Variance in Performance of AODV Based on Increased Mobility Speed

Rajesh Deshmukh[1], Asha Ambhaikar[2]

[1]Assistant Professor
Department of Computer Science and Engineering
Shri Shankaracharya Institute of Professional Management and Technology
Raipur, Chhattisgarh, India
my.mail.raj@gmail.com

[2]Associate Professor and Head
Department of Computer Science and Engineering
Rungta College of Engineering and Technology
Bhilai, Chhattisgarh, India
asha.31a@rediffmail.com

Abstract: *This paper studies impact of changing mobility speed on the performance of a reactive routing protocol AODV with reference to varying mobility speed. Initially we observed the performance of AODV with increasing Network Load from 4 packets to 24 packets at the mobility speed of 20 m/s. Another scenario shows the performance of AODV with increased Network Load from 4 packets to 24 packets at mobility speed of 30 m/s. The performance of AODV is observed across Packet Delivery Ratio, Loss Packet Ratio and Routing overhead parameters. Our simulation results witness better performance of AODV as mobility speed is increased from 20 m/s to 30 m/s.*

Keywords: AODV, MANET, Mobility Speed, Distance Vector, Overhead, Random Waypoint

1. Introduction

An ad hoc network is a dynamic network. It allows wireless mobile nodes dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration. A number of routing protocols like Dynamic Source Routing (DSR), Ad Hoc On-Demand Distance Vector Routing (AODV) and Destination-Sequenced Distance-Vector (DSDV) [3] have been proposed. In this work an attempt has been made to compare the performance of a reactive routing protocol for mobile ad hoc networks AODV [1] on the basis of varying number of packets with reference to mobility speed. The performance differentials are analyzed using varying mobility and packet size. These simulations are carried out using the ns-2 [10] network simulator, which is used to run ad hoc simulations. The results presented in this paper illustrate the importance in carefully evaluating and implementing routing protocols when evaluating an ad hoc network protocol.

1.1 On Demand Routing Protocols

On-Demand Routing Protocols (Reactive): In on demand protocols, only when a node wants to send packets to its destination it initiates a route discovery process through the network. After a route is determined or all possible permutations have been examined, the process of route discovery is completed. The discovered route has to be maintained by a route maintenance process until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. Some reactive protocols are Cluster Based Routing Protocol (CBRP), Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR) [8], Temporally Ordered Routing Algorithm (TORA) [6], Associativity Based Routing (ABR), Signal Stability Routing (SSR) and Location Aided Routing (LAR).

1.2 1.1 Dynamic Source Routing Protocol (DSR)

DSR [3] is a reactive protocol based on the source route approach. The principal of this approach is that the whole route is chosen by the source, and is put within each packet sent. Each node keeps in its cache the source routes learned. When it needs to send a packet, it first checks its cache, if it finds a route to the corresponding destination then it uses it, otherwise it launches a route discovery by broadcasting a request (RREQ) [4] packet through the network. When receiving the RREQ, a node seeks a route in its cache for the RREQ's destination, if it finds such a route, it sends a route reply (RREP) [4] packet to the source, if no appropriate route exists then it adds its address to the request packet and continues the broadcasting. When a node detects a route failure, it sends a route error (RER) packet to the source that uses this link, and then this one applies again the route discovery process.

1.3 1.2 Ad hoc On-Demand Distance Vector (AODV)

Ad-hoc On-Demand Distance Vector (AODV) [2] is an on demand routing protocol which is used to find a route between the source and destination node as needed. It uses control messages such as Route Request (RREQ), and Route Reply (RREP) [7] for establishing a path from the source to the destination. When the source node wants to make a connection with the destination node, it broadcasts an RREQ [8] message. This RREQ message is propagated from the source, and received by neighbors (intermediate

nodes) of the source node. The intermediate nodes broadcast the RREQ [7] message to their neighbors. This process goes on until the packet is received by destination node or an intermediate node that has a fresh enough route entry for the destination in its routing table. Fresh enough means that the intermediate node has a valid route to the destination established earlier than a time period set as a threshold. Use of a reply from an intermediate node rather than the destination reduces the route establishment time and also the control traffic in the network. This, however, leads to vulnerabilities. Sequence numbers are also used in the RREP [9] messages and they serve as time stamps and allow nodes to compare how fresh their information on the other node is. When a node sends any type of routing control message, RREQ, RREP, RERR etc., it increases its own sequence number. Higher sequence number is assumed to be more accurate information and whichever node sends the highest sequence number, its information is considered most up to date and route is established over this node by the other nodes.

