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An Effective Path Protection Method to Attain the Route Stability in MANET

Preetha K G[1], Dr. A Unnikrishnan[2], Dr. K. Poulose Jacob[3]

Assistant Professor, Department of Information Technology, Rajagiri School of Engineering & Technology, Cochin, India [1]

Associate Director, NPOL, DRDO, Cochin, India[2]

Director, Department of Computer Science, Cochin University of Science & Technology, Cochin, India [3]

Abstract: With the increasing popularity of wireless network and its application, mobile ad-hoc networks (MANETS) emerged recently. MANET topology is highly dynamic in nature and nodes are highly mobile so that the rate of link failure is more in MANET. There is no central control over the nodes and the control is distributed among nodes and they can act as either router or source. MANTEs have been considered as isolated stand-alone network. Node can add or remove at any time and it is not infrastructure dependent. So at any time at any where the network can setup and a trouble free communication is possible. Due to more chances of link failures, collisions and transmission errors in MANET, the maintenance of network became costly. As per the study more frequent link failures became an important aspect of diminishing the performance of the network and also it is not predictable. The main objective of this paper is to study the route instability in AODV protocol and suggest a solution for improvement. This paper proposes a new approach to reduce the route failure by storing the alternate route in the intermediate nodes. In this algorithm intermediate nodes are also involved in the route discovery process. This reduces the route establishment overhead as well as the time to find the reroute when a link failure occurs.

Keywords: MANET, AODV, Route stability, Node Energy, Link failure

I. INTRODUCTION

Mobile ad hoc network (MANET) has an important role in the field of wireless communication. Quick setup and infrastructure less behaviour are the interesting features of MANET. MANET will not affect by any of the disasters like earthquake, theft etc due to its ad hoc and infrastructure independent nature. Dynamic nature of its topology, frequent link failures and limited power poses various challenges in MANET. Researches towards the improvement on those challenges have been going on quite well recently. Several ideas came out for solving those problems particularly the link breakage problem. Failure of link is very frequent in MANET because at any time the node can enter and leave the network. So the routing mechanism has to be capable of constructing and maintaining routes in a timely manner.

Routing mechanism in MANET is different from the wired network because of the unlimited mobility and frequent link failures. So the conventional algorithms used in wired networks are not suitable for wireless network. There are numerous algorithms developed for MANET routing. Broadly the routing algorithms are classified into two categories: proactive (table driven) and reactive (on demand) [2]. In the proactive approach, the idea of creating the routing table is same as in the wired network. Each node is created the routing table as soon as the network is established. This is a kind of off line routing table construction. After creating the routing table, each node sends the table to its neighbours. Each node updates its routing table according to the information it receives from neighbour. Periodically the routing table is updated in the table driven protocols. The requirement to propagate huge amount of routing table data tremendously increases the network overhead and wasting the node energy, though several energy efficient proactive protocols came out over the years [5]. On the other hand, in the reactive protocol data exchange is always minimum because of its on demand property. Here protocol finds its route only when it is needed.

A large number of reactive and proactive protocols have been developed over the last decade. DSDV, AODV, DSR, TORA [2] are generally used protocols in MANET. Hybrid protocols are also developed by taking the advantage of both

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proactive and reactive protocols. Performance analysis shows that reactive protocol outer perform proactive protocol in terms of throughput, packet delivery ratio, routing overhead [8, 9] etc. Accordingly, the research has mainly concentrated on reactive protocols. Ad-hoc On-demand Distance Vector (AODV) protocol [3] is the most effective and efficient one in this category. Due to its on demand nature, the network overhead is significantly reduced, with minimum number of data exchange. Even though the propagation of unwanted routing information in AODV is minimum, the route discovery processes is a major challenge in this algorithm. Whenever the network needs to send some data route discovery process is initiated to find the route. Frequency of leaving and joining the nodes in the network, typical of MANET, is very high so that the reroute discovery always results in waste of the time and increases the network overhead. Several improvements on AODV have been proposed by researchers timely. [4]. The present paper proposes a new approach to reduce the time and resources used for route discovery when route failure occurs. The paper also analyses the significance of network overheads, during the route discovery process and then tries to propose an algorithm to reduce the overhead.

The rest of this paper is organized as follows. Section 2 elaborates the issues and challenges during route discovery process in AODV. Section 3 describes the necessity of path protection in AODV. A new path protection algorithm for maintaining the route stability is discussed in section 4 and conclusions are given in section 5.

