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Effect of Mobility Models on Analysis of MANET Routing Protocols

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Abstract: *Mobile Ad-hoc networks are main thrust area of research. The analysis of performance of MANET in different propagation characteristics is key issue of concern. In this paper the analysis of MANET routing protocols for different propagation models is carried out. Some important Ad-hoc routing protocols are: DSR (Dynamic Source Routing, Destination Sequenced Distance Vector (DSDV), (AODV) Ad-hoc on demand Distance Vector, Ad-hoc on demand Multipath Distance Vector (AOMDV) are investigated and compared. The MANET network is simulated using network simulator 2.34 and its associated tools for different routing protocols. The analysis of above routing protocols is carried out for parameters like signal strength, end to end delay, packet delivery ratio, energy consumption.*

I. Introduction

AD-HOC network is a network in which two or more nodes can communicate with each other without any help of centralized administrator. In this type of network nodes are powered by battery resources so, maximizing the life time of battery of each node is an important issue. Generally, the maximum energy of nodes is consumed in sending or receiving mode, in other mode nodes are in ideal mode or sleep mode. In ideal or sleep mode minimum energy is consumed by nodes. In Ad-hoc network while communicating between two nodes routing protocol is used to find out the correct and efficient route for transmission. In Ad-hoc network well known routing protocols are AODV, DSDV, DSR, and AOMDV. These protocols are energy efficient. Energy consumption is an important factor in case of mobile node because they are operated on battery. There are two main units which consume energy, first is center processing unit and another is radio sending and receiving unit.

In Ad-hoc network nodes consume energy not only in sending or receiving mode but in ideal mode also. So if routing protocol is energy efficient then it consumes minimum energy during ideal model propagation model like two ray model or shadowing model also play a very important role for optimum use of energy while sending or receiving data among nodes. Similarly mobility model also affect the power consumption of nodes. They also help to analyze the performance of energy consumption in mobile Ad-hoc network. The well known mobility models are Random walk, Random Way Point, Random Direction.

In MANET [1] [3] nodes are forwarding packets for each other, a particular type of routing protocol is required to make the routing decisions. Routing protocols are classified in two categories first is table driven, second one is on demand routing protocols. In first type of protocols each node maintains a routing table which contains up to date routing information of all node in network. In the second type of routing protocol as and when required the node discovers the route whenever it desire to send packets. In general routing protocol must be highly efficient to cope up with the high degree of node mobility for change in the network topology. The different Ad-hoc routing protocols have their unique characteristics. It is important to carry out analysis by varying node mobility, speed, and traffic and network size to find out the performance of Ad-hoc network.

II. AD-HOC Routing Protocols

In mobile Ad-hoc network the routing protocols is classifieds in three basic types. [2] [9] [10]

1. Proactive*: It is also called as table-driven protocols, in this each node has to keep information of all remaining nodes in* network*. Each node has to maintain the routing table which contains the information of routing; any small change in* topology *should be reflected in routing table, if dynamically any request comes for data transfer so it could be able to find out the shortest path from table.*
2. Reactive: It is also called as on demand protocol, in this protocol when node require route for destination at that time route will be searched.
3. Hybrid: It is combination of Reactive and Proactive protocol. In this type of protocol the movement of node is based on the location of network and simulation time, for example if node is in Random Waypoint and crosses the range then it goes in Manhattan Grid model. On the basis of above three categories some important protocols are AODV, DSDV, DSR and AOMDV, each one of them have specific quality in different aspects of routing like load balancing, shortest path finding, and energy.

