An Enriched Reactive Routing Protocol - AODV for Mobile Adhoc Networks

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***Abstract*— Mobile ad hoc network (MANET) is an emerging trend and it has to face many challenges and issues. An ad hoc network is a collection of mobile nodes that dynamically form a temporary network, without the use of existing infrastructure. When two nodes are not within the radio range of one another, they use intermediate nodes to route packets for them. Routing in MANET is a challenging problem which draws researcher's vision, due to nodes mobility, dynamic topology, frequent link breakage, limitation of nodes (memory, battery, bandwidth, and processing power), and lack of central point like base stations or servers. So by analyzing different ad hoc routing protocols based on the metric throughput, packet delivery ratio, end to end delay which may yield a solution to the challenges in the ad hoc routing in different situations. The mobility of nodes and instability of the wireless environment may result in link breaks between neighboring nodes, even causes the route to be invalid. This paper focuses on the mobility of the source node and intermediate node which may result link failure. If a source node moves, it is able to reinitiate the Route Discovery Protocol (RDP) to find a new route to the destination using path updation. For intermediate node link break a Local Repair Procedure is used to update the path. This main objective of this paper is new path updation and resolving link failure in AODV. Computer simulation using NS2 simulator on Linux operating system shows the behavior and performance enriched in AODV routing protocol based on the metrics.**

***Keywords*— MANET, AODV, RDP, Link Failure, PDR, E2E, Throughput,NS2.**

I. INTRODUCTION

MANET (Mobile Ad hoc Network) is a mobile multi-hop, wireless self-organized distributed network [1]. The primary objective of routing protocol is to discover the route. The routing protocol for MANET undertakes to setup and maintain routes between nodes. In MANET, continuously changing network topology causes link breakage and invalidation of end-to-end route. The highly dynamic nature of wireless network imposes severe restrictions on routing protocols. This paper is mainly focus on on-demand, source initiated protocols, which set up and maintain routes from the source to the destination on an "as needed" basis. The well known best reactive protocol which is used to discover the route when the topology changes, is AODV.

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The very most challenging issue in wireless network is routing packets from one another. When a link break in an active route occurs, the node upstream of that break may choose to repair the link locally. In this paper, we have proposed a local repair scheme based on link breaks for MANET. When a link break occurs, the node that is upstream of the lost link (i.e. the repairing node) classifies the link breaks and adopts different methods for different link breaks depending on the status of its downstream node. The rest of the paper is organized as follows.

Section I discusses on the categories of routing protocol, and a detailed description of AODV (Ad hoc On-demand Distance Vector Protocol) is introduced in Section II and newly constructed path updation is discussed in Section III. The essential idea of the local repair scheme based on link breaks is described in Section IV. Detailed simulation results are discussed on the improved local repair scheme is reported in Sections V, Section VI concludes the enriched performance of AODV routing protocol.

II. CATEGORIES OF ROUTING PROTOCOL

Routing protocols for Ad hoc networks can be classified into three main categories: (1) **Proactive or Table –Driven** which uses periodic updates. DSDV is a table driven protocol (2) **Reactive/On Demand/Source initiated** which finds shortest path on demand. AODV, TORA and DSR are on-demand routing protocols. (3) **Hybrid**.

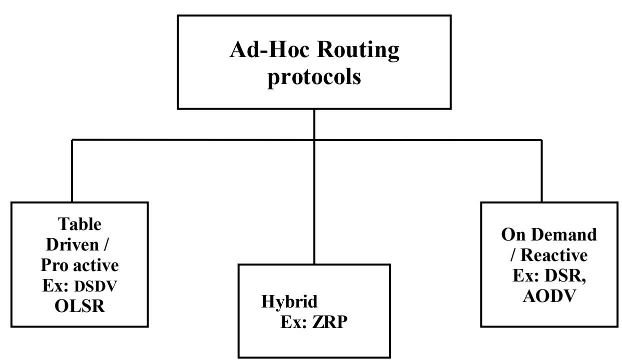

Fig 1. Types of Routing Protocols

III. WORKING PRINCIPLE OF AODV PROTOCOL

AODV [3] is a representative of reactive routing protocols of MANET. The protocol consists of two parts:
route discovery and route maintenance.

AODV discovers routes on an as needed basis via a similar route discovery process. AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers.

Whenever a packet is to be sent by a node, it first checks with its routing table to determine whether a route to the destination is already available. If so, it uses that route to send the packets to the destination. If a route is not available or the previously entered route is inactivated, then the node initiates a route discovery[3] process. A RREQ (Route REQuest)[4] packet is broadcasted by the node. Every node that receives the RREQ packet first checks whether it is the destination for that packet and if so, it sends back an RREP (Route Reply) packet.

