ISSN 2319 5975
Volume 2, No.6, October - November 2013
International Journal of Networks and Systems
Available Online at http://warse.org/pdfs/2013/ijns01262013.pdf

Simulation and Comparison of AOMDV, AODV and DSR in Manets

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ABSTRACT

A Mobile Ad-hoc Network (MANET) is a collection of wireless nodes that dynamically form a network to exchange information without using any pre-existing fixed network infrastructure. It is a temporary network. Every node acts as both a host and a router resulting in multi hop routing. The nodes frequently change their position. For comparatively small networks flat routing protocols are sufficient. However, in larger networks either hierarchic or geographic routing protocols are needed, and the protocols have to be chosen according to network characteristics, like density, size and additionally the mobility of the nodes. In this paper three routing protocols AODV (Ad-hoc on-Demand Distance Vector), AOMDV (Ad-hoc on Demand Multipath Distance Vector) and DSR (Dynamic source Routing Protocol) are compared. The performance of three routing protocols is analyzed in terms of their Packet Delivery Fraction, Average End-to-End Delay, Routing overhead, Route Discovery Frequency, and Throughput. NS2 simulator is used for comparison and critical analysis of AOMDV is done to find its merits and demerits.

Keywords: AODV, AOMDV, DSR, MANETs.

1. INTRODUCTION

Ad-hoc network has several characteristics [1] which are different from the characteristics of wired network and also static wireless network. Some of the important characteristics of ad-hoc network are as follows:

- Bandwidth constrained
- Energy constrained
- Variable bandwidth
- Highly unfavorable environmental conditions
- Dynamic nature of the nodes
- Low communication range

The nodes in an ad-hoc network are battery operated. This makes the energy a precious resource and nodes always try to reduce the consumption of the energy. They reduce their communication range for the same reason. Bandwidth available in the wireless network is limited when compared to wired network. Also the bandwidth available is not constant and it varies due to various reasons. The nodes move with different pause times and speeds making the ad-hoc network highly dynamic. Since the network is called for when the existing network doesn't function, they have to operate in highly unfavorable environmental conditions. Due to these characteristics of the ad-hoc network, routing in ad-hoc network [2] is non-trivial and is a challenging issue to be addressed.

MANET [3] [4] is one of the essential components of the next generation networks. Thus, MANET is a key part in the next generation network structure in which the wireless Internet will be involved. A MANET is a collection of mobile nodes that form a dynamic topology and highly resource constrained network. Unlike Wireless LAN (WLAN) which is a single hop and an infrastructure based network, MANET is considered a multi hop and infrastructure less network.

The main function of routing in a network is to detect and maintain the optimal routes to send data packets between source and destination via intermediate nodes. The routing protocol may determine single path from source to destination or multiples paths. Single path routing protocols are efficient when the probability of breaks in the paths is minimum. Due to the dynamic nature of the ad-hoc network multipath routing protocols are being studied. Generally, multipath routing is considered as an advantage due to easy recovery from a route failure, and thus multipath protocols are considered more reliable and robust than single path protocols. In a broad sense, multipath routing enables route reliability and also facilitates load balancing.

2. ROUTING PROTOCOLS

There are different ways of classifying the ad-hoc network routing protocols [5]. They can be broadly classified into topology based, location based, and bio-inspired routing protocols. This paper considers only topology based routing protocols. This can be further classified into single path routing protocols and multipath routing protocols. The route determination and maintenance process can be proactive or reactive. Proactive routing protocols pre-determine the routes and use them immediately when needed. Reactive routing protocols [5] determine the routes only when needed and then use them. Because proactive routing protocols involve lot of control overhead they are not recommended for ad-hoc networks. The reactive routing protocols that are studied

extensively are AODV [6], and DSR [7] [8]. Both are single path routing protocols. In this paper apart from these routing protocols, a multipath routing protocol AOMDV [9] is also considered and compared with the AODV and DSR.

