Improved AODV Protocol For Solving Link Failure In MANET

Asha Ambhaikar, H.R. Sharma, V. K. Mohabey

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 analysing and comparing different ad hoc routing protocols based on the metric throughput, packet delivery ratio, end to end delay which may give 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 neighbouring 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 behaviour and performance improved in AODV routing protocol based on the metrics.

Keywords - MANET, AODV, RDP, Link Failure, PDR, E2E, Throughput, NS2

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1 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. 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 II discusses on the categories of routing protocols including reactive and proactive routing protocol and a detailed description of AODV (Ad hoc On-demand Distance Vector Protocol) is introduced in Section I 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 VI,

Section VII concludes the improved performance of AODV routing protocol.

2 CLASSIFICATION OF PROTOCOLS

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.
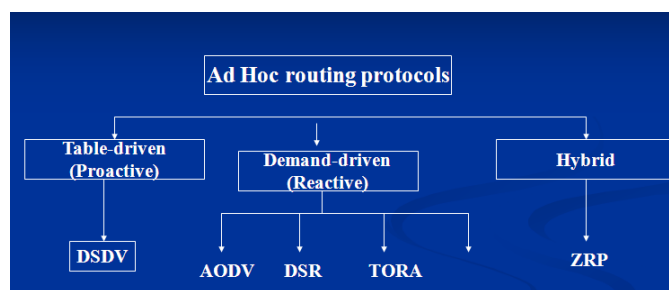

Fig. 1 Classification of Protocols

3 WORKING 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 originality 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 in recent times. A set of forerunner nodes is maintained for each   routing table entry, indicating the set of neighbouring 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 neighbour 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.
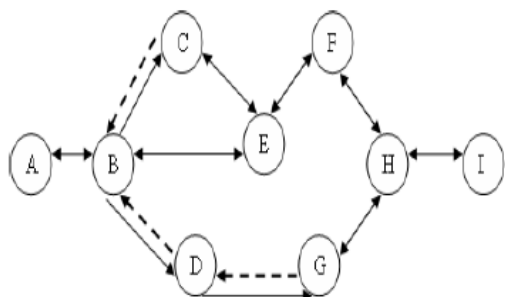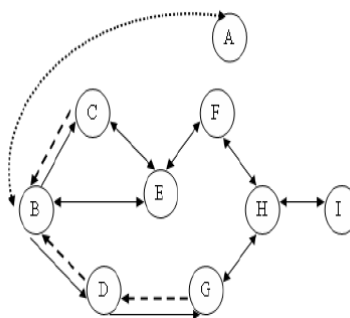

Fig. 2 Initial Setup

Fig. 3 Topology Change

4   PROPOSED 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 neighbour 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 neighbour 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.

4.1 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 recover 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.

4.2 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.

5   PROPOSED IMPROVED AODV AND LINK BREAK

The modification of the protocol is based on the improvement of the mechanisms that generate the loss 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 neighbouring nodes, even causes the route to be invalid. Some solutions have been proposed to make routing protocols more robust against link breakages.

Proposed Improvement in Existing AODV Protocol:

Condition 1:
"If a source node moves (Fig 2 & Fig 3)"
There may be a possibility of link break due to topological change.

Solution for Condition 1:
If the node is source node, then reinitiate the New Route Discovery Protocol (NRDP) to find a new route to the destination. One of the best Route Discovery protocol is AODV.

Condition 2:
"If an intermediate node moves (Fig 4, Fig 5)"
- There may be a possibility of link break due to mobility, link weakening.

Solution for Condition 2:
If the node is intermediate node, then attempt to repair the node locally, (Local Repair Procedure) by repairing

node (RNode). If not repaired by RNode, it tries to rediscover another route.
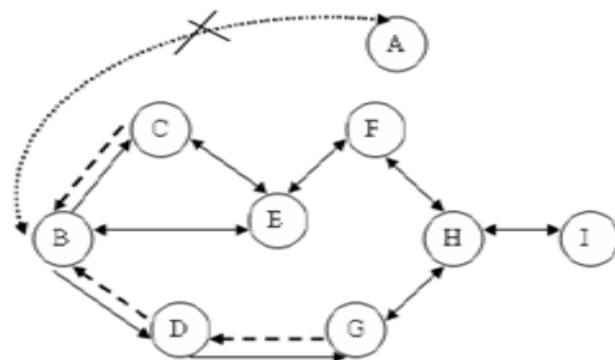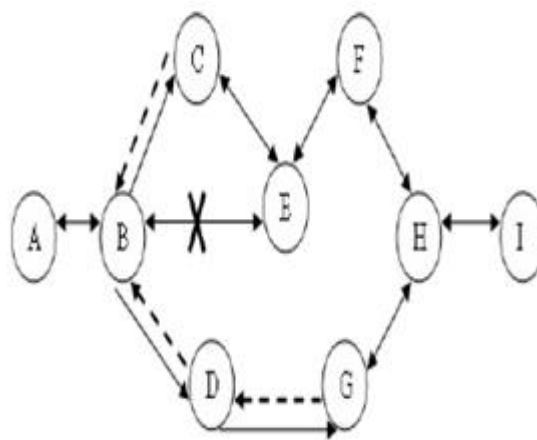

Fig 4 Link break due to source node mobility

Fig. 5 Link break in intermediate node

This proposed method for local repair procedure upgrades the performance of AODV protocol.