1. DSDV: It is a Destination Sequenced Distance Vector protocol, it comes under proactive category. This protocol is based on Bell-Man-Ford routing algorithm. In DSDV protocol each node maintain routing table which contains information of all possible destination node in network, each node entry has specific sequence number, if any new node is joined to network recently then that node has highest sequence number, also when any node left the network then this information is broadcast by transmitting packets to all node in network so that they can update their routing table, so the changes in routing table are extremely dynamic [3] [13] [14].
2. AODV**:** The protocol for finding route is used as on demand approach is called as Ad-hoc on Demand Distance Vector Routing protocol [3]. It means whenever source node wants to sends packet at that time only the route is established. It comes under reactive protocol and based on distance vector algorithm. This algorithm uses different messages to find out different routes and maintain links among nodes, means whenever any node want to communicate or send data packets to other specific node then it first find out all possible routes, it send route request to all neighbor route and all node will reply with specific message to source node. When any node send route request (RREQ) to all other nodes, the sender node will maintain all acknowledged messages from other requested nodes which helps to find route for the destination node as well as it indicate that all nodes are alive. If any other node not giving acknowledgment to the sender's request (request response: RREP) then sender node will remove that link as well as entry of that node from routing table.
3. DSR: It is Dynamic Source Routing protocol, it comes under reactive protocol. DSR protocol helps to discover desired destination root dynamically among the available roots. In DSR protocol when node sends root request (packet), then this packet stores all paths through which it has travelled to reach to the destination node. This concept reduce the periodic routing of messages which helps to reduce network bandwidth overhead, conserve battery power also avoid large routing updates through Ad-hoc networks.
4. AOMDV: The Ad-hoc On-demand Multi-path Distance Vector (AOMDV) routing protocol is multipath extension of the Ad-hoc On-demand Distance Vector (AODV) routing protocol. It comes under on demand (reactive) routing protocol. In MANET nodes are nothing but the mobiles so there is maximum possibility of route failure. To avoid these situation frequently route searching process has to start. In MANET multipath routing protocols has maximum capability to reduce the route discovery frequency than the single path routing protocols. In MANET routing protocols AOMDV is one of the best multipath routing protocol because it does not have intermodal coordination overheads like some other protocols. It ensures disjoint of alternate routes via distributed computation without the use of source routing. It find out exchanged paths with minimal additional overhead over AODV. It does this by exploiting already available exchanged routing path information.

The basic idea behind multi-path routing is of finding multiple paths between a source and a destination. On-demand routing protocols for MANETs discover a route when a source needs to communicate with a destination. The multi-path routing protocol discovers multiple paths during the single route discovery process. These multiple paths can be used for load spreading.

III. Mobility Models

In Mobile Ad-hoc Network to determine the performance of routing protocol Mobility model [12] [13] play an important role. Actually mobility model is used to set different parameter related to node movement like starting point of node, movement direction, velocity etc. At global level mobility model is divided in two parts Entity and Group. In Entity model the node move completely independently from each other but in group model they are dependent on each other.

1. Random Waypoint :It is commonly used mobility model [4] in simulation of Ad-hoc network. In this mobility model node has to be paused for certain amount of pre specified time while changing direction or speed, this time is called as pause time, once this time is over then node has to select other random destination and start travelling towards it with uniformly distributed speed.
2. Random Walk :In Random walk model mobile nodes are travelled in any direction with any speed but the value of speed and direction is chosen from predefined ranges from minimum to maximum, in this mobility model mobile node's direction will change after particular time of interval or specific amount of distance. The Random walk is memory less mobility pattern so it generates unrealistic movement such as sudden stop or sudden curve. In this model if mobile node touch boundary of simulation area it will bounce back with certain speed to its original position.
3. Random Direction :This mobility model is similar to the random walk the only difference is that in random direction when node reach to boundary of simulation it will not get reflected back, before reflecting it will pause there for certain amount of time and then choose any other direction means any angle between 0 to 180 degree and start travelling again. The random direction model was created to avoid clustering among nodes in simulation area.
4. Manhattan Grid :The Manhattan Grid is a mobility model which is used to evaluate movement of mobile nodes which are moving on road. It can be useful in modeling movement in an urban area where computation is done in between portable devices.

