Positive Impact of Mobility Speed on Performance of AODV at Increased Network Load

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Abstract — This paper studies impact of changing mobility speed on the performance of a reactive routing protocol AODV with reference to varying network load. For experimental purposes, initially we observed the performance of AODV with increasing Network Load from 4 packets to 24 packets at the maximum mobility speed of 10 m/s. In another scenario we observed the performance of AODV with increasing Network Load from 4 packets to 24 packets at maximum mobility speed of 20 m/s. The performance of AODV is observed across Packet Delivery Ratio, Loss Packet Ratio and Routing overhead parameters. Our simulation results show that AODV is performing better with higher mobility speed at higher network load.

Index Terms— AODV, MANET, Mobility Speed, Routing, Overhead, Random Waypoint

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1. Introduction

An adhoc 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) 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 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 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. Ad hoc Routing Protocols

Routing in Mobile Ad-hoc Network is a subject of extensive research, Because of the fact that it may be necessary to pass several hops (multi-hop) before a packet reaches the destination, a routing protocol is needed. Routing protocol has two functions, first is selection of routes for various source-destination pairs and second, Delivery of messages to their correct destination.

The second function is conceptually straightforward using a variety of protocols and data structures (routing tables). Ad-hoc routing protocols can be classified based on different criteria. Depending upon the routing mechanism employed by a given protocol, they fall in two classes.

Table Driven Routing Protocols (Proactive): Each node in table-driven routing protocols, continuously maintains up-to-date routes to every other node in the network. Periodic routing information is transmitted throughout the network in order to maintain consistency of the routing table. Transmission occurs without delay if the route already exists, otherwise, node needs to receive routing information corresponding to its destination while traffic packets are waiting in the queue. Certain proactive routing protocols are Destination- Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Global State Routing (GSR) and Cluster head Gateway Switch Routing (CGSR) [6].

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 [6]. Some reactive protocols are Cluster Based Routing Protocol (CBRP), Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Associativity-Based Routing (ABR), Signal Stability Routing (SSR) and Location Aided

Routing (LAR) [6].

1.1 Dynamic Source Routing Protocol (DSR)

The Dynamic Source Routing (DSR) protocol is an on demand routing protocol based on source routing. DSR protocol is composed by two "on-demand" mechanisms, which are requested only when two nodes want to communicate with each other. This Protocol is composed of two essential parts of route discovery and route maintenance. Every node maintains a cache to store recently discovered paths [5]. Route Discovery and Route Maintenance are built to behave according to changes in the routes in use, adjusting them-selves when needed. Along with those mechanisms, DSR allows multiple routes to any destination, thus can lead easily to load balancing or increase robustness .In the source routing technique, a sender determines the exact sequence of nodes through which to propagate a packet. The list of intermediate nodes for routing is explicitly contained in the packet's header. In DSR [5], every mobile node in the network needs to maintain a route cache where it caches source routes that it has learned. When a host wants to send a packet to some other host, it first checks its route cache for a source route to the destination. In the case a route is found, the sender uses this route to propagate the packet. Otherwise the source node initiates the route discovery process.

1.2 Ad hoc On-Demand Distance Vector (AODV)

Ad hoc on demand distance vector (AODV) routing protocol creates routes on-demand. In AODV, a route is created only when requested by a network connection and information regarding this route is stored only in the routing tables of those nodes that are present in the path of the route [1]. AODV 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 a route to another node it broadcasts a Route Request (RREQ) to all its neighbors [2]. In this protocol, each terminal does not need to keep a view of the whole network or a route to every other terminal. Nor does it need to periodically exchange route information with the neighbor terminals. Furthermore, only when a mobile terminal has packets to send to a destination does it need to discover and maintain a route to that destination terminal. In AODV, each terminal contains a route table for a destination [5]. A route table stores the following information: destination address and its sequence number, active neighbors for the route, hop count to the destination, and expiration time for the table. The expiration time is updated each time the route is used. If this route has not been used for a specified period of time, it is discarded [7].

1.3 Destination Sequenced Distance-Vector Routing (DSDV)

The Destination Sequenced Distance Vector Protocol (DSDV) is a proactive, distance vector protocol which uses the Bellmann - Ford algorithm [4]. DSDV is a hop by hop distance vector routing protocol, wherein each node maintains a routing table listing the "next hop" and "number of hops" for each reachable destination. This protocol requires each mobile station to advertise, to each of its current neighbors, its own routing table (for instance, by broadcasting its entries). The entries in this list may change fairly dynamically over time, so the advertisement must be made often enough to ensure that every mobile computer can almost always locate every other mobile computer of the collection. In addition, each mobile computer agrees to relay data packets to other computers upon request. This agreement places a premium on the ability to determine the shortest number of hops for a route to a destination we would like to avoid unnecessarily disturbing mobile hosts if they are in sleep mode. In this way a mobile computer may exchange data with any other mobile computer in the group even if the target of the data is not within range for direct communication. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle [4].