1.4 1.3 Destination Sequenced Distance-Vector Routing (DSDV)

Destination Sequenced Distance Vector protocol belongs to the class of pro-active routing protocols. This protocol is based on the classical Bellman-Ford routing algorithm to apply to mobile ad hoc networks. DSDV [5] also has the feature of the distance vector protocol in that each node holds a routing table including the next-hop information for each possible destination. Each entry has a sequence number. If a new entry is obtained, the protocol prefers to select the entry having the largest sequence number. If their sequence number is the same, the protocol selects the metric with the lowest value. Routing information is transmitted by broadcast. Updates have to be transmitted periodically or immediately when any significant topology change is available. Sequence numbers are assigned by destination, means the destination gives a sort of default even sequence number, and the emitter has to send out the next update with this number. Packets are transmitted between the stations of the network by using routing tables which are stored at each station of the network. Each routing table, at each of the stations, lists all available destinations, and the number of hops to each.

Each route table entry is tagged with a sequence number which is originated by the destination station. To maintain the consistency of routing tables in a dynamically topology, each station periodically transmits updates, and transmits updates immediately when significant new information is available. Routing information is advertised by broadcasting or multicasting the packets which are transmitted periodically and incrementally as topological changes are detected - for instance, when stations move within the network. Data is also kept about the length of time between arrival of the first and the arrival of best route for each destination. Based on this data, a decision may be made to delay advertising routes which are about to change soon, thus damping fluctuations of the route tables.

2. Mobility Model

2.1 Random Walk Mobility Model

It was first described mathematically by Einstein in 1926 [6]. Since many entities in nature move in extremely unpredictable ways, the Random Walk Mobility Model was developed to mimic this erratic movement. In this mobility model, an MN moves from its current location to a new location by randomly choosing a direction and speed in which to travel. The new speed and direction are both chosen from pre-defined ranges, [speedmin; speedmax] and [0; 2] respectively. Each movement in the Random Walk Mobility Model occurs in either a constant time interval t or a constant distance traveled d, at the end of which a new direction and speed are calculated. If an MN which moves according to this model reaches a simulation boundary, it "bounces" off the simulation border with an angle determined by the incoming direction. The MN then continues along this new path. Many derivatives of the Random Walk Mobility Model have been developed including the 1-D, 2-D, 3-D, and d-D walks.
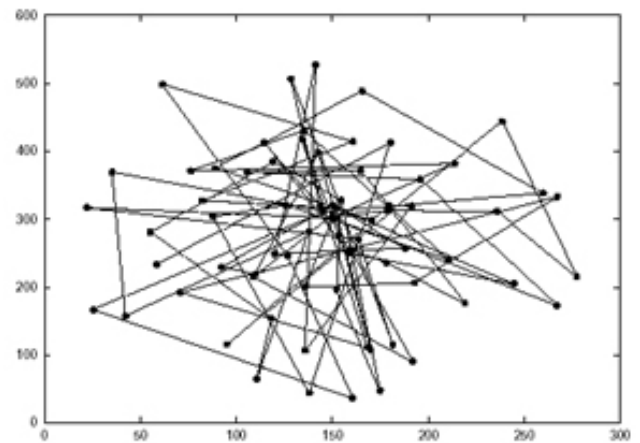