An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets.

To control network-wide broadcasts of RREQ packets, the source node use an expanding ring search technique. In this technique, source node starts searching the destination using some initial time to live (TTL) value. If no reply is received within the discovery period, TTL value incremented by an increment value. This process will continue until the threshold value is reached. When an intermediate node forwards the RREQ, it records the address of the neighbor from which first packet of the broadcast is received, thereby establishing a reverse path.

These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link. The RREQ packet gets relayed back to the source through the reverse route. The source node then updates its routing table and sends its packet through this route. During the operation, if any node identifies a link failure[5] it sends a RERR (Route ERRor) packet to all other nodes that uses this link for their communication to other nodes.

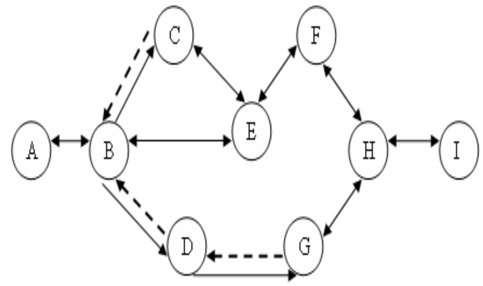

Fig 2. Initial Set-up

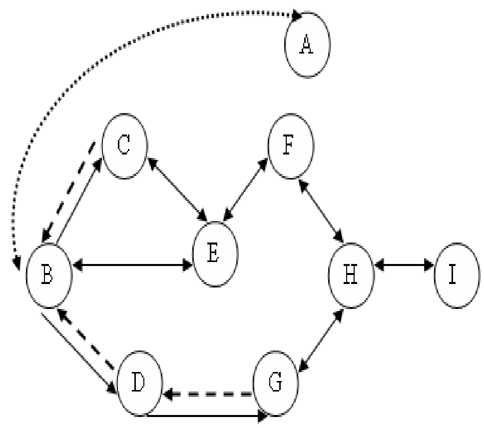

Fig 3. Topology changes due to source node movement

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Procedure PathUpdate (hopold,hopnew,ono,nno)
Begin
If hop old > hop new then
      alternate path (smaller no.of hops)
      Replace current path by new path
 Else
       No change
 End if
End
```

Fig 2 shows initial setup. Path A→B→→E→F→H→I

Fig 3 shows topology changes : Source node moves nearer to F A→F→H→I.

III. PROPOSED ENRICHED AODV

We propose an enhancement over the basic AODV routing protocol which will have better performance than the conventional AODV. New Path Updation AODV can be modified to use effectively the routing information provided by the new neighbor nodes. Each time a node discovered a new neighbor node. These two nodes exchange the necessary information. For each routing table entry, we extracted destination address, number of hop towards that destination, sequence number and expire time of that entry. The extracted entries are formed into a destination table to exchange with the new neighbor node. The destination table is processed like the following: for each entry, look up its destination address in the routing table. If the destination is found, it means that besides the current path in the routing table, there has a new path through the new neighbor node. The number of hops of these two paths is then compared. Consider the number of hops of the old path and new path are hopold and hopnew respectively. If hopold > hopnew : the new path is better (with smaller number of hops), It will replace the current one; otherwise, there will be no change

If the destination is not found in the routing table and neighbor list, an entry toward that destination is created in the routing table as a new accumulated path. The update and accumulated path both obtain the sequence number, number of hop and expire time from the destination table. With this modification, source can discover and change to a better path even if the current path is not broken. The accumulated paths will also decrease the number of Route Discovery cycles and reduce the delay time for finding a path. This design therefore improves the performance of AODV.