IV. Propagation Models

The propagation model is the model which helps to predict and analyze the power of received signal of each packet on each node. In Network Simulator there are three main propagation models which are two-ray model, free space model and shadowing model. At physical layer of each node there is one specific threshold value which indicates that if the received signal power of received packet on each node is below than that specific value then that packets are dropped by that node.

1. Two-ray model : In this model direct path ray and ground reflected ray are used. The accuracy of this model is much greater than other models. This model is preferred for nodes which are separated by long distance. In this type of model the power of received signal is given by

$$P(r) = [P_t \times G_r \times G_t \times h^2_t \times h^2_r] / d^4 \times L \ldots\ldots \text{ eq no 1}$$

Where Pr is power of received signal, Pt power of transmitted signal, Gr and Gt are gain of antenna in transmitted and receiving mode, d represent distance between two antennas, L is system loss which has specific value.

2. Free Space model: The free space model assumes ideal assumption that the sending and receiving of packets are done by line of site action. Basically in this model the transmitting antenna send signals in Omni directional it so the receiving antenna which is in the range, it will receive packets otherwise loose the packets. The power in free space model is given by following equation

$$P_r(d) = [P_t \times G_t \times G_r \times \lambda^2 / [(4\pi)^2 \times d^2 \times L] \ldots\ldots\ldots \text{eq no 2}$$

Where P_t and P_r are the power of transmitter and receiver antenna, G_r, G_t are gain of transmitter and receiver Antenna, d is distance between transmitter and receiver, λ is wavelength

3. Shadowing Models : As both the free space model and two-ray model are using distinct function of distance to predict the strength of received signal although the power at different location on each node is varying. Both models are predicting the mean received power, so to get more accuracy in received signal power use shadowing model. The shadowing model has two parts, first part is Path loss Exponent and second is Log normal random variable [final equation from rapaport].

V. Comparison of AD-HOC Routing Protocols

This section analyze and compare performance of different Ad-hoc routing protocols [7] [9] with different parameters, these parameters are packet delivery ratio, mobility of nodes, network traffic and consumed energy. Here mainly concentrate on AODV, DSDV, DSR and AOMDV protocols and check their performance by varying values of parameter. This analysis helps to know in which scenario protocol will give best performance. Simulation has been carried out by using NS2 (Network Simulator 2.34) with 2GB ram and operating system is UBUNTU 10.04. For simulating following performing parameters are set like Propagation model (two ray model and shadowing model), ANTENNA: Omni directional, Simulation time: 100ms, Area Size (500 by 500), Routing protocols (AODV, DSDV, DSR, AOMDV) are set.

The parameters like throughput, end to end delay and packet delivery ration are analyzed with different routing protocols and maximum node connections (5 to 10) with different mobility models like Random Waypoint , Random Walk, Random Direction , Manhattan Grid.

VI. Simulation Results

1. Throughput : Throughput means number of packets successfully reached to destination per unit time [13] [14], it is measured in kbps (kilo byte per second). When maximum connections are 5, traffic is TCP then comparison of throughput for different mobility models when propagation model is Two-Ray model is as shown in fig 1.1.

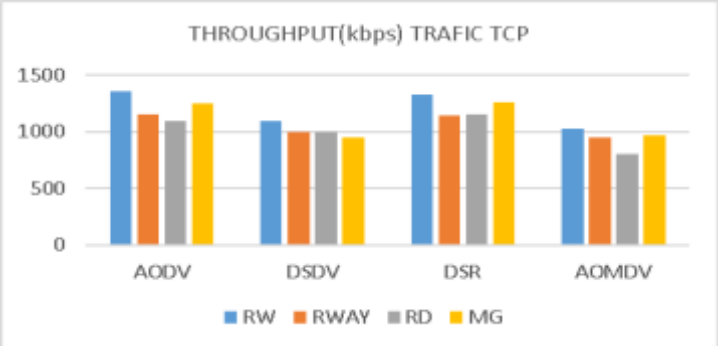

Fig 1.1 Throughputs for Traffic TCP

Above results are plotted with number of node 50 and maximum connection 5, i.e. maximum 5 node can send or receive data packets, also the nodes are moving with speed of 50 meter per second without delay with traffic TCP. From graph it is clear that AODV &DSR ad-hoc routing protocol has better results for throughput in all mobility models is as compare to other routing protocol.

