Performance Evaluation of Stable AODV Routing Protocol under Different Mobility Models

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BSTRACT

Mobile Ad hoc Networks are infrastructure less networks. Nodes themselves do routing and forwarding functions. Topology changes due to node movement. Frequent changes in topology leads to more route breaks. This in turn leads to reduction in Packet delivery Ratio (PDR). It is desired that routing protocols should select stable paths i.e. which are less likely to break. In this work, we have implemented one such protocol. Different mobility patterns lead to different performance of routing protocols. We have evaluated stable routing protocol under following mobility models: Random WayPoint, Manhattan Model, Reference Point Group Mobility and Gauss Markov Model. Performance measures of interest are Packet Delivery Ratio (PDR) and routing overhead. It is found that RPGM results in better PDR and lowest routing overhead compared to other models. Manhattan model results in lowest PDR and highest routing overhead.

Keywords

Mobile Ad-hoc Network, Topology, AODV

1. INTRODUCTION

A mobile ad-hoc network (MANET) is an infrastructure-less network where mobile nodes move randomly and therefore topology of the network changes dynamically. The routing protocols should be able to cope with dynamic environment. In MANET, routing protocol is divided into two categories: (i) proactive protocols, where each node continuously maintains routes to all possible destinations. For e.g., DSDV (Destination Sequence Distance Vector) routing algorithm. (ii) Reactive routing protocols, where each node forms path only when it is needed. For e.g., DSR (Dynamic Source Routing), AODV (Ad hoc On Demand Distance Vector) [1] Routing. (iii) Hybrid Routing Algorithms like ZRP (Zone Routing Protocol).

It is desirable that routes found should remain valid for longer duration. If routes break often, more packets are lost. Also router discovery exercise will be repeated frequently, leading to more routing overhead. Basic routing protocols don't find stable routes. They generally select routes based on hop count, but not expected lifetime of the route. In literature, many protocols are proposed which modify basic routing protocols to find stable routes. In [2], one such stable routing protocol is proposed. It modifies AODV protocol. In section VI, we have explained that protocol in detail.

Mobility is the main cause of topology change. Change in topology has an impact on performance of routing protocol. Different application scenarios have different mobility patterns. For example group mobility in military environment. In city or urban environment, nodes move according to road map i.e. have geographical restrictions. Different mobility patterns have different impact on routing performance. Many authors have studied routing performance of basic routing under different mobility models. In this work, we aim to evaluate one stable protocol, under different mobility models.

The paper is organized as follows. In section 2 gives idea of related work. Section 3 describes mobility models. Section 4 describes working of stable AODV routing protocol. Section 5 presents the simulation results and conclusion is presented in Section 6. References are listed at the end of paper.

1. 2. RELATED WORK

To improve the performance of routing protocols in mobile ad-hoc network, many modified routing algorithms have been proposed by many authors. Earlier, routing algorithms stability was defined based on how link is modified between two nodes-called link stability based routing. To minimize route breakage, it is important to find out a route which endures longer lifetime. In [3], authors have studied the effect of node mobility on the performance of DSR and DSDV routing protocols. They have used following four mobility models: random way-point, group mobility, freeway model and manhattan models. Mohit Ranjan Panda, Manas Ranjan Mishra [4] have designed stable throughput and flow admission control routing algorithm to provide stable transmission of flow operations in mobile ad hoc networks.

In [5], authors have proposed stability based routing. This algorithm finds stable route based on link expiration time. Using mobility information and updated value of link expiration time stable routes are determined. Mohamed Amine Abid and Abdelfettah Belghith have considered quality of service routing problem in [6]. They considered constraints to represent path length, number of hops and path stability. They proposed algorithm to solve quality of service problems. Xi Hu, Jinkuan Wang, Cuirong Wang have proposed their link stability prediction based routing algorithm in [7]. To determine stable link, their algorithm uses relative motion and distance between two neighbour nodes to determine mean link duration and based on that link stability is predicted.

