Performance Evaluation of On Demand Routing Protocols AODV and Modified AODV (R-AODV) in MANETS

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ABSTRACT

In mobile ad hoc networks, there is no centralized infrastructure to monitor or allocate the resources used by the mobile nodes. The absence of any central coordinator makes the routing a complex one compared to cellular networks. The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile devices. AODV uses an on demand approach for finding routes. AODV and most of the on demand ad hoc routing protocols use single route reply along the reverse path. Due to rapid changes of topology the route reply may not arrive to the source node resulting in sending several route request messages and degrading the performance of the routing protocol. The extended AODV called Reverse Ad Hoc On Demand Vector (R-AODV) protocol uses a reverse route discovery mechanism and performs well when link breakage is frequent. In this paper we compare the QoS parameters such as Throughput, Delay and Packet Delivery ratio of both traditional AODV and R-AODV using TCP New Reno as the traffic source. Simulation results show that R-AODV performs well when link breakage is frequent.

Keywords

AODV, R-AODV, MANETs, QoS Parameter & TCP New Reno

1. INTRODUCTION

Mobile ad hoc network [1], [2] is a dynamic network which allows communication between the mobile nodes without a central administrator. The network topology in such a network may keep changing randomly. Routing protocols used in traditional wired networks cannot be directly applied in ad hoc wireless networks due to their highly dynamic topology. A variety of routing protocols [7], [8] for ad hoc wireless networks have been proposed in the recent past.

Ad hoc wireless network routing protocols [7], [8] can be classified into three major categories based on the routing information update mechanism.

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1. *Proactive or table driven routing protocols*: In this, each node maintains the network topology information in the form of routing tables by periodically exchanging routing information. Routing information is generally flooded in the whole network. Whenever a node needs a route to the destination it runs an appropriate path finding algorithm on the topology information it maintains.

2. *Reactive or on demand routing protocols*: Such protocols do not maintain the network topology information. They obtain the necessary route when it is required, by using a connection establishment process. Hence these protocols do not exchange routing information periodically.

3. *Hybrid routing protocols*: These protocols combine the best features of the above two categories. Nodes with a certain distance from the source node concerned or within a particular geographical region are said to be within the routing zone of the given node. For routing within this zone, a table-driven approach is used. For nodes located beyond this zone, an on-demand approach is used.

We focus our study on on-demand routing protocols. One of the on-demand routing protocol is AODV [4]. The main advantage of this protocol is that routes are established on demand i.e., only when it is required by a source node for transmitting data packets. But due to the dynamic change of network topology, links between nodes are not permanent. When a link breaks, a node cannot send packets to the intended next hop node resulting in packet loss. If the lost packet is a route reply packet it brings much more problems as the source node needs to re-initiate route discovery procedure.

In this paper we study the performance comparison of the modified AODV (R-AODV) [10] algorithm in which route reply message is multicast to its neighbors resulting in redundant route reply messages instead of unicasting the route reply to its next hop as in the traditional AODV. With this the probability of a successful route discovery is increased as we have repetitious route reply messages in our network. The robustness of the R-AODV algorithm is tested and compared with the existing AODV algorithm by using TCP New Reno as traffic source.

The route discovery procedure and design of AODV protocol is discussed by C. Pekin et al in [4]. The design of extended AODV(R-AODV) also called Reverse AODV and the comparative analysis of AODV with R-AODV using UDP traffic for constant bit rate applications considering scalability is discussed by E.Talipov et al in [10]. In this paper we compare the QoS parameters [7], [9] of both traditional AODV and R-AODV using TCP New Reno as the traffic source.

The rest of the paper is organized as follows: Section 2 gives a brief introduction of AODV routing protocol and an overview of modified AODV(R-AODV) routing protocol. Simulation setup is described in section 3. Section 4 gives the results and performance comparison of the two routing protocols. Section 5 concludes the paper.

2. DESCRIPTION OF ROUTING PROTOCOLS

2.1 Ad hoc on demand distance vector (AODV)

Ad hoc on demand distance vector (AODV) [3] 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.