II. ROUTE ESTABLISHMENT IN AODV- ISSUES & CHALLENGES

In the proactive protocol, the network overhead is high because of the flooding of routing table information in the network for maintaining the up-to date routing information. Reactive protocol eliminates this problem by preserving its on demand property. This on demand characteristics reduces the overhead by discovering the route only when it needs to send the data. In this approach, the routing table does not have to maintain the up to date information; so the time taken to find the route is higher, compared to table driven protocols. In the wireless network, radio channels are used for communication and the range of this is very limited so the close devices can only communicate each other. Route instability imposes a major problem in every MANET protocols. While using the on demand protocols, the route failure creates the extra overhead in the network due to the flooding of route request packets. The reroute discovery starting from the beginning also increases the time to establish the route. An attempt has been made in this paper to study the characteristics of AODV and analyse the overhead issues during the reroute establishment phase.

AODV is the extension of DSDV protocol. The basic principle is same and it also maintains the on demand property. AODV route establishment phase is divided into two viz. route discovery and route maintenance [1]. If any failure occurs in the route then reroute discovery is initiated from the beginning. AODV uses the sequence number to distinguish the route request packet from the old one. The route formation starts form the source node by creating the route request message RREQ. This control message floods in the network. Sequence number is also included in each RREQ message in order to avoid the duplicates. Upon receiving the control packet RREQ, each node responds by sending destination information to the source if it knows, otherwise floods the message to its neighbours. The source node expects the response from any of the node in the network within a certain interval of time. If it does not receive any message then it assumes that there is no path existing through the node, for the destination it intends. The source node again initiates the route discovery process. If RREQ stops at the destination, then the destination node can create a route reply control packet RREP and send to the source node. When a node receives a RREQ packet it records the sender information in its routing table so as to establish the reverse path. This way any node can easily send RREP packet to the source node by establishing the reverse path. After receiving the RREP message the source can start sending the data to the required destination on the established forward path.

The nodes in the MANET can enter and leave the network at any time. Frequent link failure is a major challenge and this always degrades the performance of the network. Link failure can be identified by means of HELLO packet. Each node reveals its existence by sending the HELLO packet to its neighbours periodically. On the absence of these packets, a node can discover the link breakage easily. Once the link failure is identified, then this information is propagated to the network immediately. In AODV if any link failure is found, then the route discovery process is initiated by the source node. In this case, the same process of route establishment is repeated form the beginning. It is this reroute discovery that always creates the extra overhead in the network. All the nodes in the wireless network rely on battery power with limited capacity. Each reroute discovery process puts an additional toll on the battery power of the node, thereby reducing the availability of the node, even though improvements on energy management been well addressed by researchers [10, 15].

III. SIGNIFICANCE OF THE PROPOSED ALGORITHM

In the proactive routing protocol due to the frequent exchange of routing information the routing overhead is extremely high whereas in AODV due to minimum

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exchange of routing information the overhead is reduced. Data dissemination starts with initiating the route establishment process, having two phases viz. route discovery and route maintenance. Flooding is the most adaptable method for route discovery, where the source node sends the RREQ control packet to its neighbours. Neighbour nodes starts flood the control message to all of its neighbours and so on. Sequence number is added to each request for distinguishing the old one. Some of the nodes, though sincerely floods the message, often do not even get the destination. Because of these unproductive and unnecessary flooding, the network overhead is increased and, node energy, battery power, bandwidth are wasted. When the network grows larger the problem became unmanageable.

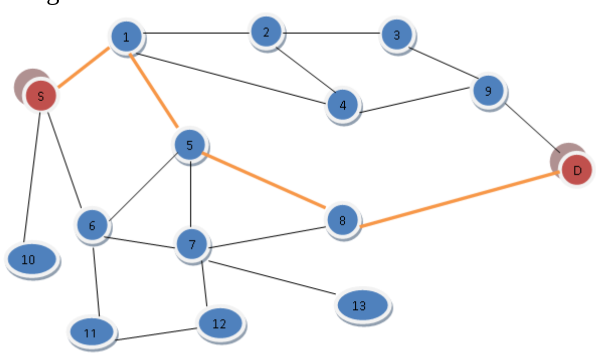

Fig 1: Network shows the process of determining path from S to D. All nodes flood the message and add to the overhead