In [8], authors have shown effect of mobility patterns on the performance of AODV routing protocol. They have used following three mobility models: random way point, random walk with reflections and random walk with wrapping. In [9], link stability based algorithm is presented that performs well in condition of high or low mobility and high or low node density by reducing path reformation. In [10], neighbour stability based routing algorithm is described. It uses cumulative stability among neighbour mobile nodes and these cumulative data is passed along the path. Whenpath is down, algorithm uses these cumulative data to find the alternate path. In [11], stable adaptive routing scheme is proposed. For route selection, this scheme uses traffic load current node, hop count information of routes and cooperative nodes packet delivery records.

3. MOBILITY MODELS

Work presented in [12] is a good survey of mobility models. Below we explain following four mobility models based on the explanation given in [12].

3.1 Random Waypoint Mobility Model (RWP)

In this mobility model, each node of the network selects a random destination and moves towards it with a chosen random velocity. Once a node reaches to the destination, the node stops for a duration defined by the pause time parameter. After pause time duration, node again selects a random destination and repeats the whole process again until the simulation ends.

3.2 Reference Point Group Mobility Model (RPGM)

In reference point group mobility model, nodes are divided in groups. Every group has a group leader that determines the movements of all nodes in the group. At each instant, speed and direction of group member is calculated based on speed and direction of leader node at that instant. This model represents movement of soldiers in a battalion, or tourists following a tourist guides.

3.3 Manhattan Mobility Model

In manhattan model, movement pattern of mobile nodes are defined by map which composed of a number of horizontal and vertical streets. Node allows moving along the grid of horizontal and vertical streets on the map. Because of temporal dependency, velocity of a mobile node at a particular time is dependent on the velocity of its previous time.

3.4 Gauss-Markov Mobility Model

In this model, initially each mobile node is assigned a current speed and direction at each fixed interval of time t. Node movement occurs by updating the speed and direction of each mobile node. Because of temporal dependency, value of speed and direction at the particular time is calculated on the basis of the value of previous speed and direction. This model eliminates abrupt stops; quick turns and is close to be realistic.

4. IMPLEMENTATION

We have implemented (in NS2) the algorithm proposed in [2] with few changes. Then it is evaluated under different mobility models. Following modifications are incorporated in AODV to make it stable.

1. In original AODV protocol, every node periodically broadcasts HELLO messages. Every node keeps counts of how many HELLO messages it has received from each of its neighbors.
2. RREQ packet is modified. It has one field known as ‘stability’. When a node forwards RREQ, it adds the count of HELLO packets (that it received from predecessor) into stability field.
3. When destination receives RREQ, it calculates average stability as follows:
   Avg stability = Cumulative stability value in RREQ / hop count
4. Route Reply (RREP) is also modified to contain ‘stability’ field. Destination copies average stability in ‘stability’ filed and RREP is sent to source.
5. Source begins data transmission as soon as it receives first RREP. When it receives RREP with better ‘stability’ value, it switches to new stable route.

5. SIMULATION RESULTS

For the simulations, we have used NS-2 (v-2.33) network simulator. At the physical and data link layer, we used the IEEE 802.11 standard. The channel used is Wireless Channel with Two Ray Ground radio propagation model. A detailed list of simulation parameters is given in Table 1.

5.1 Simulation Metrics

For both AODV and Stable AODV, following performance measures are investigated.

- **Packet Delivery Ratio**
  The packet delivery ratio (PDR) of a network is defined as the ratio of total number of data packets actually received and total number of data packets transmitted by senders.

- **Normalized Path Discovery**
  Normalized path discovery is defined as the number of RREQ packets generated per data packet.

- **End-to-End Delay**
  The End-to-End delay is defined as the difference between two time instances: one when packet is generated at the sender and the other, when packet is received by the receiving application.