The procedure of route establishment is as follows. Assume that node X wants to set up a connection with node Y. Node X initiates a path discovery process in an effort to establish a route to node Y by broadcasting a Route Request (RREQ) packet to its immediate neighbors. Each RREQ packet is identified through a combination of the transmitting node's IP address and a broadcast ID. The latter is used to identify different RREQ broadcasts by the same node and is incremented for each RREQ broadcast. Furthermore, each RREQ packet carries a sequence number which allows intermediate nodes to reply to route requests only with up-to-date route information. Upon reception of an RREQ packet by a node, the information is forwarded to the immediate neighbors of the node and the procedure continues until the RREQ is received either by node Y or by a node that has recently established a route to node Y. If subsequent copies of the same RREQ are received by a node, these are discarded.

When a node forwards a RREQ packet to its neighbors, it records in its routing table the address of the neighbor node where the first copy of the RREQ was received. This helps the nodes to establish a reverse path, which will be used to carry the response to the RREQ. AODV supports only the use of symmetric links. A timer starts running when the route is not used. If the timer exceeds the value of the 'lifetime', then the route entry is deleted.

Routes may change due to the movement of a node within the path of the route. In such a case, the upstream neighbor of this node generates a 'link failure notification message' which notifies about the deletion of the part of the route and forwards this to its upstream neighbor. The procedure continues until the source node is notified about the deletion of the route part caused by the movement of the node. Upon reception of the 'link failure notification message' the source node can initiate discovery of a route to the destination node.

2.2. Modified AODV (R-AODV)

Most of on-demand routing protocols, except multipath routing uses single route reply along the first reverse path to establish routing path. In high mobility, pre-decided reverse path can be disconnected and route reply message from destination to source can be missed. In this case, source node needs to retransmit route request message.

AODV protocol uses a single route reply message which may be lost in a network with mobile nodes. Transmission control protocols uses acknowledgements to confirm successful data transmission. When TCP is used as a transport layer protocol in MANET which employs AODV at network layer, it deteriorates the performance of the network when mobility is high.

The main purpose of our study is to increase the possibility of establishing routing path with less RREQ messages than the other protocol has, when topology changes by nodes mobility.

The modified AODV (R-AODV) [10] protocol discovers routes on-demand using a reverse route discovery procedure. During route discovery procedure source node and destination node plays some role from the point of sending control messages. Thus after receiving RREQ message, destination node floods reverse request (R-RREQ), to find source node. When source node receives an R-RREQ message, data packet transmission is started immediately.

3. SIMULATION SETUP

The R-AODV [8] protocol incorporates a route reply similar to route request in AODV [4]. To verify the hypothesis, we have implemented R-AODV by changing the source code of AODV in NS2 simulator [5], [6] to enable multiple route reply packets. The simulation setup is described in Table1.

Table 1. Simulation Parameters

Parameter	Value
Routing Protocols	AODV, R-AODV
MAC Layer	802.11
Terrain Size	1315m*572m
No. of Nodes	25
Mobility Model	Random Mobility Model
Packet Size	1500B
Bandwidth	11MB
Frequency	2.472GHz
Antenna Type	Omni antenna
Propagation Model	2-Ray ground
Speed	0-5-10-15-20-25m/s
Simulation Time	100s
Traffic Source	TCP New Reno
Application Layer	FTP

We have built a validation module by constructing a scenario of 25 mobile nodes using TCL script. The awk script is run on the trace file obtained after the simulation in Linux Kernel to obtain the statistics of throughput, delay and packet delivery ratio. We make comparison between AODV and R-AODV under TCP New Reno considering the extracted statistics.

3.1 Performance metrics

Mobile ad hoc network routing protocols can be evaluated by a number of quantitative metrics described by RFC2501 [7]. We have used the following metrics for evaluating the performance of the two routing protocols (AODV & R-AODV).

3.1.1 Throughput

It is the rate of successfully transmitted data packets per second in the network during the simulation.

3.1.2 Average end-to-end delay

It is defined as the average time taken by the data packets to propagate from source to destination across a MANET. This includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the MAC, propagation and transfer times.

3.1.3 Packet Delivery Ratio

It is the ratio of the number of packets received by the destination to the number of data packets generated by the source.

4. SIMULATION RESULTS

Here we present a comparative analysis of the performance metrics of both the on-demand routing protocols AODV and R-AODV with TCP New Reno as the traffic source for different node speeds 5,10,15,20 & 25m/s.

