The simulation is performed using the NS-2 simulator with the two different traffics i.e. TCP (Transmission Control Protocol) and UDP (User Datagram protocol).

The model parameters that have been utilized in this work are shown in the table below:

Table 1: Model Parameters

Parameters	Values
Simulator	NS2
Simulation Time	600 sec
Routing protocols	OLSR, DSR
Channel Frequency	2.4 GHz
Number of nodes	10
Speed	1 m/s – 20 m/s
Traffic Type	TCP, UDP
MAC Type	802.11
Packet Size	512 bytes
No. of groups	2

3. Metrics Parameters

The performance metrics selected to make the performance differences are:

Throughput
End-to-End Delay
Packet Delivery Ratio

End-to-End Delay

The end-to-end average packet delay of the data packet is the time (in seconds) required as the source/sender node to generate and transmit a data packet across the network, until it is received by the destination node.[7] It can be calculated by divided the summation of all time differences between sending and receiving of packets. In the delay, the low average end to end delay in network is a good indicator for performance of the routing protocol.

Throughput

The average network throughput refers to the amount of the data packets in seconds that are transmitted over a communication channel to the final destination node successfully. In this paper throughput is defined as:
Throughput = Number of delivered packets * packet size*8 bit / total duration of simulation.

It is always measured in data packets/second or data packets/time slot.

Packet Delivery Ratio

It is defined as the ratio of number packets received by the destination to the number of packets originated by the source. This ratio is used to illustrate the level of delivered data to the destination node.[8] When the ratio of the delivering packet is higher it means that the protocol is successes in delivering all the packets to the destination node so it indicates that the performance of the protocol is good.[9] We can calculate the Packet Loss ratio and Packet Dropped by the formula given below:

Packet Loss Ratio (%) = (1- received packet/sent packet) *100 Packet Dropped = sent packet-received packet

4. Simulation Results

Throughput Results

We have taken both the traffics i.e. TCP and UDP. The two experiments are done with TCP and UDP with DSR and OLSR to find the throughput.[10] We have to calculate the throughput by using AWK script. Throughput over TCP (OLSR vs. DSR)

In case of throughput TCP over OLSR, the throughput is same at 1m/s speed and after that throughput increases, but at speed 15m/s the throughput decrease and at 20m/s the throughput again increase.[11] In case of throughput TCP over DSR, the throughput is same at 1m/s speed and after that throughput decrease a little bit at 5m/s but at speed 10m/s the throughput increase and at 20m/s the throughput also increase In case of TCP over OLSR, the throughput is higher than TCP over DSR. So, the above result shows that the TCP over OLSR routing protocol is better.

Table 2: Throughput vs. Speed TCP over (OLSR vs. DSR)

Speed / Routing Protocol	1 m/s	5 m/s	10 m/s	15 m/s	20 m/s
DSR	55344.2	52072.4	75156.01	74431.68	98570.05
OLSR	51457.221	108979.24	133982.75	114950.38	141259.58

Table 3: Throughput vs. Speed TCP over (OLSR vs. DSR)

Speed	1 m/s	5 m/s	10 m/s	15 m/s	20 m/s
DSR	546133.33	490237.06	466772.62	459004.78	454894.12
OLSR	546133.33	459794.73	422563.54	416054.91	406034.25

Throughput over UDP (OSLR vs. DSR)

In case of throughput UDP over OLSR, the throughput is same at 1m/s speed and after that throughput decrease as increasing the speed. Both routing techniques (OLSR & DSR) were simulated, the throughput decreases as speed increases, since finding the route requires more and more routing traffic as speed increases.[12] Therefore less and less of the channel will be used for data transfer, thus decreasing the overall throughput.

Delay Result

Delay over TCP (OLSR vs. DSR):

Table 4: Delay vs. Speed TCP over (OLSR vs. DSR)

Speed	1 m/s	5 m/s	10 m/s	15 m/s	20 m/s
DSR	0.36214	0.28796	0.197358	0.187328	0.168963
OLSR	0.334692	0.130662	0.125244	0.127186	0.122685

Delay over UDP (OLSR vs. DSR):

Table 5: Delay vs. Speed UDP over (OLSR vs. DSR)

Speed / Routing Protocol	1 m/s	5 m/s	10 m/s	15 m/s	20 m/s
DSR	0.003382	0.041385	0.054949	0.059964	0.061933
OLSR	0.003446	0.01504	0.009766	0.013361	0.006137

Packet Loss Ratio

Packet Loss Ratio over TCP (OLSR vs. DSR):

Table 6: Packet Loss Ratio vs. Speed TCP over (OLSR vs. DSR)

Speed	1 m/s	5 m/s	10 m/s	15 m/s	20 m/s
DSR	0.524005098	1.284540702	0.972803347	1.109599079	0.745676662
OLSR	0.682170543	0.452898551	0.42275458	0.507543628	0.327011118

Packet Loss Ratio over UDP (OLSR vs. DSR):

Table 7: Packet Loss Ratio vs. Speed UDP over (OLSR vs. DSR)

Speed	1 m/s	5 m/s	10 m/s	15 m/s	20 m/s
DSR	0.002678524	10.23731719	14.53366904	15.95596507	16.7086302
OLSR	0.002678524	15.8113248	22.62816735	23.82011036	25.65489902

5. Conclusion

This paper presents the performance between the two categories of routing protocols, first one is the OLSR (Optimized Link State Routing Protocol) from the Proactive family and the second one is the DSR (Dynamic Source Routing) from the Reactive family with two different traffic TCP and UDP. Both protocols were simulated by using NS-2 package. Both routing protocols were simulated in terms of average throughput, packets delivery ratio and average delay, with the same number of nodes (10 nodes) while the movement speed of the nodes was varied from 1m/s to 20m/s in steps of 5 m/s. We can conclude that if delay is our main criteria than TCP over OLSR and UDP over OLSR can be our best choice. If throughput and packet loss ratio are our main parameters then TCP over DSR gives better results. OLSR perfectly scales to a small network with low node speeds. The objective of this paper is to study mobility speed of nodes within MANET and then conclude which type of routing protocol is best suited in one type of environment and another. In this case, the simplicity of OLSR is preferred over the other more complex techniques without sacrificing the performance. Here we focus only on the network throughput, packet loss ratio and the delay.

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