Figure 2. Travelling pattern of an MN using 2 D Random Walk Mobility Model

2.2 Random Waypoint Mobility Model

The Random waypoint model [6] is a random-based mobility model used in mobility management schemes for mobile communication systems. Random Waypoint (RW) model assumes that each host is initially placed at a random position within the simulation area. The mobility model is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time. Mobility models are used for simulation purposes when new network protocols are evaluated. In random based mobility simulation models, the mobile nodes move randomly and freely without restrictions. To be more specific, the destination, speed and direction are all chosen randomly and independently of other nodes. This kind of model has been used in many simulation studies. Two variants, the Random walk model and the Random direction model are variants of the Random waypoint model.
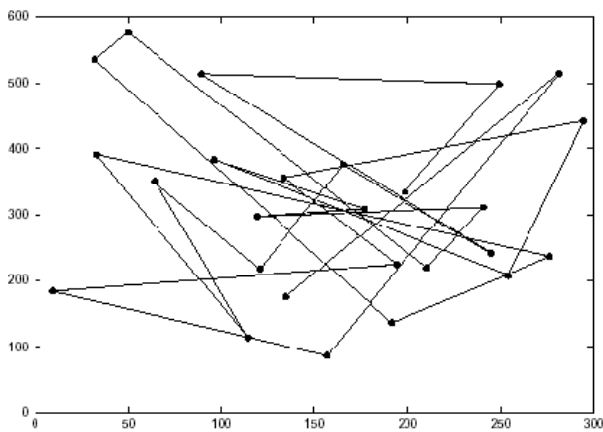
Figure 3. Travelling pattern of an MN using Random Waypoint Mobility Model

In this model, a mobile node moves from its current location to a randomly chosen new location within the simulation area, using a random speed uniformly distributed between [vmin, vmax] [6]. vmin refers to the minimum speed of the simulation, vmax to the maximum speed. The Random Waypoint Mobility Model includes pause times when a new direction and speed is selected. As soon as a mobile node arrives at the new destination, it pauses for a selected time period (pause time) before starting traveling again. A Mobile node begins by staying in one location for a certain period of time (i.e. pause). Once this time expires, the mobile node chooses a random destination in the simulation area and a speed that is uniformly distributed between [vmin, vmax]. The mobile node then travels toward the newly chosen destination at the selected speed. Upon arrival, the mobile node pauses for a specified period of time starting the process again. The random waypoint model is the most commonly used mobility model in the simulation of ad hoc networks. It is known that the spatial distribution of network nodes moving according to this model is non-uniform. However, a closed-form expression of this distribution and an in depth investigation is still missing. This fact impairs the accuracy of the current simulation methodology of ad hoc networks and makes it impossible to relate simulation based performance results to corresponding analytical results. To overcome these problems, it is presented a detailed analytical study of the spatial node distribution generated by random waypoint mobility. It is considered that a generalization of the model in which the pause time of the mobile nodes is chosen arbitrarily in each waypoint and a fraction of nodes may remain static for the entire simulation time.

3. The Traffic and Scenario generator

Continuous bit rate (CBR) [11] traffic sources are used. The source-destination pairs are spread randomly over the network. The simulation uses Random Waypoint mobility model in a 1020 m x 1020 m field with varying network load of 4 packets to 24 packets whereas mobility speed is kept at 20 m/s maximum. In the next simulation network load is varied from 4 packets to 24 packets, but this time mobility speed is kept 30 m/s maximum. Here, each packet starts its journey from a random location to a random

destination with a randomly chosen speed. Once the destination is reached, another random destination is targeted after a pause. The pause time, which affects the relative speeds of the mobile hosts, is kept at 20s. Simulations are run for 200 simulated seconds.

4. Performance Metrics

Following important metrics are evaluated:

- Packet Delivery ratio (PDR) - Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the CBR source.
- Loss Packet Ratio (LPR) - Loss Packet Ratio is calculated by dividing the number of packets that never reached the destination through the number of packets originated by the CBR source.
- Routing Overhead –Routing overhead, which measures the ratio of total routing packets sent and the total number of packets sent.

5. Simulation Setup

In this simulation we wanted to investigate how mobility speed affects on the behavior AODV with increasing network load.

Table 1: Evaluation with Mobility Speed 20 m/s

Parameter	Value
Protocols	AODV
Simulation Time	200 s
Number of Nodes	100
Network Load	4, 8, 12, 16, 20, 24 Packets
Pause Time	20 s
Environment Size	1020 m x 1020 m
Traffic Type	Constant Bit Rate
Maximum Speed	20 m / s
Mobility Model	Random Waypoint
Network Simulator	NS 2.33

Table 2: Evaluation with Mobility Speed 30 m/s

Parameter	Value
Protocols	AODV
Simulation Time	200 s
Number of Nodes	100
Network Load	4, 8, 12, 16, 20, 24 Packets
Pause Time	20 s
Environment Size	1020 m x 1020 m
Traffic Type	Constant Bit Rate
Maximum Speed	30 m / s
Mobility Model	Random Waypoint
Network Simulator	NS 2.33

6. Results and Discussions

During the simulation we have increased the network load with maximum mobility maximum speed of 20 m/s and recorded the performance of AODV. We did this simulation for 200 simulated seconds with maximum 8 cbr connections. Readings were taken for different network loads (4, 8, 12, 16, 20 and 24packets). Again same simulation is performed, but this time with maximum speed of 30 m/s. From the results it is evident that AODV starts to perform better with mobility speed of 30 m/s as compared to 20 m/s for same scenario. At higher network

load and maximum speed of 30 m/s, the Packet Delivery ratio increases, Loss Packet Ratio decreases and Routing Overhead decreases.