Route discovery in wireless network using flooding is illustrated in the Fig.1. Here S denotes the source node and D the destination node. If S wants to send data to D, then first step is to initiate the route discovery. S floods the RREQ to its neighboring nodes 1, 6 and 10. Then each node in {1, 6, 10} will forward this RREQ to its neighbors and finally reach the destination node D. D reply back with RREP control message to S. In this network, though there are many paths existing between S and D, the source node S selects the most favored path and sends data to D, through the path discovered. Selection of favored path depends on different criteria, like time to get the RREQ message and number of nodes in the path. Some of the nodes like {10, 13} do not find any path to the destination; but these are also involved in the route discovery process and flood the RREQ message unproductively. This leads to channel contention, collision and congestions in the network.

Any node moving away from the network causes link failure in the network and the neighboring nodes can easily identify the failure by the absence of HELLO messages. The failure can be reported to its neighboring nodes immediately by sending the route error control RERR message. This message finally reaches the source node and then the source concludes that there is a loss of path between the source and destination. The source again starts the route discovery process, even if another path exists in the network. This lack of awareness leads to extra overhead and wasting the valuable resources in the network. Due to the frequent link failures, there is no guarantee of stable route in the network also at nay time. An efficient algorithm minimizes the overhead due to excessive flooding would be very welcome to the MANET users. However, very few proposals have been identified in this area [6,7].

The main intension of the proposed algorithm is to maintain the stable route during the dissemination of data in MANET. This algorithm guarantees that the path is protected with the use of least amount of network resources and also with less computational complexity and communication overhead. The algorithm also reduces the time delay for determining the route in the AODV algorithm.

IV. THE PATH PROTECTION ALGORITHM FOR STABLE AODV

Flooding is the major cause of wasting the resources and time. In this algorithm includes the intermediate nodes in the route discovery process so as to reduce the route discovery overhead when the failures are discovered. Stable routing is the big issue identified in the MANET scenario. During the data transmission at any time the link failure can be detected due to the unlimited mobility of the nodes in MANET. The Figure 2 gives an idea of link failure during data transmission. In the figure, S wants to send a message to D. It initiates the route discovery process by creating the RREQ control packet and floods this over the network. There are many paths available to the destination and node which knows the destination can respond immediately to the source. Each intermediate node creates a path table in addition to the routing table store all the available path to the destination and also stores the distance to the destination. Node S selects one of the best path and start sending data to the destination. In this case the path is < S 1 5 8 D>. Assume that in the midst of data dissemination, node 5 moves away from the network. Node 1 can detect this by the absence of HELLO message from node 5 and normally report this to its neighbors, including S. But in the method proposed here, the intermediate nodes also take part in the route discovery, since they also retain all available paths to the destination D in its path table. So if any failure is detected, before reporting this to the neighbors, node 1 checks the path table for another available path to D. If any path is found then node 1 can inform the source node via reverse path, which is already known. The source node then checks the security issues and allows sending the data to the

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path selected by the intermediate node. In the Fig. 2, node 1 has 4 paths to destination. These are < 1 5 8 D >, < 1 2 3 9 D >, < 1 4 9 D >, < 1 2 4 9 D >. The node 1 select < 1 4 9 D > as the best path and after getting permission from the source, it send data through this path.

The path table is updated accordingly. This algorithm does not wait for determining the route by the source node. The problem of time delay and number of dropped packets are reduced. The Fig.3 depicts the model for stable routing.

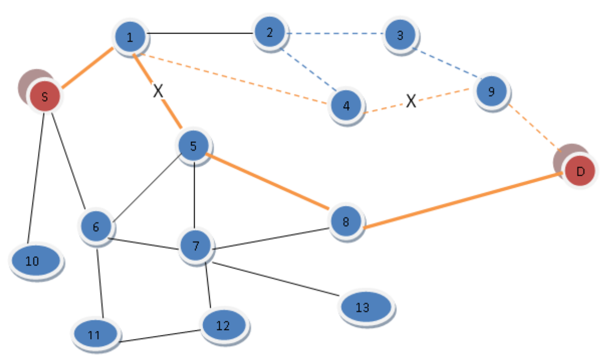

Fig 2: The typical network shows the link breakage

In the Fig. 3, node N detects any link failure then it first checks its path table for next available path and removes the table entry for failed node. Then it sends the new path to source node and send data to the destination through the path which is selected by N. This ensures the stable route during the data transmission, without dropping the packet in the midst of transmission.

