Efficient routing algorithm for Mobile Ad hoc Networks

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Abstract: **A mobile ad hoc network is a multi hop wireless network formed by a group of mobile nodes that have wireless capabilities. Connections in MANET (Mobile Ad hoc Networks) are established and revoked dynamically as the network is dynamic. The entities in the network can join and leave the network anytime. Transmission of data becomes challenging in such networks where the position of a node is not fixed nor is the link joining the two nodes permanent. Efficient routing algorithms are required for efficiently transmitting data in the network. Research in the area of designing an efficient algorithm is an upcoming area, the expected outcome of which is an efficient algorithm which can help in better performance. This work proposes improved AODV (Ad hoc On demand Distance Vector) routing algorithm named as AODV - BL which helps in quick rebuilding of the broken links from source to destination. Protocol maintains a backup list at the source node containing all the possible routes from source to destination. The model has been implemented and tested on NS2 (Network Simulator) and results are compared with standard AODV protocol. Results exhibit the better performance of the proposed algorithm.**

Keywords : **AODV, Link Break, Backup Lists.**

I.   Introduction

Ad hoc networks are multi hop networks because of limitation of radio propagation range and dynamic topology of the network. Routing in such dynamic networks is challenging. It has attracted interest of many researchers to work and develop efficient routing algorithm for such networks. There is no centralized monitoring in ad hoc networks. Nodes connect to each other without any CA (Central Authority) and node serves as a router for other nodes. As nodes act as routers they need to maintain a dynamic routing table which can cope up with the quickly changing network topology. Routing protocols for ad hoc networks are broadly categorized into Proactive (Table driven) and reactive (on demand) types. Proactive protocols maintain a table of all active routes and update it by exchanging the routing information between nodes periodically. Reactive protocols establishes route from source to destination only when required. Path overhead in reactive protocols is low in comparison with proactive protocols. In case of route break proactive protocols perform better than reactive protocols as in case of reactive protocols time is wasted in reestablishing a route. During this time period the transmitted packets are lost / buffered and

communication is stopped till the establishment of new route. This work proposes a modified AODV protocol called as AODV - BL which maintains a backup list to maintain the continuous data transmission in case of link breakages

The paper is organized in the following subsections. Section 2 gives a brief detail of the working of AODV routing protocol. Related work has been discussed in section 3. Section 4 describes the proposed methodology for the proposed protocol. Simulation environment used for this study has been detailed in section 5. Performance metrics used to evaluate the performance of the proposed protocol are evaluated and presented in section 6 with concluding remarks in section 7.

II.   AODV Protocol

The AODV [1] (Ad hoc On demand Distance Vector) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is capable of each unicast and multicast routing. it is an on demand algorithm, that means that it builds routes between nodes solely as desired by source nodes. These routes are maintained as long as they\'re needed by the sources. AODV uses sequence numbers that ensures how recent a current route is. it is loop-free, self-starting, and works well for large numbers of mobile nodes. AODV builds routes employing a route request route reply query cycle. once a source node wishes a route to a destination for which it doesn't have already got a route in its routing table, it broadcasts a RREQ (Route Request) packet that is received by all its neighbor nodes. Nodes receiving this RREQ packet update their routing table with the knowledge of the supply node and establish a backward path to the source node within the route tables. in addition to the source nodes' IP address, current sequence number, and broadcast ID, the RREQ also contains the foremost recent sequence number for the destination of which the source node is aware. A node receiving the RREQ could send a RREP (Route Reply) if it is either the destination or if it has a route to the destination with corresponding sequence number bigger than or up to that contained within the RREQ. If this is the case, it unicasts a RREP back to the source. Otherwise, RREQ packet is broadcasted. Nodes keep track of the source that send the RREQ packet, records it IP address and broadcast ID. If any node in the network receives a RREQ packet which it had already processed, it discards the RREQ packet. As the

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RREP is propagated back to the source node, other neighboring nodes set up forward path to the destination. Once the source node receives the RREP, it initiates data transmission in the forward direction to the destination. If the source later receives a RREP containing a bigger sequence number or contains identical sequence number with a smaller hop-count, it's going to update its routing information for that destination and begin using the better route. As long as the route remains active, it'll still be maintained. A route is taken into account active as long as there are data packets periodically traveling from the source to the destination on that path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate nodes' routing tables. If a link break happens whereas the route is active, the node upstream of the break propagates a RERR (Route Error) message to the source node to tell it of the currently inaccessible destination(s). when receiving the RERR, if the source node still wishes the route, it will reinitiate route discovery.