AODV is based on the distance vector i.e., each node maintains a routing table called distance vector which contains information about the destination and the next hop to be taken to reach the destination. Since it is a reactive routing protocol, routes are determined on-demand only as and when required. To determine the route source node which requires the route to the destination generates a control packet called route request packet and broadcasts it. All the neighbors of the source node receive it. They check whether the route to the destination is available or not in their routing tables. If the route is available the nodes may reply to the source using the route reply control packet. The route reply packets are unicasted to the source not broadcasted. If the route is not available the route request packet is forwarded. This process may continue until the destination is reached. The destination replies with the route information to the source. The intermediate nodes which receive the route reply adjust the routing tables to enable inclusion of path to the destination. Link breaks information is communicated using route error messages. The node upstream of the break propagates a route error message to the source expressing its inability to reach the destination.

AODV uses sequence numbers to avoid loops. In case of two routes with the same sequence number, the route with the higher sequence number is used. Also if two routes have the same sequence number then the route with low hop count value is chosen. To prevent flooding of route requests, route requests carry identification number and also unique sequence number. Intermediate nodes forward the route request only if it has not forwarded the route request with the same identification number and sequence number.

DSR is also a reactive routing protocol. But it is a source routing protocol i.e., source node determines the complete path to the destination and then places the entire path to the destination on the data packet that is forwarded to the destination. At each intermediate node, the node searchers for its identity in the path and transmits it to the next node in the path.

One important differentiating characteristic of DSR is it uses the cache memory efficiently. The route determination process is similar to the procedure adopted by AODV. When the source node wants to send a data packet to the destination, it checks for the route to the destination in the cache memory. If the route is present it makes use of the route. If the route is not present then it initiates the route discovery process by sending the route request control packet. The route request packet is broadcasted. Each intermediate node checks for the route to the destination in the route cache. If the route is present it replies to the source. If the route in not present it appends its own identity to the route request packet and forwards.

DSR uses promiscuous mode of operation. To determine the break in the links, each node operates in the promiscuous mode i.e., it listens passively to the next node to which it has transmitted. If the next node transmits it further then the sender assumes that the next node is functioning properly and also there is no break in the link between sender and next node. If the next node doesn't transmit, it indicates that the next node is either malfunctioning or there is a break in the link. The promiscuous mode of operation can be used to detect misbehaving nodes. Also in DSR a node can explicitly ask for the acknowledgement i.e., when the node receives data packet it has to send ACK to the sender immediately. Route error packets are also used to inform about the break in the links.

AOMDV is a routing protocol derived from AODV. It has many characteristics similar to that of AODV, but it is a multi path routing protocol i.e., it determines multiple paths (not single path) between source and destination and uses these paths for transmitting data packets. The route determination is similar to that of AODV. When the route is required to a particular destination, a route request control packet is generated and is broadcasted.

When the source node gets back the route relies from multiple intermediate nodes and destination, instead of choosing the best among them, it stores the information about all the possible routes. Similar strategy is adopted by intermediate nodes. The presence of multiple routes definitely is an advantage. It reduces the route discovery frequency and prevents overloading of the best path. Multiple routes to the same destination are disjoint. There are two kinds of disjoint paths, node disjoint and link disjoint. Node disjoint path means the routes doesn't have common node whereas link disjoint means nodes doesn't have common links.

3. SIMULATION

The simulations are performed using Network Simulator [10] Ns-2.34. TCP and UDP are the two transport protocols considered. Constant bit rate (CBR) is used as traffic generator. The mobility of the nodes is created using random way point model in a rectangular field of 1000 x 1000 sqm. A node chooses its initial position randomly, chooses the next position also randomly and moves towards it with chosen speed and pause time. In this simulation different pause times and speeds are used. Pause time is the amount of time a node remains stationary at a fixed position before moving from that position. A pause time of zero means continuous movement and a pause time equivalent to simulation time means node is static. Traffic models supported by NS2 are used to generate the traffic. Simulation time is restricted to 100sec. Post processing of the trace files generated by NS2 is done using awk scripts.

