PERFORMANCE COMPARISON OF TWO MOBILITY MODELS USING AODV

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ABSTRACT

AODV is the most important routing protocol for Ad Hoc network. In this, we make a comparison of two mobility models viz. Random Direction and Probabilistic Random Walk based over AODV protocol in context of the services offered by them to the transport layer. Detailed simulations are then performed to compare the performance in terms of packet delivery ratio, routing overhead, average end-2-end delay and normalized routing load of both models with respect to varying number of nodes. This paper presents simulation results in order to choose the best mobility model to give the highest performance when implemented on the AODV and TCP as traffic generator. We observe the high variability of the result, exact behavior of the system and the impossibility to define a unique proposal, which is general to every environment. On the bases of these observations, we found that Random Direction model having good packet delivery ratio on some aspects and less normalized routing load when the number of nodes are increasing. On the other hand end-2-end delay is less in the Probabilistic Random Walk.

KEYWORDS: MANET, TCP, AODV, Random Direction, Probabilistic Random Walk.

INTRODUCTION

MANET is an example of mobile wireless network that does not require any fixed infrastructure, which means that its topologies can vary randomly at unpredictable time. In past few years, the Internet Engineering Task Force (IETF) MANET working group [1] had contributed various protocols for ad Hoc networks. Most of the tools such as ns-2 [5] make use of synthetic models for mobility and data patterns. However, the general problem of modeling the behavior of the nodes belonging to a mobile network has not a unique and straight forward solution. Routing path in MANET potentially contains multiple hops, and every node in MANET has responsibility to act as a router [8].

The mobility models that are commonly used to simulate MANET are generally classified into two categories [17]: individual-based and group-based. An individual-based model describes node mobility independent of any nodes with group-based mobility models. Individual nodes movement depends on the movement of close by nodes.

There are various mobility models such as Random Way Point, Random Walk, Random Direction, Probabilistic Random Walk etc. that have been proposed for evolution [9, 10] and with the help of Bonn motion 1.5a [2] we can find out the scenario of the nodes in the mobility models. The individual-based

mobility model is the *Random Direction and Probabilistic Random Walk* model, where motion is characterized by two factors: the maximum speed and the pause time. Each node starts moving from its initial position to a random target position selected inside the simulation area. The node speed is uniformly distributed between 0 and the maximum speed. When a node reaches the target position, it waits for the pause time, then selects another random target location and moves again. Many other variations of this model exist which increase the randomness of the mobility process.

Azizol Abdullah et. al. [4] mainly target the performance comparison based on packet delivery fraction and normalized routing load corresponding to the pause time (second). We may use fraction/ ratio interchangeably throughout the paper. They find out that AODV gives better performance. Then in 2009, they analyzed the realistic comparison of three routing protocols AODV, DSDV and DSR [6]. The reactive routing protocol AODV performed better by considering its ability to maintain connection by periodic exchange of information, which is required for TCP based traffic. In 2010, Harminder Bindra et. al. [3] group mobility model with CBR traffic sources AODV perform better. But in case of TCP traffic, DSR performs better in stressful situation (high load or high mobility). DSR routing load is always less than AODV in all types of traffic. Average end-to-end delay of AODV is less than DSR in both types of traffic. They find out that the performance of AODV is better than DSR in CBR traffic and real time delivery of data. But DSR perform better in TCP traffic under restricted bandwidth condition.

In this paper, we have evaluated the performance of AODV protocol under the two different mobility models viz. Probabilistic Random Walk and Random Direction with respect to varying number of nodes.

The rest of this paper is organized as follow: section 2 describes the routing protocol AODV [11]. In section 3 describes the mobility models and the software tool we have used. The performance metrics which are used to compare the performance of two mobility models in MANET using TCP traffic are explained in section 4. Section 5 is all about Results and Discussions whereas section 6 concludes the paper.

AD HOC ON DEMAND DISTANCE VECTOR

The Ad Hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad Hoc mobile network [4], which is capable of both unicast and multicast routing [12]. It is an on demand algorithm that builds routes between nodes only when desired by source nodes. It maintains these routes as long as they are needed by source. It enables multi hop routing between the participating mobile nodes wishing to establish and maintain are ad Hoc networks [13, 7]. It is a reactive protocol based upon the distance vector algorithm. The algorithm uses different types of messages to discover and maintain links. Whenever a node wants to try and find out a route to another node it broadcasts a Route Request (RREQ) to all its neighbors. The RREQ propagates through the network until it reaches its destination or the node with a fresh enough route to the destination. A node receiving the RREQ may send a route reply (RREP) if it is either the destination or it has a route to that contained in the RREQ's source IP address and broadcast ID [16]. Once the RREQ is received by any node, it is then discarded not

forwarded [6]. As the RREP propagates back to the source then the setup nodes will forward pointers to the destination. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing information for that destination and begin using the better route. If the source node still desires the route after receiving the RERP, then it can reinitiate route discovery.