III.   **Related work**

Literature proposes many protocols that try to improve the performance of AODV routing protocol. Many of them use building of backup routes around the active route or build multiple paths from source to destination. ABR (Associativity Based Routing) [2] and AOMDV (Ad-hoc On demand Multi-path Distance Vector Routing) [3] which works on periodic propagation of control packets to maintain the topology but it increases the network traffic. [4] proposes a scheme where a node on the active route senses and detects a danger of link break to an upstream node and reestablishes a new route before a route break. This strategy uses the four elements for identifying the danger of route break like received radio, the overlapping routes, battery and the density of the network. [5] route is built on demand and maintained locally by updating the route information. This works on the idea of building multiple routes around active route from source to destination. AODV- BR [6] uses a mesh structure and maintains multiple alternate forward paths from source to destination and alternate paths are used only when the primary path fails. It does not generate any additional control messages so the traffic on the network is controlled. Maintaining multiple paths from source to destination are beneficial as route break in wireless networks are very frequent because of node mobility, fading of a signal, interference, packet collisions etc. [7] has developed a new route update procedure which evaluates a route on the basis of delay, hop count and disjointness.

Multipath routing [8] caches multiple routes from source to destination in a single route discovery process. When a link breaks it uses an alternative path from this cached route to forward the packets. Better utilization of network resources is improved using this strategy bu number of packets drop and delay increases because the cached route at time T may become stale at sometime T+1.in AODV [1] when a link breaks the forwarding node decides either to

send the a RERR (Route error) message back to the source or to use a local repair method to repair the route. In case of RERR the source performs the route discovery to the destination again. In case of local repair there is a danger of using non optimal route even in the presence of some other fresh optimal route to the destination.

IV.   **Proposed Methodology**

Objective of the proposed work is to maintain transmission continuity among the nodes in a network. Whenever a RERR is generated in case of a link break or next hop is unreachable / unavailable.AODV protocol maintains a backup list apart from a routing table in this approach. Backup list records the details of all active possible routes from source to destination during route discovery process.

When a node using AODV-BL routing protocol wants to transmit data to some destination it broadcast a RREQ (Route Request) packet. Each RREQ has a unique identifier so that a check on duplicate RREQ can be kept and they can be dropped. Every intermediate node, if has a path to destination records the details of previous hop in its routing table and sends a RREP (Route Reply) packet to the source node. Intermediate node further broadcasts the RREQ packet. Source node records all the paths in a backup list maintained by the source node. The RREQ packet when reaches the destination, the destination node selects one backward path depending on the freshness of the route which is decided by the sequence number of the RREQ packet. Destination sends a RREP packet through this selected path.
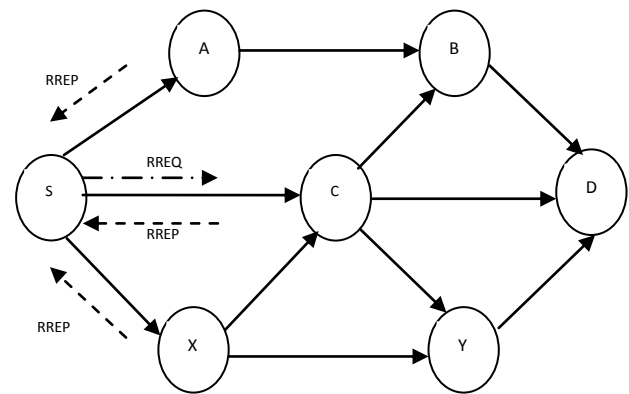

Figure 1.   RREQ send from Sourec S

where

----·----·----▶   RREQ (Route Request)
------------▶   RREP   (Route Reply)

When routes from source to destination experience a link break then a RERR message is send to the source . the source node then chooses an alternative path from the backup list and forwards the data through this path and at the same time it starts a new route discovery process by broadcasting   the RREQ packet. While the new route discovery records the fresh route from source to destination,

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the packet which could have been dropped because of link break reaches the destination following an alternative path. This strategy helps in saving the time of waiting to transmit a packet after a new route discovery is done. Fig. 1 shows when a RREQ packet is broadcasted by source S it receives a RREP packet from all the neighbors having route to the destination. Source node records this in the backup list as shown in Table I.