2. Mobility Model

2.1 Random Waypoint Mobility Model

The Random waypoint model 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 [3]. The mobility model is designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time [3]. 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.

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] [3]. vmin refers to the minimum speed of the simulation, vmax to the maximum speed [3]. The Random Waypoint Mobility

ISSN 2229-5518

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].

3. The Traffic and Scenario Generator

Continuous bit rate (CBR) 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 10 m/s maximum. In the next simulation network load is varied from 4 packets to 24 packets, but this time mobility speed is kept 20 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 100 simulated seconds.

4. Performance Metrics

Following important metrics are evaluated-

1. 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.
2. 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.
3. 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 10 m/s

Parameter	Value
Protocols	AODV
Simulation Time	100 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	10 m / s
Mobility Model	Random Waypoint
Network Simulator	NS 2.33

TABLE 2

Evaluation with Mobility Speed 20 m/s

Parameter	Value
Protocols	AODV
Simulation Time	100 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

6. Results and Discussions

During the simulation we have increased the network load with maximum mobility maximum speed of 10 m/s and recorded the performance of AODV. We did this simulation for 100 simulated seconds with maximum 8 cbr connections. Readings were taken for different network loads (4, 8, 12, 16, 20 and 24 packets). Again same simulation is performed, but this time with maximum speed of 20 m/s. From the results it is evident that AODV starts to perform better with mobility speed of 20 m/s as compared to 10 m/s for same scenario. At higher network load and maximum speed of 20 m/s, the Packet Delivery ratio increases, Loss Packet Ratio decreases and Routing Overhead decreases.

7. Performance Evaluation

Observation for Mobility Speed of 10 m/s: Simulation result in figure 1 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. Same with the Routing overhead, Figure 3 shows that Routing Overhead keeps on increasing until network load of 12 packets and from that point overhead starts to decrease till the network load reaches 16 packets. After this point routing overhead keeps on increasing and never recovers again.
Observation for Mobility Speed of 20 m/s: Simulation result in figure 1 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 10 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 10 m/s. About Routing overhead, Figure 3 shows that Routing Overhead remains either equal or better than 10 m/s scenario until network load reach 12 packets. Routing overhead stays consistent till 16 packets and then again gets worse till the 16 packets mark. From their AODV starts to improve the performance and achieves better readings compared to reading with 10 m/s as network load crosses the 20 packets mark.

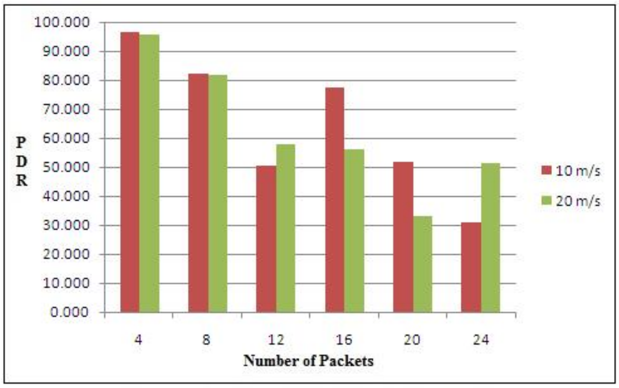

Fig 1. Number of Packets Vs Packet Delivery Ratio

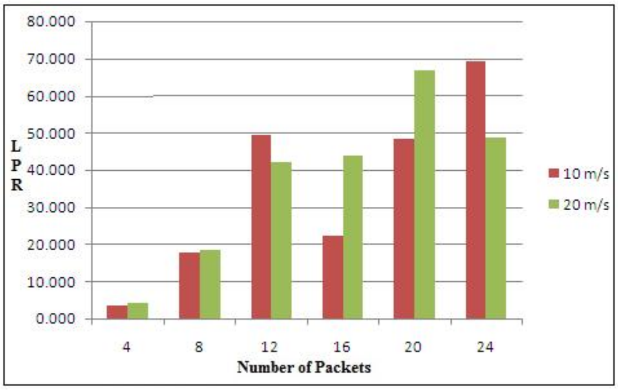

Fig 2. Number of Packets Vs Loss Packet Ratio

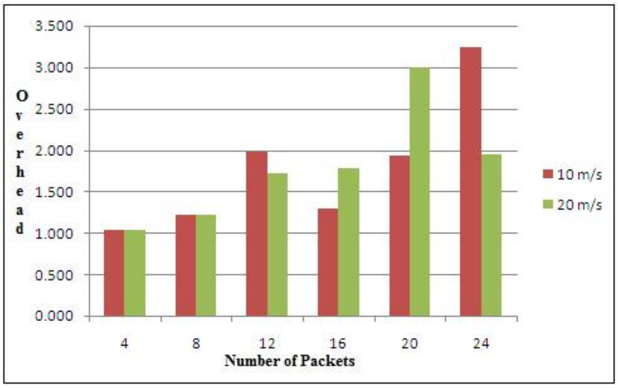

Fig 3. Number of Packets Vs Routing Overhead

8. Conclusion and Future Work

Empirical 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.
The future scope is 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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