AODV-MS: Ad-hoc on Demand Distance Vector Routing Protocol with Multipath and Selective Flooding

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ABSTRACT

Mobile ad hoc networks (MANETs) are infrastructure less networks consist of wireless mobile nodes which dynamically exchange data among themselves. Position of nodes in MANET changes frequently. Design of efficient routing protocols in such dynamic networks is a challenging issue. Many routing protocols have been proposed to improve the performance of ad-hoc networks. The on-demand protocols depend on query floods to discover routes whenever a new route is needed. Such floods results in wastage of network bandwidth. In this paper we proposed a protocol Adhoc on Demand Distance Vector Routing Protocol with Multipath and Selective Flooding (AODV-MS). In AODV-MS source node uses selective flooding during route discovery phase and stores node disjoint multiple paths to destination. Selective flooding reduces the number of packets in network and improves bandwidth utilization. Multiple paths between source and destination results in low delay, less packet drops and improves throughput.

Keywords: AODV, MANET, Multipath Routing, flooding, AODV-MS

1. INTRODUCTION

An ad hoc network is a collection of devices that change their position dynamically. The nodes in ad hoc network do not depend on any fixed infrastructure (e.g., base stations or access points) for their communication. Communication is done through wireless links among mobile hosts through their antenna. The nodes close to each other communicate directly while nodes that are not in the range of each other communicate via the intermediate nodes. The nodes that communicate directly are said to be neighbouring nodes. The intermediate nodes act as a router. Furthermore, due to the movement of nodes, the network topology changes rapidly [10]. Therefore, an efficient routing protocol is neededfor better communication between the nodes. Routing protocols in ad hoc networks are divided in to two categories: proactive (Table driven) routing protocols and reactive (On Demand) routing protocols. In proactive routing protocols [3], every node store routing information about every other node in the network. Proactive protocols lead to relatively high overhead on the network due to exchange of information periodically. On the other hand, reactive routing protocols [4][2], creates routes only when one node wants to communicate with another node which reduces routing overhead and increases bandwidth utilization. Once a route is created, it is maintained by using some route maintenance mechanism as long as the source node wants to communicate with the destination node. In Ad hoc networks link break occurs frequently due to nodes mobility, greater error rates, interference of signals, fading environment etc. But an actual route break occurs due to mobility of nodes. In AODV node that finds link break send a RERR message to the source. Source none after receiving the RERR starts a new fresh route discovery cycle if it wants further communication with the destination node.

In multipath routing [1][6][7][8][9], multiple routes from source to destination are stored during a single route discovery cycle. In case of the occurrence of link break, any of the alternative routes is selected to forward the packets. The performance of multipath routing shows better utilization of network resources but number of packet drops and delay is increased because alternative cached routes may become stale. These limitations of AODV motivated us to propose an efficient routing protocol, Adhoc on Demand Distance Vector Routing Protocol with Multipath and Selective Flooding(AODV-MS), which improves the performance of an existing on-demand routing protocols, specifically AODV.

The paper is organized as follows. The propose scheme is discussed in Section 2. The comparisons of proposed and existing schemes are presented in section 3. Finally, the conclusions of the paper are presented in Section 4.

Destination	Sequence no.	Hop count	Next Hop	Expiration Time out

Figure 1a: Structure of routing table entries for an AODV

Destination	Sequence no.	Hop count	Next Hop	Priority	Expiration Time out

Figure 1b: Structure of routing table entries for an AODV-MS

2. PROPOSED SCHEME

Our proposed protocol is based on selective flooding [5] and multipath [1][6][7][8][9] routing concept.

Flooding is the root cause of routing overhead in AODV which is a consequence of broadcasting of RREQ packet during route discovery cycle. Hence, reduction of indiscriminate flooding is imperative. In a mobile adhoc network, multiple paths exist between any two nodes and particular path between a source and destination had a very little life and sub optimal paths may not really degrade the routing performance. Based on these observations, selective flooding [] is proposed in place of broadcasting. Hence we also incorporated the concept of selective flooding with slight modification in our protocol. In selective flooding first RREQ message is send to one-third neighbours randomly. If it gets reply before the request time out period it is done, otherwise, again route request message to another one-third of the neighbours and keep on doing the same operation until all the neighbours are selected or it gets an out reply. This reduces the routing packet overhead and increased throughput but increases the delay also. In our protocol AODV-MS, source node send RREQ message to one-half of neighbours instead of one-third, this results in reduction of delay that was increased in selective flooding protocol.