TABLE I.   BACKUP LIST AT SOURCE S

Source	Destination	Neighbor node	Possible paths from source to destination
S	D	A	S-A-B-D
S	D	C	S-C-B-D
S	D	C	S-C-D
S	D	X	S-X-Y-D
S	D	C	S-C-Y-D
S	D	X	S-X-C-D
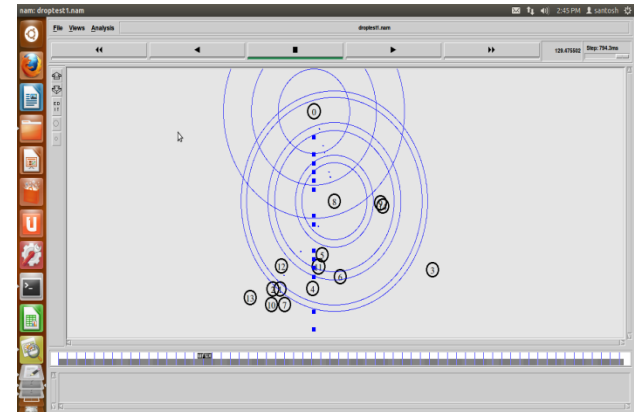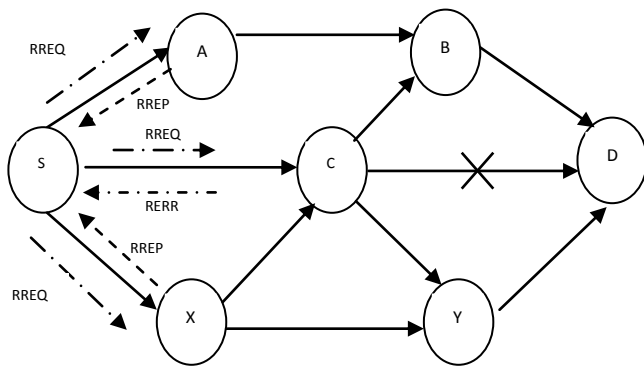
Figure 2.   RERR propagation in case of link break

where

— · — · — ▶   RREQ (Route Request)
- - - - - - ▶   RREP   (Route Reply)
— · · — · · — ▶   RERR   (Route Error)

Fig. 2 shows that when there is link break between node C and D, intermediate node C sends a RERR (Route error) message to the source S. Source then chooses an alternative path from the backup list shown in Table. I to forward the data and at the same time generates a new route request to get the current optimal paths from source S to destination D

V.   **Simulation Environment**

This section evaluates the performance of AODV – BL against classical AODV. The simulation has been carried out using NS-2 [9]. Work has been tested by varying the number of nodes and their mobility. Default values for AODV protocol used by NS 2 have been used for the study. Network is formed and tested as per the simulation parameters given in Table.

Fig. 3 shows the MANET scenario used for this study where nodes are uniformly distributed over an area of 1000 m * 1000 m, moving with random way point movement model. Nodes move with a certain speed from one point to another, stop there during pause time and then moves to a new direction.

Figure 3.   Manet Scenario

Simulation Parameters used to test this protocol are as given in Table II.

TABLE II.   SIMULATION PARAMETERS

Parameter	Value
Number of nodes	10,15,20, 25
Simulation time	500s
Environment Size	1000 x 1000
Traffic Type	CBR (Constant Bit Rate)
Simulator	NS-2.34
Mobility Model	Random waypoint
Antenna type	Omni directional
Routing Protocol	AODV , AODV - BL
Maximum speed	8m/s,10m/s,15m/s
Pause time	60s
MAC Layer	802.11
Transmission range	250m
Antenna height	1.5m

Results collected after running the simulation exhibit the enhanced performance of the proposed protocol over the classical one existing.

VI.   **Performance Metrics**

There are number of metrics which are helpful for deciding the efficiency of a protocol. In this work the parameters   used to evaluate the efficiency of a protocol are the packet delivery ratio, packet statistics in the network and the throughput of the network. The protocols AODV and AODV - BL are checked against these parameters for their performance. Packet delivery ratio of the network is improved as the mobility with respect to the number of nodes changes.