a. Route Maintenance in the Proposed AODV

After selecting the route between the source and the destination and during data transmission, if any node participating in the route moves, then the node that tries to send data will detect a link break. Then it tries to salvage the packet, that is, it searches in its cache to find an alternate route to reach the destination. If there is any route, then it will send data through that new route.

Otherwise, it creates a ‘Route Error’ packet and sends it to the source node to indicate the failure of the link. When forwarding the route error packet, the intermediate nodes remove the cache entries corresponding to the node, which moved and then forward the packet. On receiving the error packet, the source node also removes the entries corresponding to the node and tries to find another route to the destination in its cache.

b. Route Reply in the Proposed AODV

After broadcasting the route request, the source node waits for reply some amount of time, before retransmitting the request again. Till that time, the data packets that are to be transmitted are stored in a buffer.

Source starts collecting the request until the time expires. Then it checks the reply to find out any repeated next hop. If it is, select any one of the repeated next hop paths, otherwise select randomly from the collected route replies and use that route to transmit the data.

IV. PROPOSED ENRICHED AODV AND LINK BREAK

The modification of the protocol is based on the

of packets. The loss of packets may be happen in many cases.

Link Failure is one of the case, and it is due to node mobility is a common feature of multi-hop, wireless ad hoc networks. Link Failure may occur in many ways. The mobility of nodes and instability of the wireless environment may result in link breaks between neighboring nodes, even causes the route to be invalid. Some solutions have been proposed to make routing protocols more robust against link breakages. Consider the following cases.

Case 1:

”If a source node moves (Fig 3, Fig 4)”

There may be a possibility of link break due to topological change.

Case 2:

“If an intermediate node moves”

- There may be a possibility of link break(Fig 5) due to mobility, link weakening.

Solution for case 1:

If the node is source node, then reinitiate the Route Discovery Protocol (RDP) to find a new route to the destination. One of the best Route Discovery protocol is AODV.

Solution for case 2:

If the node is intermediate node, then attempt to repair the node locally repair (Local Repair Procedure) by repairing node (RN). If not repaired by RN, it tries to rediscover another route.

Procedure Local Repair (mnttl,mxttl,RN,RREQ,RREP, RERR)

Begin

minttl←1, maxttl=25 (in milliseconds)

For I←minttl To maxttl do

Begin

Dns[]=RREQ // (RN broadcasts RREQ to all its downstream nodes)

If RN ← RREP then

Break

End

if I == maxttl and RREP then

ups[]=RERR // RN sends RERR to its upstream nodes

towards source node

ins[].rentries=NULL //(Remove the route entries of the

corresponding node in the intermediate nodes and source

node whose receiving RERR Source node should

another route to the destination)
else
//if I!=maxttl and RREP then