6   SIMULATION RESULTS

Simulations are performed using Network Simulator with Linux Fig 6 & Fig 7. This simulation focuses on the mobility of the source node and intermediate node which may result link failure. It is able to reinitiate the Route Discovery Protocol (RDP) if a source node moves. It will find a new route to the destination by updating the path. A Local Repair Procedure is used to update the path in case intermediate node link breaks. Thus, resolving link failure in AODV.

Simulation shows the behaviour and performance improvement in AODV based on the evaluation metrics. 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).

The following four important performance metrics are considered for evaluation:

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

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.

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.

TABLE 5
SIMULATION SETUP FOR IMPROVED AODV

Parameters	Value
Protocols	AODV, Improved AODV
Simulation time	100 s
No. of Nodes	10
Pause time	0, 20, 40, 100
Environment Size	500 m x 500 m
Traffic Type	Constant Bit Rate
CBR Sources	5, 10, 15, 20
Maximum Speed	5 m/s
Packet Size	512 bytes
Packets Rate	4 packets / s

7 RESULTS & DISCUSSION

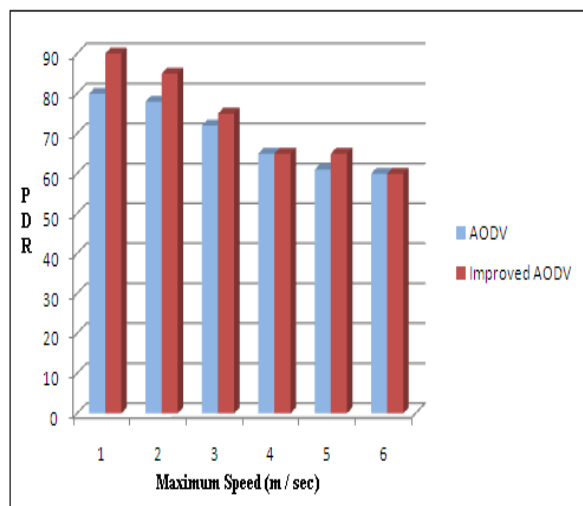Performance comparison of Conventional AODV vs Improved AODV:
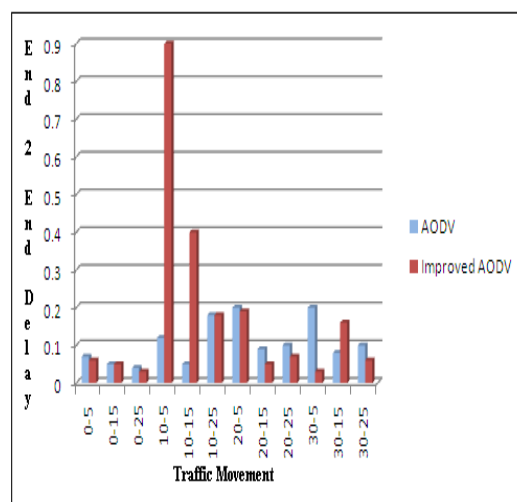

Fig 6 Maximum Speed Vs Packet Delivery Ratio

Fig 7 Traffic movement Vs E2E Delay

Simulation results show that improved AODV Protocol provides better performance than the old AODV based on the Packet Delivery Ratio and E2E delay. We have used 5 different simulation patterns and 4 different traffic patterns. These patterns created 20 different scenarios, where each scenario combines a movement pattern and a traffic pattern.

8 CONCLUSION

This research work proposes an improvement of existing AODV and compares its performance on various parameters. The improved AODV functions differently by updating new path and resolving link break due to various reasons. Our simulation results 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 improved AODV protocol is a better choice for reliable communication.

ABOUT AUTHORS

Prof. Asha Ambhaikar received B.E from Nagpur University, Nagpur, India, in Electronics Engineering in the year 2000 and later did her M.Tech in Information Technology Allahabad Deemed University, India. Recently she has submitted her PhD in C.S.V.T.U, Bhilai. Currently she is working as an Associate Professor in Rungta College of Engineering & Technology (Department of Computer Science and Engineering), Bhilai, India. She has published more than 20 research papers in reputed national and international journals & conferences. Her area of interest includes, Computer Networking, Data warehousing and mining, and Cloud Computing, Image processing, Distributed system and Information systems and Security.

Dr. H.R. Sharma received his M.Tech degree from Delhi University in Computer Science and has completed his Ph.D from IIT, Delhi. He has also published more than 300 research papers at National and International level. He has given more than 20 seminars at IIT's, NIT's and VJTI Bombay etc. He has more than 40 years of teaching experience at Graduate and Post Graduate level. Guided about 300 projects of UG Students of Comp. Sc. Specially in Image Processing, Pattern making, Artificial Intelligence & Expert system etc.Supervising Ph.D. Scholars at TITS Bhiwani (Haryana), RSU Raipur, CSVTU BHILAI and C.V. Raman University, Bilaspur in computer Engineering Discipline. He is presently working as the Dean (R&D) & professor of Computer Science Department, Rungta College of Engineering and Technology, Raipur.

Dr. V. K. Mohabey presently works as a, Director R&D, BCET, CSVTU Bhilai. He has given his valuable contribution towards research by publishing more than 356 research papers published at National and International journals. His area of interest is Networking, Nanotechnology, cloud computing etc. He has supervised more than 10 research projects sponsored by UGC, DST, MAPCOST, etc. He has over 40 years of teaching experience at Graduate and Post Graduate level. He has guided so many PhD researchers from various reputed university of Chattisgarh as well as out of Chattisgarh too.

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