Performance Metrics

The following are the performance metrics used:

1. End-To-End Delay: This is the average time delay for data packet to go from source to destination.

2. Packet Delivery Ratio: It's the ratio of the number of data packets received by the destination node to the number of data packets sent by the source mobile node.

3. Routing Overhead: The total number of routing packets transmitted during the simulation.

4. Route Discovery Frequency: The aggregate number of route requests generated by all sources per second is called the route discovery frequency.

5. Packet Loss: The number of data packets not received by the destination node but sent by the source node.

6. Throughput: It is number of bits transmitted per second.

Simulation environment used is shown in Table 1:

Table 1: Simulation Parameters

Parameter Type	Value
Simulator	NS 2.34
Number of nodes	10
Simulation time	100 sec
Node speed	10 m/sec
Data rate	1 Mbps, 10 Mbps
Simulation area	1000m * 1000m
Data type	CBR
Pause time	0-100 sec

Simulation Results

Data rate: 1Mbps

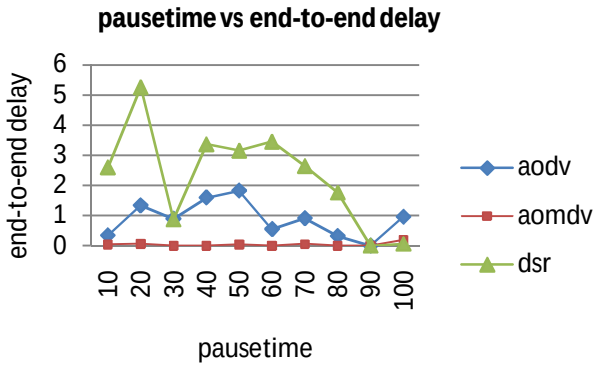

Figure 1 shows end-to-end delay with varying pause times

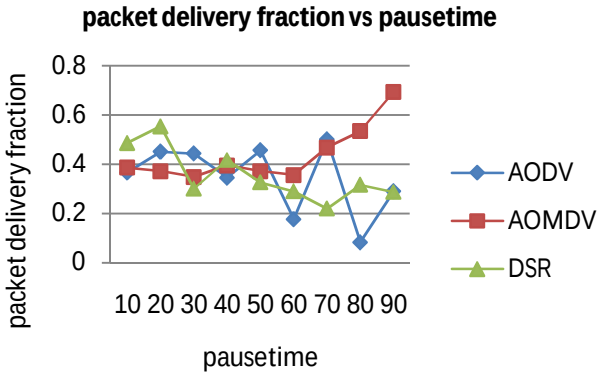

Figure 2 shows packet delivery ratio with varying pause times

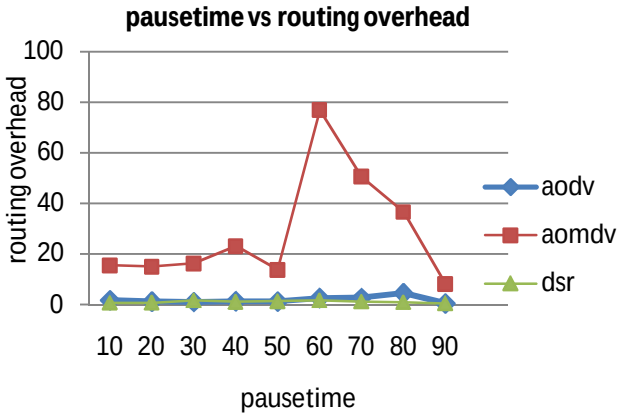

Figure 3 shows routing overhead with varying pause times

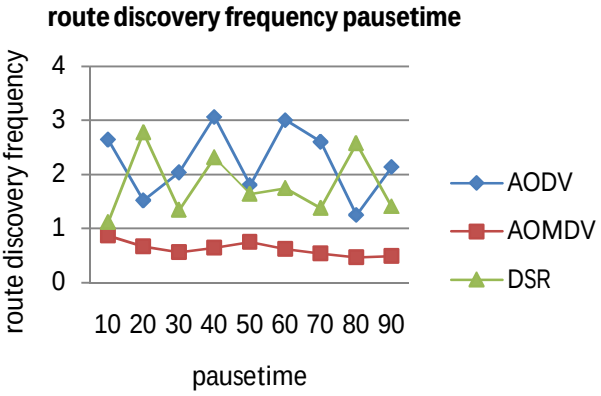

Figure 4 shows route discovery frequency with varying pause times

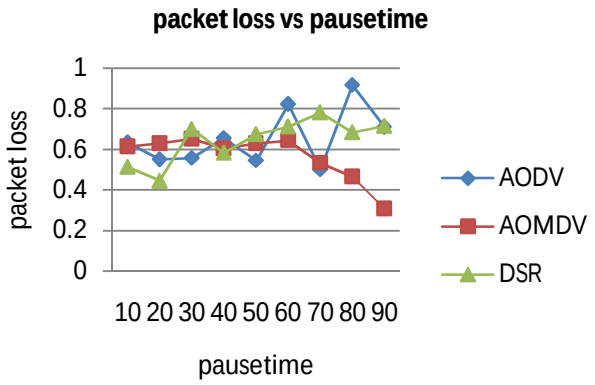

Figure 5 shows packet loss with varying pause times

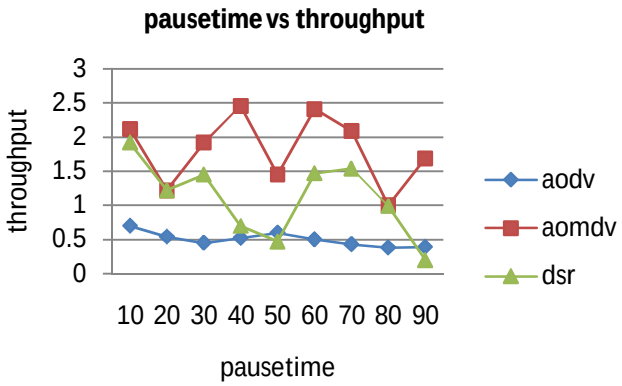

Figure 6 shows throughput with varying pause times

Data rate: 10Mbps

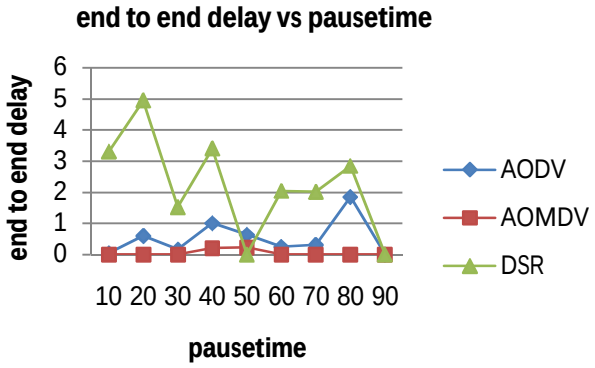

Figure 7 shows end-to-end delay with varying pause times

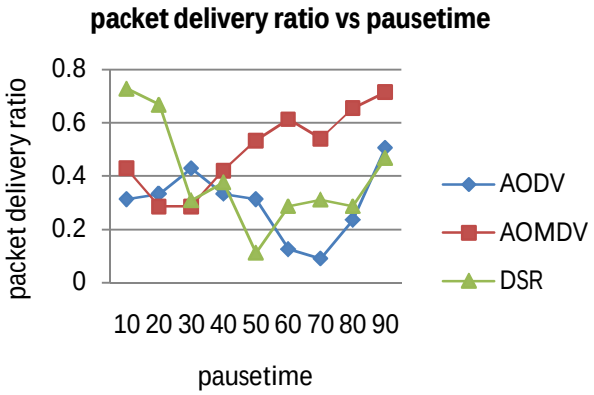

Figure 8 shows packet delivery ratio with varying pause times

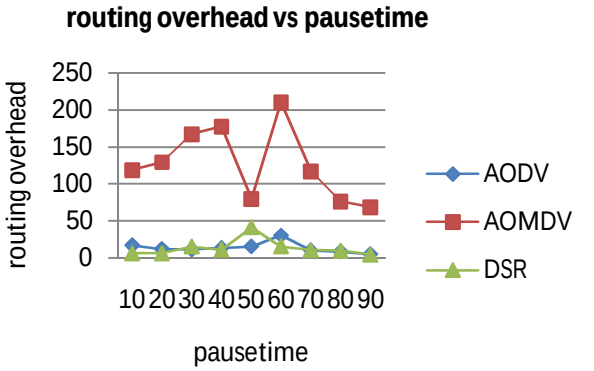

