HP-AODV: An Enhanced AODV Routing Protocol for High Mobility MANETs

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ABSTRACT
MANETs (Mobile Ad Hoc Networks) are wireless networks with characteristics such as self organizing or autonomous, multi-hop and resource constrained. These resource constraints includes limited power, bandwidth etc. which in turn increases the difficulty in MANETs routing. The problem space includes route break, control overhead, limited energy etc. Ad-hoc On Demand Distance Vector (AODV) is the most popular routing protocol for MANETs. In this paper, we propose an enhanced version of AODV known as High performance AODV (HP-AODV) which provides better route maintenance by reducing control overhead. The proposed protocol is providing alternate routes by an extra broadcast in case of route failure. These alternate routes are reducing number of control packet effectively. We have done simulation for different Pause time and different number of sources to get the results. Simulation results compared with AODV protocol indicate that HP-AODV is performing better in terms of Normalized Routing Load (NRL).

General Terms
Routing protocol, Communication procedure

Keywords
AODV, MANETs, Route Maintenance, NRL.

1. INTRODUCTION
We have seen a fast growth in the field of internet which leads to new possibilities in this field. One such field is MANETs. The Mobile Ad Hoc Network (MANET) is a autonomous system which is consist of mobile host and every mobile host also act as a router in order to forward data packets or control packets to other nodes, as shown in Figure 1. The AODV is a reactive routing protocol so it means routes will be determined as per need. In AODV, in order to detect the links to neighbors, Hello messages are used which are broadcasted on a periodic basis by each active node. When source have the data to send to a destination for which route is not known then source start the route discovery process by broadcasting the RREQ (route request) packet. when an intermediate node receive the RREQ packet then a "route to source" is created and it will re-broadcast the RREQ packet if it does not have the fresh route to destination, it has not received this RREQ before, and it is not the destination. If the receiving node is destination or does have the fresh route to destination then it generates a RREP (route reply) packet. This RREP is unicasted to source in a hop by hop fashion. When a node receive RREP packet a "route to destination" is created. A source may receive multiple RREPs in that case a route with the shortest hop count will be chosen.

In order to determine freshness of a route, a timer is associated with each route and it will be updated each time when data will flow via that route. so if a route is not used for a long period of time then it will be removed from the routing table.

If a link break is detected then a RERR (route error) packet will be sent to the source of data and each intermediate node will also invalidates routes to that unreachable destination. When source receives RERR packet it will invalidate the route and start the route discovery process again if required.

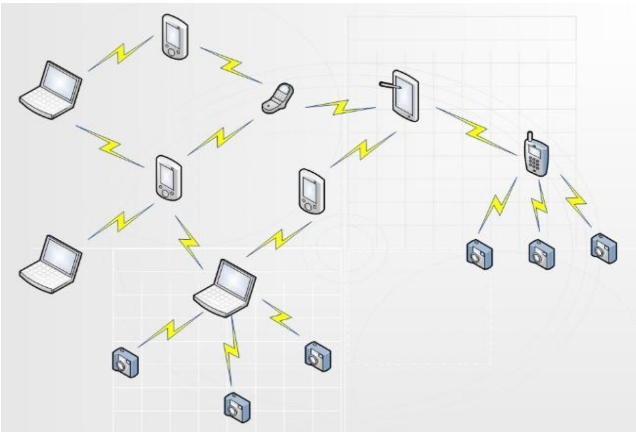

Fig 1: MANET

2. RELATED WORK
Mobility is a very important characteristic of MANET. There are several improved AODV routing protocols to handle high mobility scenario. In [2], the author proposed AD-AODV routing protocol in which they have used a metric M whose value depend upon hop number and average mobility of a given route. By using this metric M the most stable route is selected. In order to compute M it needs two factors first is route average mobility so they have computed each node's relative mobility degree which is quantified periodically, this process is accomplished while nodes exchanges hello packets with their neighbors. Every node counts the number of nodes that joins and leaves its range in a certain period of time, then they have computed Route average mobility (RAM) by using each nodes relative mobility along the route. They have also included a weighing factor λ which will denote up to what degree a route could sacrifice its hops for better reliability of route and the route with smallest M will be selected.

$$M = RAM + \lambda * hops$$

In another proposal [3], in order to maintain route in a better way, author proposed Preemptive AODV routing protocol which extends the definition of AODV with the ability to discover multi path routes to a host and switch between them, if an active route becoming weak and there is a risk that it will disappear. They have also altered the structure of the routing table entries.

In order to minimize the control overhead the author proposed two versions in [5], These two versions uses global positioning system (GPS) to limit the routing discovery control messages. The first version is AODV-LAR which is a variation of location added routing (LAR) protocol. In this version the idea is if we know the location of the destination then we can reduce the area of flooding. If source node S knows the location and average speed of destination node D at specified time $t_{0,}$ then it can restrict the flooding to restricted rectangular area. The second version is AODV-LINE protocol. Here the main idea is restrict the flooding of control packet to just near the line that connects the source and destination node. Each node decides to rebroadcast the RREQ messages based on its distance from the line connecting source and destination and the distance between itself and destination node.