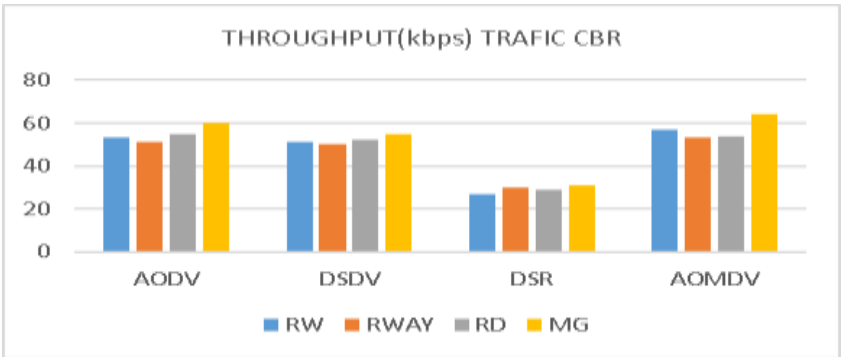

Fig 1.2 Throughputs for Traffic CBR

Fig 1.2 shows the simulation results for CBR traffic. It shows that the throughput of AODV&AOMDV is better than the other ad-hoc routing protocols for all Mobility models. Similarly, DSR have minimum throughput in all mobility models. Fig 1.1 and 1.2 shows that AODV protocol gives better performance in both the traffic.

2. End to End Delay : Next performance parameter is end to end delay, it is a measure of how much time is taken by packets to be transmitted from source to destination. It is measured in millisecond [14] [15]. The result for this parameter for all routing protocols when traffic is TCP and maximum connections are 5 is as shown figure 1.3

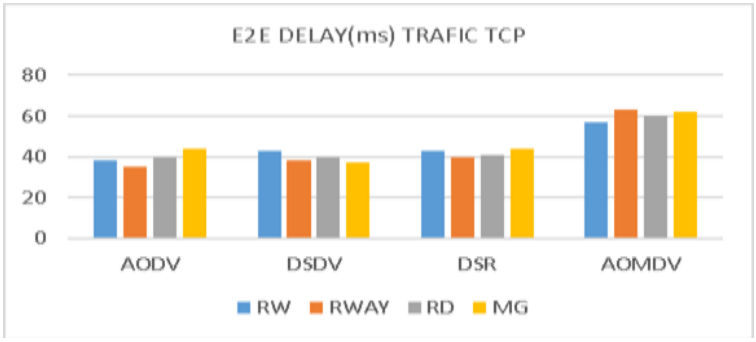

Fig 1.3 End to End Delay (ms) Traffic TCP

For above set parameter from graph it is clear that for TCP traffic the AOMDV took more time to transfer in all mobility model. By changing traffic from TCP to CBR for same setup the results are as in fig 1.4.

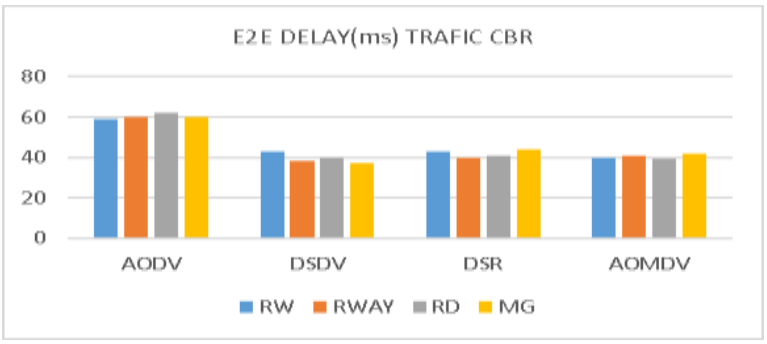

Fig 1.4 End to End Delay (ms) Traffic CBR

Fig 1.4 shows that AODV is taking much time to transfer packets as compare to other protocols, for all mobility models DSR &DSDV are having good result as compare to other protocols.