2.1. ROUTE DISCOVERY IN AODV-MS

In our proposed scheme, AODV-MS, source node prepares a RREQ packet and send it to one-half of its neighbors selected randomly. Source node stores multiple node-disjoint paths. If a RREQ packet is received by an intermediate node i, and it has route to destination, it sends a route reply packet, RREP, to source node S. Otherwise it broadcast the RREQ packet to its neighbors. Intermediate node i, discard duplicate RREQ packets it receives from other nodes. If RREQ is received by destination node, it sends a RREP packet to the node whom it received RREQ packet. Destination node do not discard duplicate RREQ packet, instead it sends RREP packet to all nodes from which it receives RREQ packet. When RREP packet is received by intermediate node i, it makes an entry in its routing table for that destination and forward RREP packet towards source. When a source node S received a RREP packet, it makes an entry in its routing table for that destination. Source node maintains more than one node-disjoint route for the same destination in its routing table.

The proposed scheme has introduced a new attribute priority in routing table whose value indicates the priority of route to destination D, initially when S starts route discovery for D it set the value of Priority to 0.

2.2. ROUTE DISCOVERY ALGORITHM IN AODV-MS

Suppose node S wants to communicate with Destination D.

/* Priority is a field in routing table whose value indicates number of routes to destination D exists in routing table, initially when S starts route discovery for D it set the value of Priority to 0.
n is a temporary user defined variable. It indicates maximum number of routes source S can store in its routing table for any destination D.
***/**

S prepares a RREQ packet and sends it to one-half of its neighbors.

```
1.  if (RREQ is received by an intermediate node i and
    it is not a duplicate packet)
2.        { if node i has valid route to destination
3.          { node i prepares a RREP packet and
    unicast towards source S
            }
    else
4.          node i broadcast RREQ packet to its
    neighbors
        }
      }
5.  if (node i receives a duplicate RREQ packet)
6.      { node i discard RREQ packet
    }
7.  if RREQ is received by Destination node D
8.      { node D prepares a RREP packet and unicast
    towards source S
        }
9.  if (RREP is received by an intermediate node i and
    it is not the duplicate packet )
10.     { node i makes an entry in its routing table for
    that destination and forward the
11.        RREP packet towards source
        }   // intermediate node discard all duplicate
    RREP packets
12. if RREP is received by source node S
    {
        If (Priority==0)
            {
    S makes an entry in its routing table for that
              destination and starts sending data
              on that route.
              Priority++
             }
         else
13.     {
         if (Priority ==1)
           {
             S makes another entry in its routing
table for that destination.
             Priority++
                }
              else {
                  S discards the RREP packet
                  }
               }
        }
14. END
```

2.3. ROUTE MAINTENANCE ALGORITHM IN AODV-MS

Data packets are send using the primary route unless the link breaks occurs. The operation after the intermediate node (say N2) has identified link break is presented below:

1. Node N2 prepares and sends a RERR packet to source S.
2. Source node S on receiving the RERR packet delete the entry for that destination on which it was sending data

and search its routing table for another route to destination D.

3. If there exists another valid route to D, S starts sending data on that route having lowest value of Priority.
4. If Sdid not find route to D in its routing table it starts new route discovery for D.
5. END

Illustration of route discovery with example

Suppose node S wants to communicate with node D. Source node S sends RREQ packet to only half of its neighbors (say N2, N4, N5), Fig 2. Intermediate nodes on receiving RREQ packet broadcast it to their neighbors. RREQ packet reaches destination from node M and node T. Destination node D unicast RREP packet to node T and M. Intermediate nodes on receiving RREP packet make entry in their routing table, Table 1,for D and forward RREP packet to source node S. Intermediate nodes set the value of priority to 1 in their routing table. When source node S receives first RREP packet from one of its neighbor (say N2), it makes entry in its routing table, Table 1, for D and priority equals to 1. Now Source node S makes another entry in its routing table, Table 1, for destination D on receiving RREP from node N5 and set priority to 2.