pdates its Route Table and sends data packets to its
downstream nodes.
End;

This proposed local repair procedure improves the performance of AODV protocol.

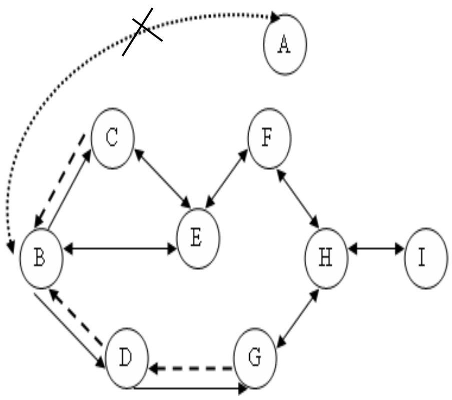


Fig 4. Link break due to source node mobility

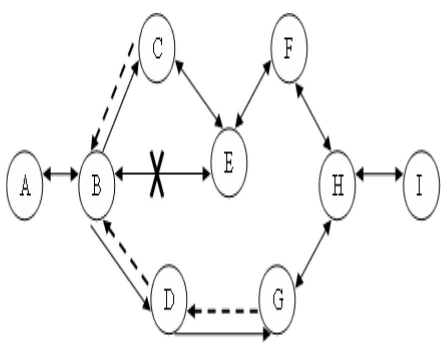


Fig 5. Link break in intermediate node

V. SIMULATION RESULTS

Computer Simulation using Network Simulator (NS-2) sing Linux (Fig.6, Fig.7, Fig.8) shows that enriched AODV Protocol provides better performance than the conventional AODV based on the metric PDR and End to End delay. The simulations use 5 different movement patterns (pause time 0, 20, 40, 100 seconds) and 4 different traffic patterns (5, 10, 15, and 20 sources). These patterns create 20 scenarios; each scenario combines a movement pattern and a traffic pattern. A wide variety of node scenario files and CBR scenario files were generated to evaluate varying network conditions. The main objective of our

Delivery Ratio[9] and Average Delay Time [9] as metric.

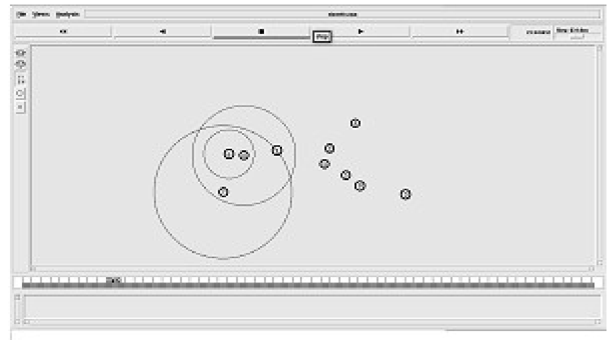


Fig 6. Route Discovery in proposed Enriched AODV

a. Node mobility

Node mobility indicates the mobility speed of nodes. When the node mobility is very less the packet delivery ratio is very high.

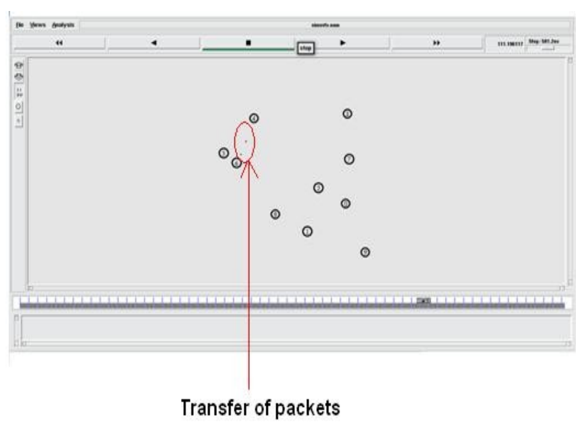
b. Packet Delivery Ratio (PDR)

PDR is used to measure the reliability. It is defined as a percentage of data packets delivered to that of no. of data packets sent for that node. The Average PDR is calculated by considering all the nodes in the network.

$$PDR= \sum \text{No.of Packets received} / \sum \text{No.of Packets sent}$$

When the node mobility is increased the packet delivery ratio is slightly decreased. Fig 5. shows the increased packet delivery ratio by using proposed AODV compared to conventional AODV.

Fig 7. Transfer of Packets



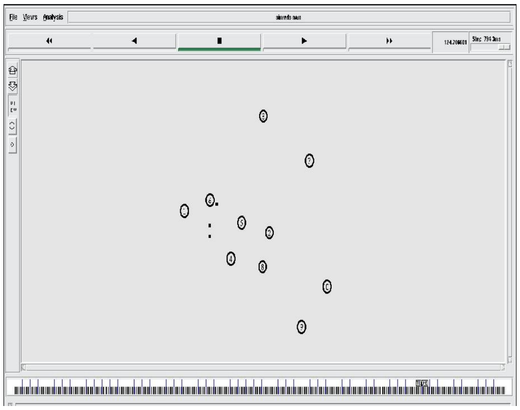


Fig 8. Packet Loss

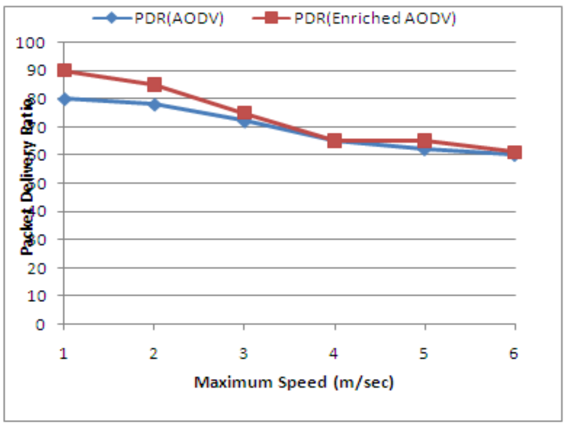


Fig 9. Packet Delivery Ratio Vs Speed

c. Average End-to-End Delay (AE2E Delay)

This is the average delay between the sending data packet by the source and its receipt at the corresponding receiver. This includes all the delays caused during route acquisition, buffering and processing at intermediate nodes, retransmission delays, etc. It is measured in milliseconds. Fig.6 shows the increased end-to-end delay compared to conventional AODV.

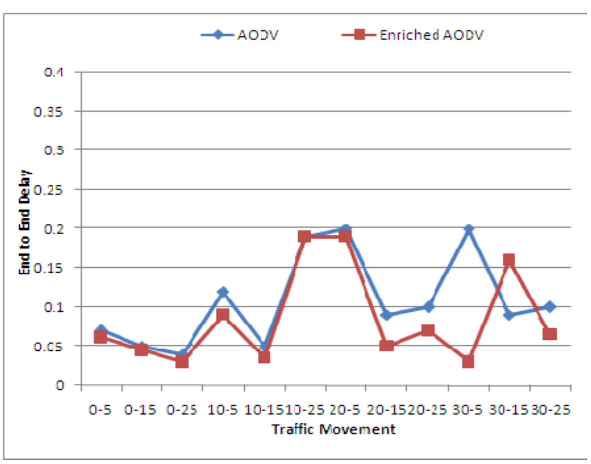


Fig 10. End to End Delay Vs Traffic Movement

D. Throughput

The throughput data reflects the effective network capacity. It is computed by dividing the message size with the time it took to arrive at its destination. It is measured considering the hops performed by each packet

$$\text{Throughput} = \left(\sum \text{No.of Pkts. received} / \sum \text{No.of Pkts. sent}\right) * 100$$

VI. CONCLUSION

This paper proposes an enrichment of existing AODV and compares its performance on various metrics. The enriched AODV comes forward by updating new path and it resolves link break due to mobility. The metrics Packet Delivery Ratio, Average End-to-End Delay supports to take a decision that proposed AODV is better than conventional AODV by increased PDR, throughput and decreased Average end to end delay. And finally, concluded that the enriched AODV protocol is an ideal choice for better communication with less **end to end delay** and good **packet delivery ratio, throughput.**