7. Performance Evaluation

Observation for Mobility Speed of 20 m/s: Simulation result in figure 3 shows that performance of AODV in terms of Packet Delivery Ratio degrades as network load is increased. When network load reach 12 packets, PDR is dropped considerably. Even though PDR starts to improve gradually from that point and reach a much better performance around 16 packets of load. Once again performance starts degrading, and continues to degrade more.

Observation for Mobility Speed of 30 m/s: Simulation result in figure 3 shows that performance of AODV degrades as network load is increased. A point to notice is that when network load reach 12 packets, performance of AODV is much improved as compared to performance with Mobility Speed of 20 m/s. Packet Delivery Ratio stays consistent until network load reaches 16 packets, even though it is performing poor than the earlier simulation scenario. PDR keeps on decreasing until a point where network load reach 20 packets. From this point PDR starts to improve gradually and achieves a much better performance as compared to performance with mobility speed of 20 m/s.
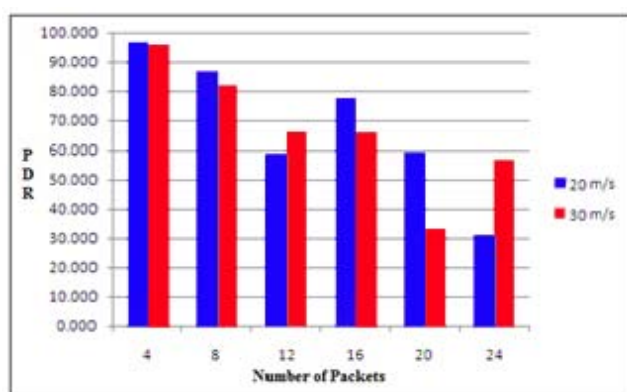

Figure 3. Number of Packets Vs Packet Delivery Ratio

8. Conclusion and Future Work

Results illustrate that the performance of AODV varies widely across different network loads, and study results from two different scenarios shows that increasing the mobility speed does help to improve the performance of AODV when it comes to higher network loads. Hence we have to consider the network load of an application while selecting the mobility speed.

Yet there is more need to find out what factors can bring more improvements in performance of AODV not only while the network load is further increased but also on the load where AODV has not performed well in simulations presented here. Further simulation needs to be carried out for the performance evaluation with not only increased mobility speed but also varying other related parameters like Pause Time, Mobility models etc.

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Author Profiles

Prof. Rajesh Deshmukh: After receiving Bachelor of Technology in I.T., he received Master of Technology in C.S.E. from Chhattisgarh Swami Vivekanand Technical University, Bhilai. Currently he is working as Assistant Professor in Shri Shankaracharya Institute of Professional Management & Technology (Department of Computer Science Engineering), Raipur, India. He has published more than 15 research papers in various National / International Journals and Conferences. His area of research area includes Mobile Ad hoc Network Routing

Protocols, Wireless Sensor Networks, Distributed System, Cloud Computing and Operating System.

Prof. Asha Ambhaikar received B.E from Nagpur University, Nagpur, India, in Electronics Engineering and later did her Master of Technology. Presently she is pursuing Doctor of Philosophy in Computer Science and Engineering from CSVTU, Bhilai. Currently she is working as Associate Professor and Head of the Department (C.S.E.) in Rungta College of Engineering & Technology (Department of Information Technology), Bhilai, India. She has published more than 30 research papers in reputed National and International Journals & Conferences. She has guided more than 30 M. Tech Research Scholars. She is also holding position of Chairman Board of Studies of Information Technology in CSVTU, Bhilai. Her area of interest includes, Computer Networking, Data Warehousing and Data Mining, Signal processing, Image processing, and Information systems and Security.