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Increase in the PDR (Packet delivery ratio is because of the less number of packet drops when AODV - BL is used. Fig. 4 justify the better performance of AODV - BL routing protocol over AODV protocol in terms of less number of packets drop.
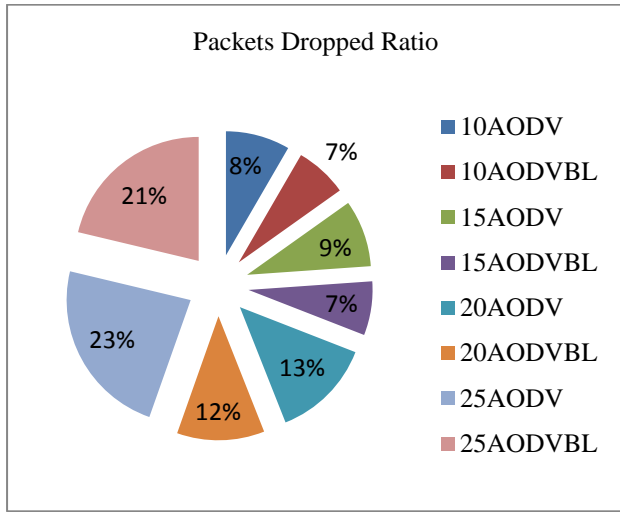
Figure 4.   Packet Drop ratio

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Packet Delivery Ratio (PDR): It is the percentage of total packet received in the network to the total packet send and can be calculated as given in equation below.

$$\%PDR = \left(\text{Total number of} \frac{\text{packets received}}{\text{packets send}} \right) * 100$$
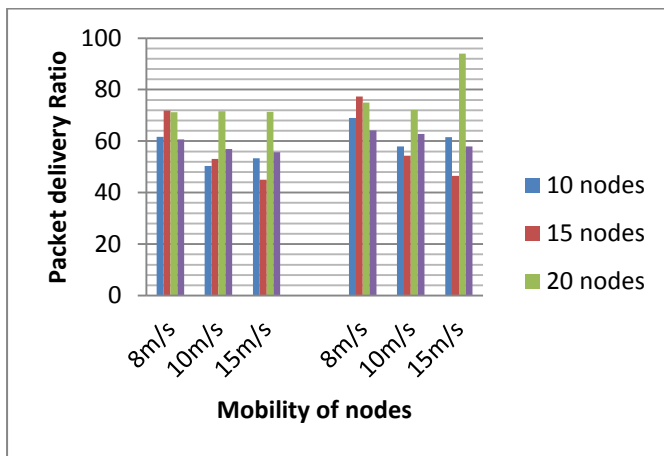
Figure 5.   Packet Delivery Ratio v/s Mobility of nodes

Fig. 5 shows the packet delivery ratio improvement of the network and clearly exhibits that the performance of AODV - BL is better than classical AODV.

Throughput: Throughput represents the successful deliveries of packets in given time. This has great influence in the selection of a routing protocol in any communication network. Throughput can be expressed in as bytes or bits per sec and calculated as per equation given below.

$$\text{Throughput} = \frac{\text{Total number of packets delivered*Size of the packet in network*8}}{\text{Total Simulation time}}$$

From Fig. 6 it is clearly seen that the throughput of the network improves when the strategy of backup list maintained at every node is used.
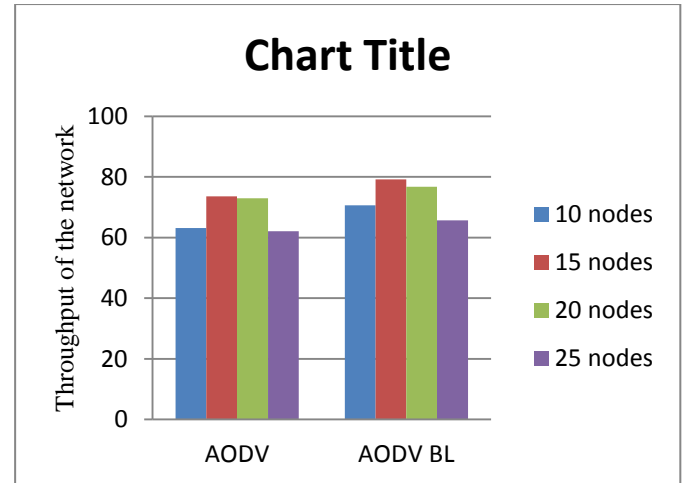
Figure 6.   Throughput of the network

VII.   Conclusion

In this work a backup list based routing protocol AODV - BL has been proposed which can help to maintain the connectivity of broken links and transfers uninterrupted data throughout the network. This helps to maintain a better throughput of the network. From the results we can conclude that the proposed system enhances the total performance of the network and helps in making a better network when AODV - BL routing protocol is used.

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