5.2 Packet Delivery Ratio v/s. Mobility

AODV Routing Protocol

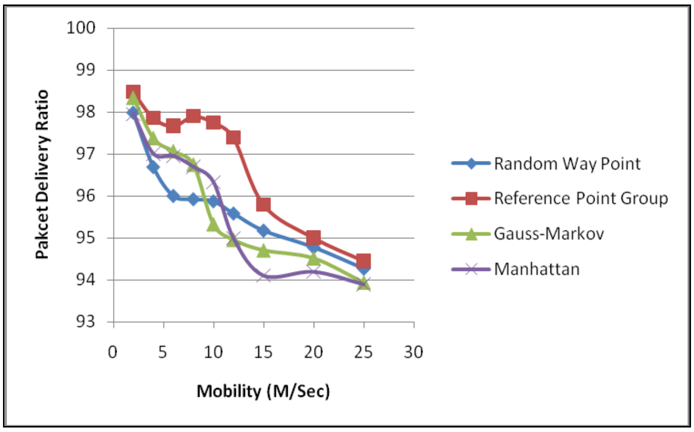

Figure 1: Packet Delivery Ratio v/s. Mobility (AODV)

Table 1 Simulation parameter values

Parameter	Value	Value	Value	Value
Mobility Model	Random Waypoint	Reference Point Group	Manhattan	Gauss-Markov
Simulation Time	500 sec	500 sec	500 sec	500 sec
Number of Nodes	50	50	50	50
Routing Protocol	AODV	AODV	AODV	AODV
Traffic Type	TCP	TCP	TCP	TCP
Environment Size	750 m x 750 m	750 m x 750 m	750 m x 750 m	750 m x 750 m
Transmission Range	250 m	250 m	250 m	250 m
Packet Size	512 bytes	512 bytes	512 bytes	512 bytes
Rate of Traffic	4 packets/s	4 packets/s	4 packets/s	4 packets/s
Pause time	0, 100, 200, 300, 400 sec	0, 100, 200, 300, 400 sec	0	0
Maximum Mobility	2 to 25 m/sec	2 to 25 m/sec	2 to 25 m/sec	2 to 25 m/sec
No. of blocks along x-axis	n/a	n/a	5	n/a
No. of blocks along y-axis	n/a	n/a	4	n/a
Turn probability	n/a	n/a	0.5	n/a
Update Distance	n/a	n/a	5	n/a
Angle Std Dev	n/a	n/a	0.39	n/a
Speed Std Dev	n/a	n/a	0.2	0.5
Group Size	n/a	5	n/a	n/a

Stable AODV Routing Protocol

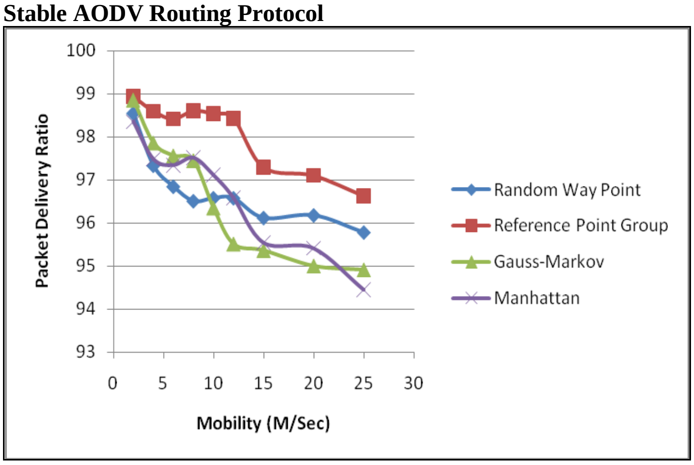

Figure 2: Packet Delivery Ratio v/s. Mobility (Stable AODV)