3. METHODOLOGY

In this section, we illustrate our protocol's routing mechanism.

3.1 New High Performance Route Reply Procedure for High Mobility MANETs

Destination node (D):

Start_Route_Reply( )

{

(1) Destination node D will unicast a "RREP" message to Source node S through main route with a unique sequence no. let's say D.1

(2) Then Destination node D will broadcast an alternate route reply "ARREP" message which will contain that same Unique sequence no. D.1, Hops to destination = 1 and Next hop to destination = D.

}

Intermediate nodes (C):

Receive_ARREP(D.1)

{

(1) Check whether intermediate node C has already received a "ARREP" with sequence no. D.1 or not.

(2) If yes then discard this "ARREP" message.

(3) else enter the Unique sequence no., Hops to destination and Next hop to destination of "ARREP" message in "ARREP_TABLE".

(4) Call "Broadcast_ARREP" procedure.

}

Broadcast_ARREP(D.1)

{

(1) Increase the hop count by 1.

(2) Enter this node id i.e. 'C' into "Next hop to destination"

(3) Rebroadcast "ARREP" message.

}

3.2 New High Performance Route Maintenance Procedure

Intermediate node:

Link_Failure_Handler()

{

(1) When a link failure happens it will not send any "RERR" message to precursor nodes.

(2) It will buffer all the packets that were forwarded using the link that has been failed.

(3) Call "Route_Search" to find new route for these buffered packets whose destination is D.

}

Route_Search(D)

{

(1) It will send a message to all the active neighbors except precursor node to ask whether they have a route or "alternative route" to that particular destination D or not.

(2) if yes then send the reply containing number of hops for that destination.

(3) Now select the active neighbor with minimum number of hops to destination in order to forward the buffered data packets.

(4) else it will initiate the route discovery process in order to find the fresh route to destination.

}

4. PERFORMANCE EVALUATION

We have used Network simulator (Version 2.34) to simulate AODV and HP-AODV routing protocol.

4.1 Experiment Setup

We setup a 500m * 500m flat grid network field in which mobile node will move according to node movement scenario. The total Number of node is 50. In order to provide the random movement scenario for all nodes we have used setdest implementation of NS-2. At application layer we are using CBR traffic generator to produce data packet at the rate of 1Mbps. The time for each simulation is 1000s. Every node could store 50 packets in its queue buffer. The minimum speed of nodes is 1m/s and the maximum speed of nodes is 20m/s. The pause time will vary from 0 second to 1000 second. The number of traffic sources will vary from 10 to 40.

4.2 Performance Metric

In order to compare the performance of both protocols, we are using Normalized Routing Load as performance metric. Normalized routing Load is the number of routing packets transmitted per data packet delivered at the destination.

4.3 Simulation Result and Analysis

The main objective of this paper is to reduce the control overhead incurred in routing of packets i.e. Normalized routing load.

In Figure 2 and 3 we measure the Normalized Routing Load (NRL) of original AODV and HP-AODV and we can see that Normalized Routing Load (NRL) of HP-AODV is less when we compare it with AODV's NRL. This NRL reduction saves the resources of mobile nodes. Here less pause time indicate high mobility scenario which leads to frequent link failures and more pause time indicates less mobility scenario. Both these protocols are behaving differently in case of link failures. HP-AODV always has a lower NRL than AODV because in HP-AODV, to resolve link failure, we are using alternate path, which was created during route reply phase.

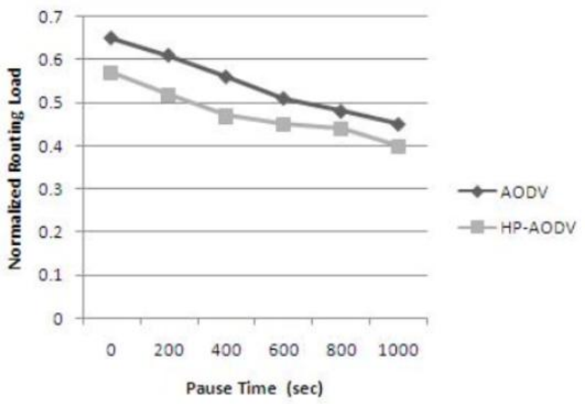

Fig 2: Normalized Routing Load for 10 sources

But when link failure happens in AODV protocol, it leads to new route discoveries because AODV has only one route for each destination in its routing table. So the Number of route discoveries is directly proportional to the number of link failures. Every route discovery requires a large number of control packets which is an overhead. We can also see that when the number of traffic sources is less, the NRL (Normalized routing load) is also less in both AODV and HP-AODV because less number of traffic sources is generating less data packets hence less control packets.