4.1 Throughput

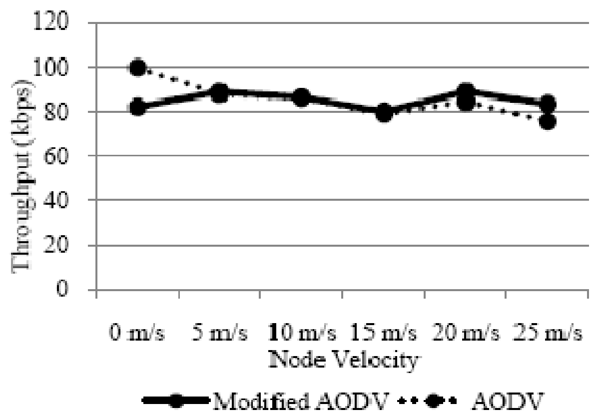

Fig. 1. Throughput, when mobile nodes velocity varies

From above figure it is clear that at 0m/s, AODV gives better throughput than R-AODV. As the node mobility increases to 18m/s both AODV and R-AODV has almost same throughput but as the speed increases beyond 18m/s R-AODV outperforms AODV (as the throughput of AODV decreases with node velocity).

4.2 Average Delay

From figure2 it is clear that AODV gives more delay than R-AODV routing protocol and it increases with the node velocity. Average delay is less for R-AODV routing protocol and is almost constant for various node velocity. Thus R-AODV gives better delay performance than AODV.

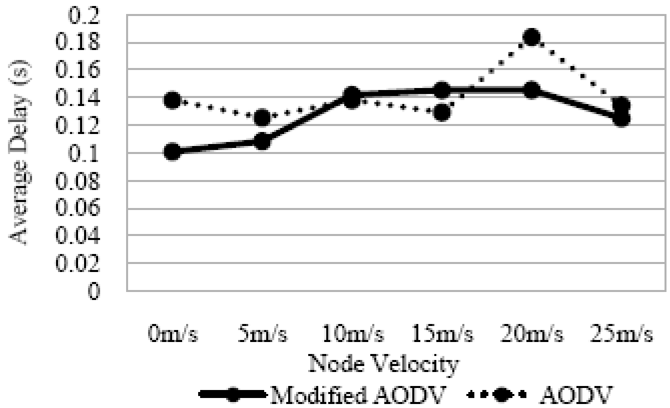

Fig. 2. Average delay, when mobile nodes velocity varies

4.3 Packet Delivery Ratio

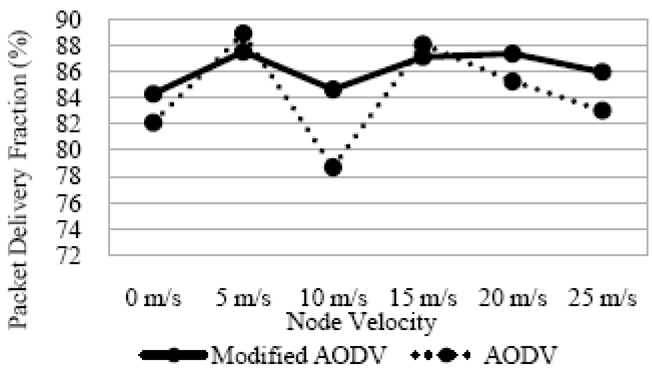

Fig. 3. Packet delivery ratio, when the mobile node velocity varies

Figure 3 gives the packet delivery ratio when the node velocity varies. With node velocity from 0 to 5m/s both AODV and R-AODV has almost same packet delivery ratio but as the velocity increases to 10m/s the ratio decreases rapidly in case of AODV whereas R-AODV maintains the same ratio. Thus with the increase in node velocity R-AODV gives more PDR thereby outperforming AODV.

5. CONCLUSIONS

Successful delivery of route reply message is very important in a MANET as a lot of route discovery effort is wasted if a reply message is lost, moreover a new route discovery process has to be reinitiated. Our simulation results show that R-AODV protocol has better throughput and average delay with increasing node velocity. Further multiple route reply messages in MANET results in a stable packet delivery ratio. Thus, with the increase in node velocity R-AODV gives more PDR outperforming AODV. We validate the use of R-AODV with TCP New Reno traffic for FTP applications.

In this paper the two on-demand routing protocols AODV & R-AODV are analyzed and their performances have been evaluated with respect to three performance metrics using TCP New Reno as the traffic source. This paper can be enhanced by analyzing other MANET routing protocols with different traffic sources.

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