Above figures show the graphs of PDR v/s mobility patterns with different mobility models. When mobility of node increases, network becomes very less stable. This results in more link breakage. As a result source node has to discover the path frequently. Meanwhile, transmitted packets get lost, which reduces packet delivery ratio. To prevent this, we need to find modified path between source node and destination node. From above results we can say that in 50 nodes network, reference group mobility model is good compared to other mobility models. This happens because coordinated motion behaviour among group members and the swing around reference points tend to produce a smaller change all over the topology and hence better packet delivery ratio (PDR). Widely
RWP mobility model produces straight line motion pattern between pauses, which impacts on routing. Delivery ratio in Manhattan model decreases with increasing mobility. This happens due to restriction of a node movement and also when two nodes move apart, the probability of traffic signal breaking up increases. Due to elimination of sudden stops and sharp turns in Gauss-Markov model, there is no major reduction in delivery ratio. Figure 2 clearly shows that increasing mobility has less impact on packet delivery ratio in case of modified AODV routing protocol. There is no much delivery ratio difference in case of both routing protocol, but increasing mobility has sudden impact on delivery ratio of traditional AODV routing protocol (fig. 1), which is less in case of stable AODV routing protocol.

5.3 Normalized Path Discovery v/s. Mobility

AODV Routing Protocol

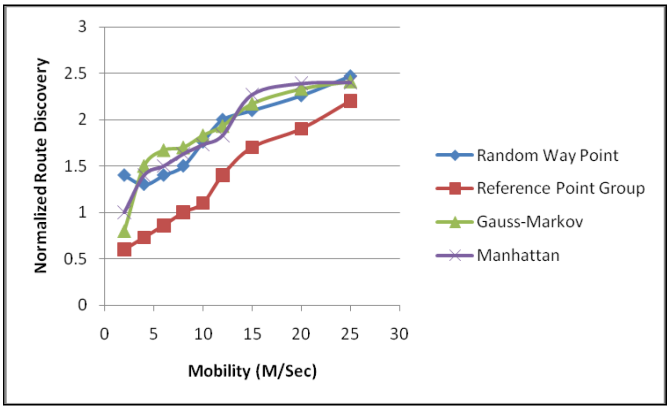

Figure 3: Normalized Path Discovery v/s. Mobility (AODV)

Stable AODV Routing Protocol

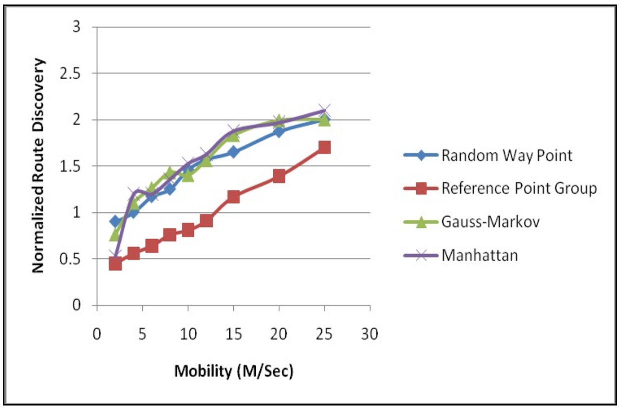

Figure 4: Normalized Path Discovery v/s. Mobility (Stable AODV)

Figure 3 and Figure 4 show normalized route discovery v/s mobility with different mobility models for AODV & stable AODV routing protocol respectively. It clearly shows that when mobility increases, normalized route discovery increases for all mobility models. Due to increase of mobility, the routes change more frequently and there is a need of finding new routes as well. So more RREQ messages generate after each link breaks. Normalized route discovery process is invoked less times in RPGM model than other mobility models as the mobility increases. stable AODV chooses modified path so less route discovery process needs to be invoked which reduces routing overhead.

6. CONCLUSION

From the simulation results, we found that stable AODV routing protocol works better than normal AODV routing protocol under all mobility models having different mobility. In RPGM mobility models, we achieved better performance than other mobility models. During simulation, Two Ray Ground propagation model is used. But the mobility models and propagation models both can significantly affect the performance of routing protocols. So to study the impact of propagation models on the performance of normal AODV & stable AODV protocol under different mobility models is our future work.

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