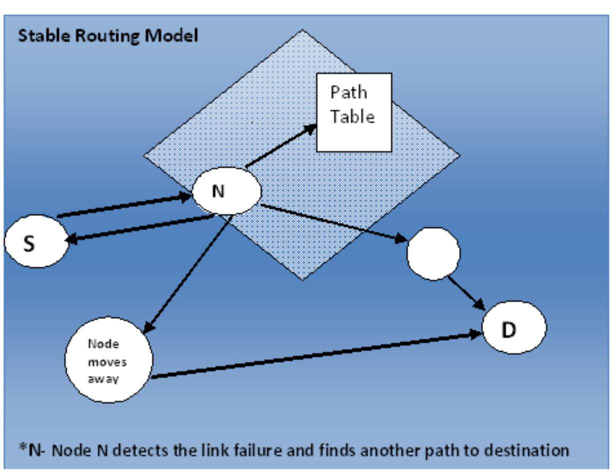

Fig 3: Model for Stable Routing

The algorithm for path stability is discussed in Sec. 3.1. The data structures used for implementing the algorithm and observations after implementation are discussed in Sec 3.2 and 3.3 respectively.

A. Path Protection Algorithm for Stable Routing

```
node X ;
If (any link failure detected)
{
   Checks the path table;        // X is the affected
node
   if ( any other available path)
      {
         Select the best path;
         //here the number of nodes along the path
as the criteria
         Send the alternate path details to source
through the reverse path
         along with the details of link failure;
         Waits for the permission from the source;
         If ( source send "OK" packet)
            Node X starts sending data to the
destination through the
            alternate path it selected;
      }
    else
         {
          Failure is reported;
          Route discovery is initiated by the source
node
         }
 }
```

B. Data Structures

Each node associated with a routing table, which contains the routing path to destination node it has already found. The nodes in MANET are dynamic in nature so that the node which initiates the connection is also associated with a timer. After a certain intervals of time, the timer expires and the route discovery process starts to find the best path in the network. In addition to the traditional data structures, the new approach also has another table called path table. Each node maintains the path table and stores the details of the available path to destination. If any failures detected then the node can easily finds another route to destination from the path table. This ensures the uninterrupted data transfer in the network. The path table for the example of Fig.2 is shown in the following Tables 1, 2, and 3 below.

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Destination	Next Node	Distance
D	5	3
D	2	4
D	4	3

Table1. Path table for node 1

Destination	Next Node	Distance
D	9	2
D	2	4
D	1	5

Table2. Path table for node 4

Destination	Next Node	Distance
D	1	4
D	3	3
D	4	3

Table3. Path table for node 2

C. Observations

It has been observed that AODV with path protection algorithm (Stable AODV) performs better than the normal AODV in terms of time and number resources used when the route failures detected. This would clearly ensure the performance increase in terms of energy efficiency and network cost. In the AODV without the path protection algorithm any failure is reported the source node to initiate the route discovery from the beginning. This will surely degrade the throughput because some of the packets are dropped in the midst of the transmission.

The dropped packets should retransmit again. The packet can be transmitted only after the new route is established, which will lead to the delay in packet delivery. In the proposed stable AODV, the number of retransmissions is reduced as much as possible. In this case, whenever the route failure occurs, the intermediate node stores the packet which has arrived and then finds the available path to destination. The new approach will also reduce the network overhead and use the maximum available bandwidth. Fig. 4 and 5 gives the comparison of normal AODV with stable AODV in terms of time to set the route and number of resources used after any route failure.

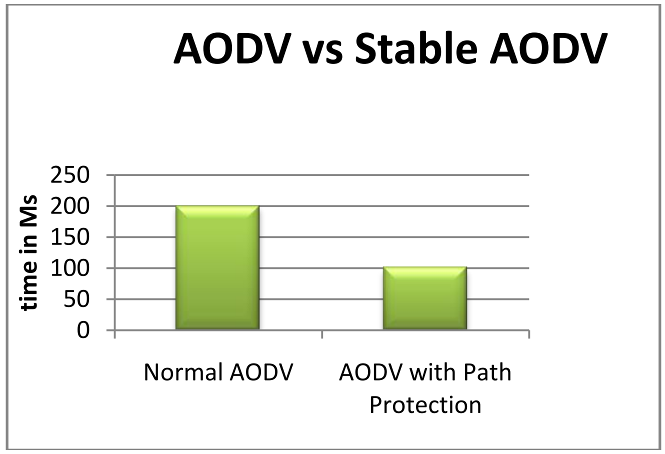

Fig 4: The stable AODV perform faster than the AODV when route failure occurs (Number of nodes taken is 50)