3. Packet Delivery Ratio: Packet Delivery Ratio or packet delivery fraction can be defined as a ratio of successfully received packets at receiver to the successfully transferred packets from sender node. Generally it is measured in percentage. The Packet Delivery Ratio (PDR) with all mobility models in TCP traffic, are plotted in fig 1.5

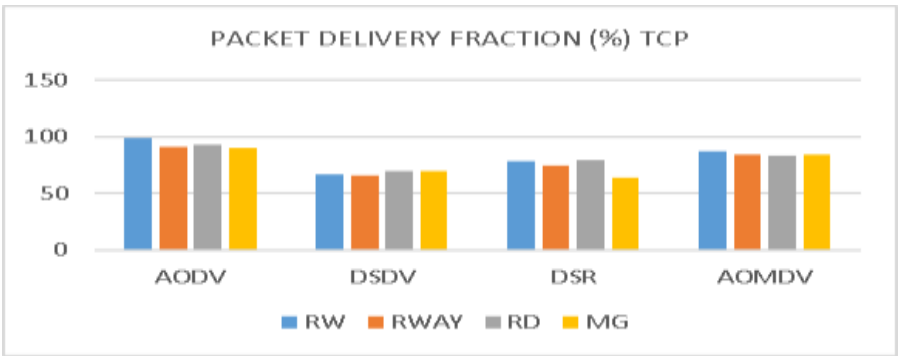

Fig 1.5 PD fraction (%) Traffic TCP

For traffic TCP the PDR is near about same in AODV and AOMDV protocols, but the DSR & DSDV has poor response

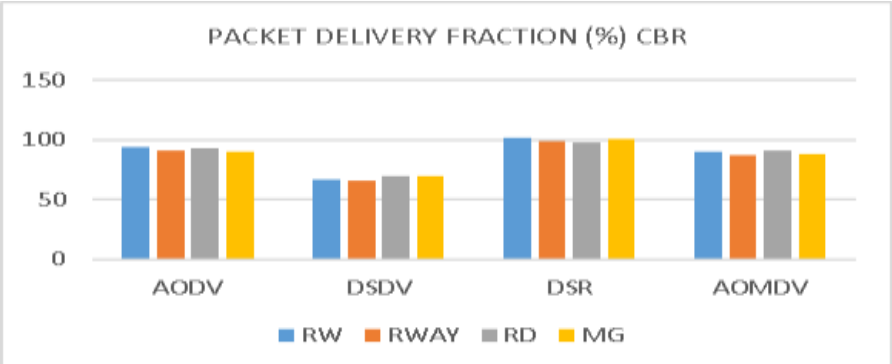

Fig 1.6 PD fraction (%) Traffic CBR

For CBR traffic AODV, AOMDV and DSR give near about same performance except DSDV. Only DSDV protocol is having poor responses. By comparing PDR responses for all mobility models in both traffic then AODV, DSDV and AOMDV gives good results.

VII. Conclusion

Performance of different routing protocols (AODV, DSDV, DSR, and AOMDV) for varying mobility models (RW, RWAY, RD and MG) with Two-Ray Propagation models are shown in graph. The important parameter like Throughputs, End-to-end delay and PDR are plotted in graph, it is concluded that Ad-hoc routing protocols performance changes according to the changes in mobility models. Performances carried out by taking Two-Ray propagation model, it is found that performance of AODV and AOMDV protocol is better as compare to other protocols

VIII. Future scope

The next task will be to analysis performance of all protocols by varying the mobility models for shadowing and free space propagation model and to test protocols response when received signal strength is varying.

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