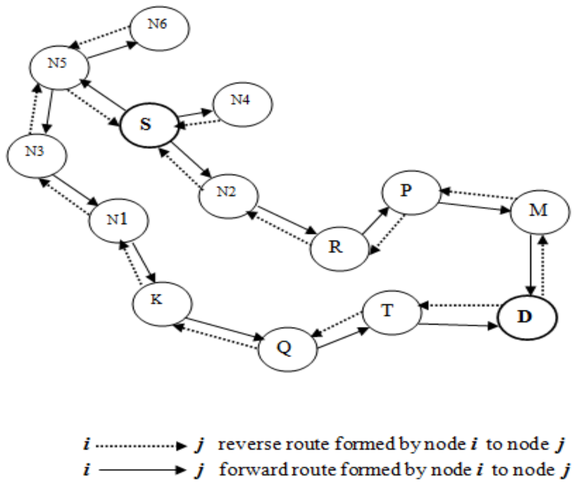

Fig. 2. Route discovery phase

Table 1. Routing table of Source node S

Destination	**Sequence number**	**Hop count**	**Next Hop**	**Priority**	**Expiration Time out**
D	…	5	N2	1	…
D	…	7	N5	2	…

Illustration of route maintenance with example

Suppose source node S is communicating with destination node D and link between node N2 and node R breaks. Node N2 sends RERR message to source S. Source node S upon receiving the RERR packet delete entry with next hop N2 and searches its routing table, Table 2, for another route to destination D. Source node S finds another route to node D and start sending data on this route.

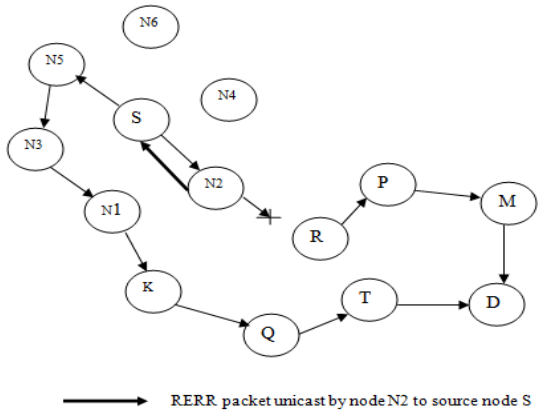

Fig. 3. Route maintenance phase

Table 2. Updated routing table of Source node S after link break

Destination	Sequence number	Hop count	Next Hop	Priority	Expiration Time out
~~D~~	~~…~~	~~5~~	~~N2~~	~~1~~	~~…~~
D	…	7	N5	2	…

3. PERFORMANCE ANALYSIS OF AODV-MS

Various cases are considered for evaluating the performance of the proposed scheme AODV-MS and it is also compared with AODV [4].

CASE 1: REDUCED ROUTING OVERHEAD

In AODV-MS source node send RREQ packet to only one-half of its neighbor which decreases routing packet overhead compare to AODV.

CASE 2: INCREASED THROUGHPUT AND BANDWIDTH UTILIZATION

As number of packets during route discovery in AODV-MS reduces, bandwidth utilization and throughput increases compare to AODV.

CASE 3: REDUCED DELAY

Since source node switch to alternate route on receiving RERR message, it reduces the delay caused due to route discovery on link break in AODV.

4. CONCLUSIONS

In this paper, AODV-MS scheme is proposed to improve an AODV routing protocol. AODV-MS uses a combined strategy of AODV, AODV with selective flooding and multipath routing protocol to improve the performance of AODV routing protocol. AODV-MS reduces the route latency time when a RERR message is generated and uses selective flooding to reduce routing overhead. Hence improves the performance of AODV. In future we implement AODV-MS on network simulator and compare its performance with other MANET protocols.

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