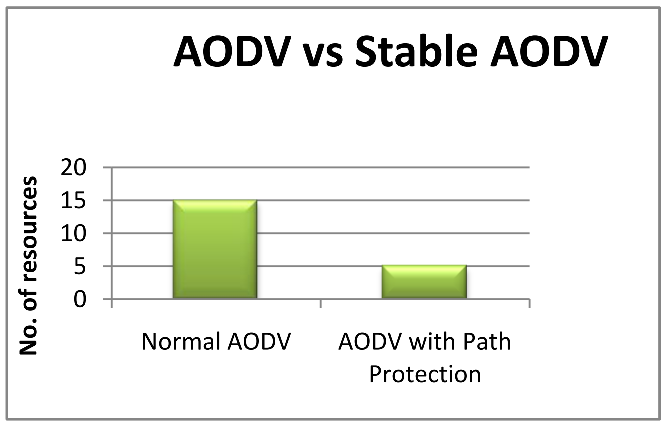

Fig 5: The stable AODV uses lesser number of resources than Normal AODV during the route discovery when route failure occurs

V. CONCLUSION

Even though flooding is a simple mechanism of route establishment in an on demand routing algorithm like AODV, it always induces more overhead in the network and wasting the battery power for forwarding unproductive information. This paper explains the route failure in the network and the limitations of the mechanisms adopted to overcome this problem in the AODV. When there is a failure in route discovery or route breaks, a new route discovery cycle is repeated. The number of packet drop is very high during link error. All the dropped packets should be retransmitted. The proposed approach has been designed to minimize the network overhead, node energy and time delay to establish the route after the failure is detected. The

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proposed method helps to suppress the flooding of unproductive control messages. This also ensures the performance enhancement in terms of throughput by reducing the number of dropped packets. The approach outlined above does not have any additional computational complexity and this uses the same principle of AODV protocol, which is universally accepted. The proposed algorithm works well for quick setup, even if the number of nodes increases. The experimental results presented in the above section illustrate the effectiveness of the new approach.

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BIOGRAPHY

Ms. Preetha K G has completed her B Tech and M Tech Degree in Computer Science from Calicut University and Dr. MGR University respectively. She is associated with Rajagir School of Engineering & Technology as an Assistant Professor in the department of Information Technology. She has around twelve years of academic experience. Currently she is a research scholar in Cochin University of science and Technology. Her Research interests includes Mobile Computing, Wireless Networks, Ad-hoc Networks Etc.

Dr. A Unnikrishnan- Graduated from REC (Calicut), India in Electrical Engineering(1975), completed his M.Tech from IIT, Kanpur in Electrical Engineering (1978) and Ph.D from IISc, Bangalore in "Image Data Structures" (1988). Presently, he is the Associate Director in Naval Physical and Oceanographical Laboratory, Kochi which is a premiere laboratory of defence research and development organisation. His field of interests includes Sonar Signal Processing, Image Processing and Soft Computing. He has authored about fifty National and International Journal and Conference Papers. He is a Fellow of IETE & IEI, India.

Dr. K.Poulose Jacob, Professor of Computer Science at Cochin University of Science and Technology since 1994, is currently Director of the School of Computer Science Studies. . He was Chairman of two Boards of Studies earlier. He has been the Dean of the Faculty of Engineering and is presently Chairman, Board of Studies in Computer Science. He is a member of Academic Council and has been in the University Senate for 10 years. He has presented research papers in several International Conferences in Europe, USA, UK, Australia and other countries. He has delivered invited talks at several national and international events.He has served as a Member of the Standing Committee of the UGC on Computer Education & Development. He is the Zonal Coordinator of the DOEACC Society under the Ministry of Information Technology, Government of India. He serves as a member of the AICTE expert panel for accreditation and approval. Dr. K. Poulose Jacob is a Professional member of the ACM (Association for Computing Machinery) and a Life Member of the Computer Society of India.