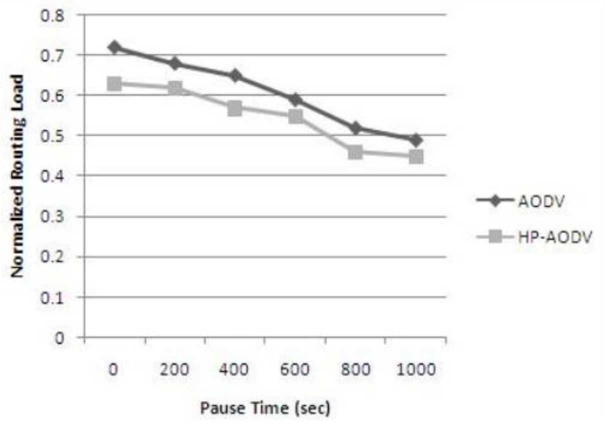

Fig 3: Normalized Routing Load for 20 sources

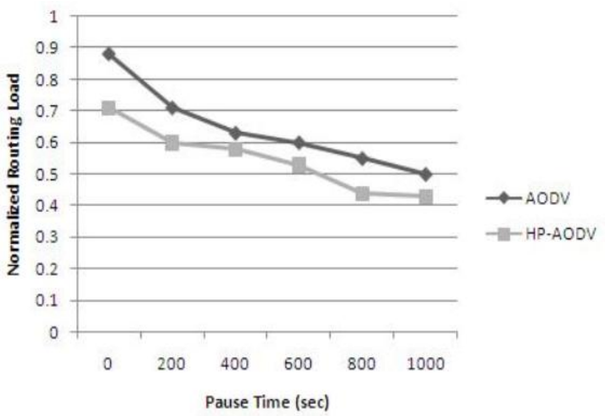

Fig 4: Normalized Routing Load for 30 sources

In figure 4 and 5 again we have measured the NRL for original AODV and HP-AODV but with more number of traffic sources and again results are showing that Normalized Routing Load (NRL) of HP-AODV is less when we compare it with AODV's NRL. This decrease in NRL proves the validity of the proposed protocol. We can also see that the value of NRL is increasing when we are increasing the number of sources because increasing number of traffic sources are increasing data traffic. This significant reduction in NRL will ultimately leads to reduction in the consumption of mobile node resources (power, memory and computational resources).

These simulation's results clearly shows that HP-AODV is performing better than AODV in high mobility scenario.

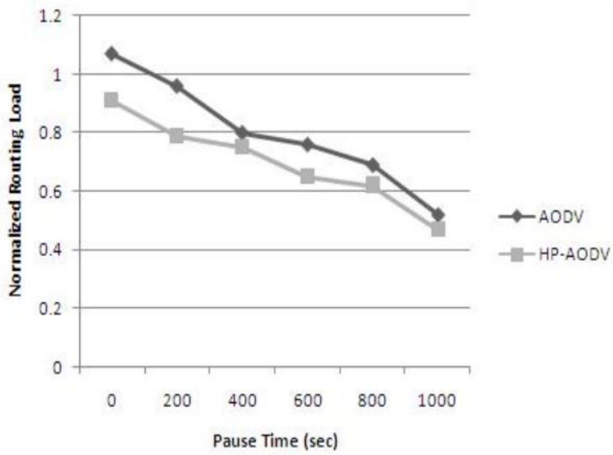

Fig 5: Normalized Routing Load for 40 sources

Table 1. NRL Values for AODV Protocol

Sources / Pause Time	10 Sources	20 Sources	30 Sources	40 Sources
0000 Sec.	0.652	0.728	0.884	1.075
0200 Sec.	0.610	0.684	0.719	0.968
0400 Sec.	0.560	0.653	0.632	0.804
0600 Sec.	0.510	0.599	0.602	0.762
0800 Sec.	0.484	0.523	0.550	0.695
1000 Sec.	0.450	0.491	0.508	0.522

Table 2. NRL Values for HP-AODV Protocol

Sources / Pause Time	10 Sources	20 Sources	30 Sources	40 Sources
0000 Sec.	0.578	0.638	0.710	0.910
0200 Sec.	0.520	0.620	0.603	0.792
0400 Sec.	0.474	0.576	0.584	0.752
0600 Sec.	0.456	0.554	0.531	0.659
0800 Sec.	0.440	0.463	0.449	0.620
1000 Sec.	0.401	0.453	0.433	0.470

5. CONCLUSION

In HP-AODV routing protocol we have proposed two new procedures called "New high performance route reply procedure for high mobility environment " and "New high performance route maintenance procedure for high mobility environment ". The proposed protocol is using one broadcast per route discovery process to provide alternate routes in case of route failure. These alternate routes are reducing number of control packet significantly in case of link failure. But in AODV, every time a link failure happens, it leads to a new route discovery phase. The experiment results are showing that the performance of HP-AODV is better than original AODV in terms of Normalized Routing Load.

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