Figure 9 shows routing overhead with varying pause times

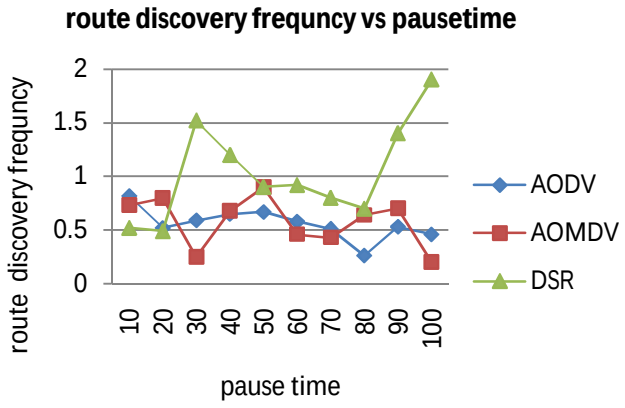

Figure 10 shows route discovery frequency with varying pause times

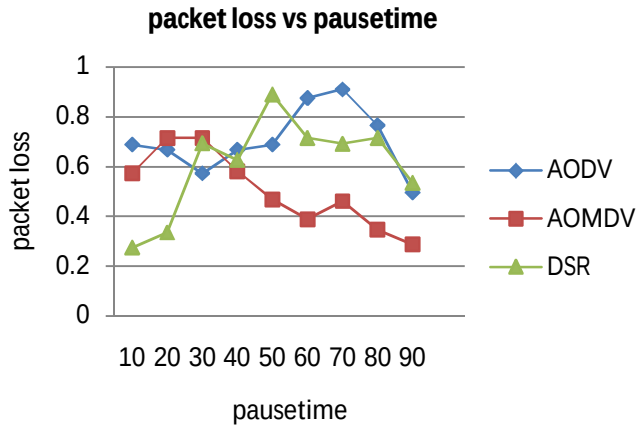

Figure 11 shows packet loss with varying pause times

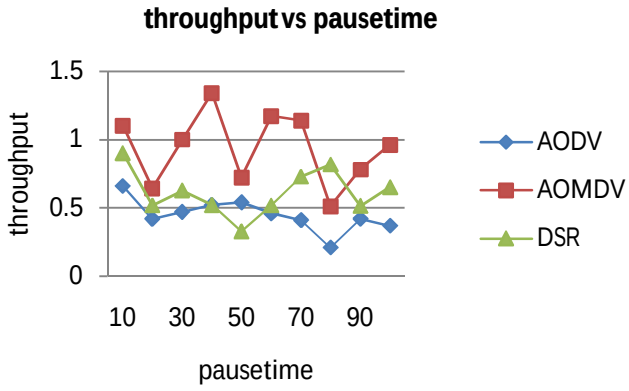

Figure 12 shows throughput with varying pause times

4. CONCLUSION

The performance of three popular on-demand routing protocols, AOMDV, AODV and DSR is evaluated by comparing various parameters like route discovery frequency, packet delivery ratio, end-to-end delay, routing overhead, packet loss, and throughput. From the results it can be concluded that the route discovery frequency, end to end delay and packet loss for AOMDV is very less when compared to AODV and DSR. Routing overhead is high in AOMDV protocol. However, packet delivery ratio and Throughput are relatively better for AOMDV when compared to AODV and DSR.

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