ACKNOWLEGMENT

The authors are thankful for the encouragement and support received throughout this research work to the Management of Vivekanandha Educational Institutions, Tiruchengode.

REFERENCES

[1] Charles Perkins and Elizabeth Royer, "Ad Hoc On-Demand Distance Vector Routing," Proc. of the 2nd IEEE Workshop on Mobile Computing Systems and Applications, pages 90–100, 1999.

[2] Yu-Chee Tseng, Wen-Hua Liao, Shih-Lin Wu, "Mobile Ad Hoc Networks and Routing Protocols", Handbook of Wireless Networks and Mobile Computing, Edited by Ivan Stojmenovic´ Copyright © 2002 John Wiley & Sons, Inc. ISBNs: 0-471-41902-8 (Paper); 0-471- 22456-1 (Electronic)

[3] Asis Nasipuri , Robert Castañeda, Samir R. Das," Performance of Multipath Routing for On- Demand Protocols in Mobile Ad Hoc Networks", Mobile Networks and Applications 6, 339–349, 2001 © 2001 Kluwer Academic Publishers. Manufactured in The Netherlands.

[4] Srdjan Krco and Marina Dupcinov, "Improved Neighbor Detection Algorithm for AODV Routing Protocol", IEEE Communications Letters, vol. 7, No. 12, december 2003.

[5] Meenu Chawla , Jyoti Singhai & Rana J L, "Local Repair with Handoff Approach for On Demand Routing Protocols in Ad Hoc Networks", International Journal of Computer Networks (IJCN) Volume: 2 Issue: 2, 2004.

[6] Sandhya Khurana Neelima Gupta Nagender Aneja, "Reliable Ad-hoc On-demand Distance Vector Routing Protocol", Proceedings of the Fifth International Conference on Networking (ICN 2006), The International Conference on Systems (ICONS 2006), and The First International Conference on Mobile Communications and Learning (MCL 2006).

[7] Akkaphop Otakahn, Mayuree Lertwatechakul,"An Improvement of Ad Hoc Route Maintenance", Department of Information Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, E-mail:s706 11 02gkmitl.ac.th, klmayuree@kmitl.ac.th.

[8] Hua Qu, Peng Zhang, Ji-Hong Zhao, "A New Local Repair Scheme Based on Link Breaks for Mobile Ad Hoc Networks", 2009 Seventh Annual Communications Networks and Services Research Conference

[9] Arafatur Rahman Md. , Farhat Anwar, Saiful Azad Md. , "Integrated Metric-Ad Hoc On-Demand Distance Vector:A Routing Protocol over Wireless Mesh Networks" Journal of Computer Science 5 (7): 511-518, 2009, ISSN 1549-3636

[10] A Arafatur Rahman Md. , Farhat Anwar, Saiful Azad Md. , "Integrated Metric-Ad Hoc On-Demand Distance Vector:A Routing Protocol over Wireless Mesh Networks" Journal of Computer Science 5 (7): 511-518, 2009, ISSN 1549-3636

[11] Hua Qu Peng Zhang Ji-hong Zhao, " A New Local Repair Scheme Based on Link Breaks for Mobile Ad Hoc Networks", Seventh Annual Communication Networks and Networks and Services Research Conference -2009.

[12] Jasmine Jeni P.R., Vimala Juliet A, Shaji B, SRM university Chennai, "MDSR (Modified Dynamic Source Routing) and AODV (Ad hoc On Demand Distance Vector) in MANET", European Journal of Scientific Research ISSN 1450-216X Vol.39 No.4 (2010), pp.606-612 ©EuroJournals Publishing, Inc. 2010 http://www.eurojournals.com/ejsr.htm

[13] "Network Simulator, ns-2," available online at http://www.isi.edu/nsnam/ns/.