MOBILITY MODLES

This work presents two aforesaid different mobility models which combines the random waypoint model with the concept of group. The models are as follows:

Random Direction Model ("RandomDirection"): It forces MNs to travel to the edge of the simulation area before changing direction and speed [17]. It does not suffer from the density waves in the center of the simulation space that Random Waypoint model does. In this model, MNs choose a random direction to travel similar to the Random Walk Mobility Model. An MN then travels towards the border of the simulation area in that direction. Once the simulation boundary is reached, the MN pauses for a specialized time; it then chooses another angular direction (between 0 and 180 degrees) and continues the process. The following command is used to create the scenario file for this model:

BM -f scenario1 RandomDirection -n 100 -d 900 -i 3600 -o 10

BM NSFile –f scenario1

Probabilistic Random Walk Model ("ProbRandom-Walk"): The model utilizes a set of probabilities to determine the next position of an MN [17]. It utilizes a probability matrix that defines the probabilities of a node moving forwards, backwards, or remaining still in both the x and y direction. Once the direction of travel has been determined, the node will travel with a fixed speed (as per the Toilers' code) for a specialized allotment of time. This amount of time is set with the -t flag. The desired time should follow the flag after a space, for e.g., -t 15, for 15s. The following command is used to create the scenario file for this model:

BM -f scenario1 ProbRandomWalk -n 100 -d 900 -i 3600 -t 10

BM NSFile –f scenario1

*MN – Mobile Nodes

SIMULATION

There are many simulators such as NS2, OPNET modeler, Glomosim, OMNET++ etc for network simulation and we have used network simulator tool (NS-2) version 2.34 with Red Hat Linux environment developed at UC Berkeley [14, 15] for validating the compression of mobility models.

Table 1: Simulation Parameters

Parameters	Value
Routing Protocol	AODV
MAC Layer	802.11
Packet Size	512 bytes
Terrain Size	200m * 200m
Nodes	10-50
Mobility Models	Random Direction, Probabilistic Random Walk
Data Traffic	TCP
No. of Connections	80%
Simulation Time	900 sec.
Maximum Speed	1.5m/sec
Minimum Speed	0.5m/sec

NS-2 is suitable for designing new protocols comparing different protocols and traffic evolutions. It is a new object oriented simulation written in C++, with an OTCL interpreter as a front end. It accepts as input a scenario file that describes the exact motion of each node, together with the exact time at which each change in motion or packet origination has to occur. The detailed trace file created by each run is stored on disk, and analyzed using a variety of script, particularly one called file '*.tr' that counts the numbers of packets successfully delivered, the length of the paths taken by the packets, as well as additional information about the interval functioning of each scripts executed. This data is further analyzed with AWK script and Microsoft Excel has been used to draw the graph curves. All the results are based on a network configuration consisting of TCP traffic communication over an 802.11 wireless network with routing provided by the AODV protocol. The type of traffic (TCP) and the maximum number of sources are generated by the inbuilt tool available in NS2. Table 1 summarizes the parameters used for carrying out simulation.

PERFORMANCE METRICS

The performance metrics a r e important to measure the performance and activities that are running in NS-2 simulation. The work contained in this paper mainly focuses on fol lowing performance metrics [3] which are quantitatively measured:

Packet Delivery Ratio

It is the ratio of data packets delivered to the destination and which have been generated by the sources. It is calculated by dividing the number of packet received by destination through the number packet originated from source.

$$\text{Pkt Delivery Ratio} = \frac{\sum TC \Pr ecv}{\sum TCPdelv} \times 100$$

Average End-To-End Delay of Data Packets

There are possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. Average end-to-end delay is an average end-to-end delay of data packets, which is calculated by dividing the time difference of every TCP packet sent and received and the total time difference over the total number of TCP packets. This metric describes the packet delivery time. The lower the end-to-end delay the better the application performance.

$D = (Tr - Ts)$

When Tr is receive time and Ts is sent time

Routing Overhead

It is the total number of control/ routing (RTR) packets generated by routing protocol during the simulation. All packets sent or forwarded at network layer are considered as routing overhead.

Normalized Routing Load

This load is calculated according to the number of routing packets "transmitted" per data packet "delivered" at destination. Each hop-wise transmission of a routing is counted as one transmission. It is the sum of all control packets sent by all nodes in a network to discover and maintain route.
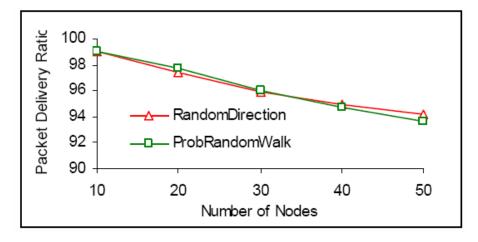
NRL = Routing Packet/Received Packets

RESULTS AND DISCUSSIONS

Details of analysis are focusing on Packet Delivery Ratio (PDR), Normalized Routing Load (NRL), and End-toend Delay and Routing Overhead with respect to varying number of mobility nodes.

Packet Delivery Ratio (PDR)

For this simulation we have chooses variety of number of nodes i.e. 10, 20, 30, 40, 50 with the MANET protocol AODV. Figure 1 show when the number of nodes increases, the PDR decreases respectively. But graph shows that when number of nodes is 20 then the probabilistic random direction model having more PDR. But in case of Probability random walk model, when we are increasing the nodes the PDR decreases. So we can say that Random Direction mobility model outperforms the probabilistic random walk in case of PDR

Figure 1: Packet Delivery Ratio

Average End-To-End Delay

The delay is affected by high rate of TCP packets. It can be easily seen from the figure 2 that the average delay of both models is same at all times except the case when the number of nodes are 20, and we have analyzed that Probabilistic Random Walk having less delay as compare with the Random Direction.
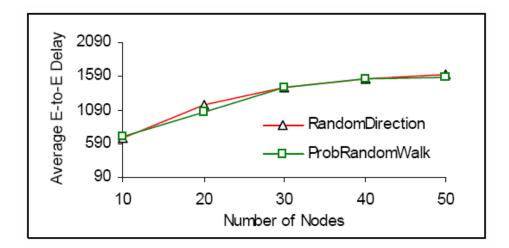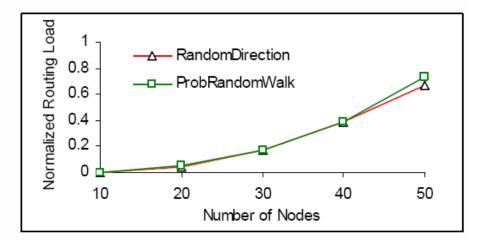

Figure 2: Average End-to-end Delay
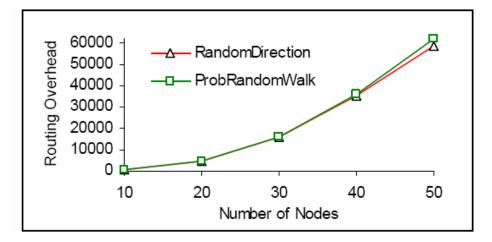
(A3) Normalized Routing Load (NRL)

The normalized routing load of both mobility models is almost same as shown in figure 3, except the case when the number of nodes is 50. At that time NRL is more in the Probabilistic Random Walk mobility model as compared to Random Direction.

Figure 3: Normalized Routing Load

Routing Overhead

All the routing packets whether broadcast or unicast per hop should be count at least once.

The total number of routing packets also counted per hop. As shown in figure 4 Routing Overhead is more in the Probabilistic random walk mobility model as it increases with the number of nodes. So we analyze the result that random direction gives the better performance under the routing protocol AODV and Routing Overhead is more in Probabilistic Random Walk.

CONCLUSIONS

This paper does the realistic comparison of two mobility models Random Direction and Probabilistic Random Walk over the routing protocol AODV (ad Hoc On-demand Distance vector). The significant observation is that the simulation results agree with expected results based on theoretical analysis. The observation shows that random Direction mobility model gives best performance under the protocol AODV having the traffic generator TCP. Both the models (Random Direction and Probabilistic Random Walk) give the same performance when the number of nodes is less than 20 with in the area of 200Sq.m.

The final conclusion is that in case of Random Direction the Packet Delivery Ratio, Normalized Routing Load and Routing Overhead is better whereas End-2-End delay is less in the Probabilistic Random Walk and vice-versa. The future work may investigate not only for AODV protocol but with DSR (Distance Source Routing), DSDV (Destination- Sequenced Distance Vector). We can also find performance of other mobility models with CBR and TCP traffic generator.

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