Enhanced Ad Hoc on Demand Distance Vector Local Repair Trial for MANET

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Abstract. Ad hoc On-demand Distance Vector (AODV) is a routing schema for delivering messages in a connected Mobile Ad hoc Network (MANET). Connectivity between any sources to destination pair in the network exists when they are in radio range of each other. Local Repair is an important issue in routing protocol which is needed for minimizing flooding and performance improvement. Routes can be locally repaired by the node that detects the link break along the end to end path. In this paper, the existing Local Repair Trial method in AODV is extended to achieve broadcasting and minimizing the flooding. The enhanced protocol first creates the group of mobile nodes then broadcasting can be done and if the link breaks then local repair technique can be applied. In the network the numbers of intermediate nodes are increased by using Diameter Perimeter Model. Enhanced AODV-Local Repair Trial (EAODVLRT) protocol is implemented on NS2 network simulator. Simulations are performed to analyze and compare the behavior of proposed protocol (EAODVLRT) for varying parameters such as size of network, node load etc. Proposed protocol has been compared with the existing AODV-LRT in terms of routing load, Data delivery ratio.

Keywords: AODVLRT, MANET, Local Repair ADHOC network and Perimeter routing.

1 Introduction

A wireless network is a rising technology that will allow users to access services and information electronically, irrespective of their geographic position. Wireless communication network is a collection of independent devices connected to each other. Some of the advantages of wireless network are it is easily deployable and flexible in nature as compared to wired networks. A mobile ad hoc network (MANET) (Fig. 1) each device (nodes) is dynamically self organized in network without using any pre-existing infrastructure.

Motivation for current work is that Ad hoc network allows all wireless devices within range of each other without involving any central access point and administration. Increase in number of nodes degrades the performance of large ad hoc

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network that makes the design of routing protocols more challenging. There are many simulation study has been done so far for the routing protocols. This paper has been organized as follows: In the following section we briefly review the two protocols AODVLRT (AODV with Local Repair Trials) [1] and AODV [2].

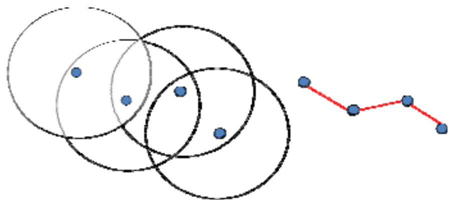

Fig. 1. Mobile Ad-Hoc Network

The main objective of this paper is to enhance AODVLRT (AODV Local Repair Trial) protocol by minimizing flooding using perimeter routing. In the previous implementation [1] throughput increases with the increase of routing overhead but, in this paper a novel method is proposed to reduce the two parameters i.e. controlling overhead and increasing throughput are the major areas of focus. The remainder of this paper is organized as follows. In section 2, a short introduction to AODV, AODVLR (AODV Local Repair), AODVLRT (AODV Local Repair Trial) is presented. In Section 3, we suggest an improvement of AODVLRT by implementing perimeter routing. Section 4 describes the simulation model adopted, and then a detailed simulation is performed to evaluate the performance of the Enhanced AODVLRT (EAODVLRT). Conclusions are presented in section 5.

2 AODV and Route Repair

Ad hoc on demand distance vector routing is an on demand approach of route finding. Routing can be done when source nodes sends the packet for transmission. AODV differs from the other on-demand routing protocols is in a way that it uses a destination sequence number to determine an up-to-date path to the destination but it doesn't broadcast update information in the network. But in this case the entire topology had being change in the network periodically [3].

Major advantage of AODV is that the connection setup delay is much less than other protocol [3]. While the drawback is that the inconsistent routes are also discovered. The periodic beaconing also leads to unnecessary bandwidth consumption.

2.1 Local Repair AODV

AODV is a popular on demand routing protocols for mobile adhoc network. The major drawback which the AODV suffer lots of link failure [4] with the failure of single node the whole route is rejected AODV can basically work in two repair techniques, i.e. source repair and local repair[5, 6]**.** In the AODV routing protocol is reactive protocol which means route discovery can be done on demand, if the particular node failure can occur then the whole routing can be done again. To avoid this problem local repair technique is being added by AODV and new protocol had being generated called as AODVLRT [1].

2.2 AODV Local Repair Trial (AODVLRT)

AODVLRT [1] enhancement leads to higher throughput and lower latency when compared to AODV. Major difference between AODVLR and AODVLRT is just one trial to find a repair to the route by broadcasting RREQ packet with TTL come from below equation which is taken from [1].

$$TTL = Max\,(0.5 \times N_H, TTL_{MNR}) + TTL_{LA}$$

Where,

TTL_{MNR}: the last known hop count from the upstream node of the failure to the destination.

TTL_{LA}: constant value

N_H: the number of hops from the upstream node of the failure to the source of the currently undeliverable packet.

3 Improvements to the Standard AODVLRT

Routing can be done from source node to the destination node by flooding the route request packet. It employs destination sequence numbers to identify the most recent path. The destination sequence number is created by the destination that is included along with any route information it sends to the requesting nodes. Destination sequence number gives the choice between two routes; a requesting node is required to select the one with the greatest sequence number. During the process of routing failure, of a node causes the whole route to be rejected. To overcome this, repairing technique can be used. The behavior of AODV in case of link failure as defined in [1, 4]. In EAODVLRT flooding can be minimized by combining the conception of perimeter routing [7].

3.1 System Model

We represent a wireless ad hoc network by a graph G= (V, E) where V is the set of vertices which represents mobile nodes and E subset of V^2 the set of edges between these vertices. An edge exists between two nodes if they are able to communicate to each other, that is two nodes u and v can communicate if they are in communicating radius of each other. If all nodes have the same range R, the set E is defined as:

$$E = \{(u, v) \in V^2 |\ u \neq v\ \&\ d(u, v) \leq R \ \text{R}$$

D (u,v) being the Euclidean distance between u and v. we also define neighborhood set N (u) of the vertex u as

$$N(u) = \{v| \text{(u, v)} \in E\}$$

3.2 EAODVLRT Algorithm

- In the algorithm, an AODV-node informs its neighbours about its own existence by constantly sending ``hello messages" at a defined interval.
- Discovery of neighboring nodes is done by perimeter routing protocol. Through perimeter routing, the sender can only broadcast the RREQ packets to the outer boundary in counter clockwise direction. A RREQ contains the sender's address, the address of the source node and the maximum sequence number received from the node which exists.
- If the source cannot find the destination then that route can be discarded, again new route can be searched by using the local repair techniques.
- Local Repair will increase the routing protocol performance. The major idea is controlling messages from neighbour nodes; this can be done by minimizing flooding.
- In the AODV model, the inquiry about the particular route from source to destination by default is 2 but it can be increased to 7 times in EAODVLRT.
- The receiving node checks whether it has a route to the particular node. If a route exists and the sequence-number for new received route is higher than the existing route then it accepts the new route.
- If the original node does not receive an answer within a time-limit the node can assume that the source nodes are unreachable. Then the request was sent to all neighboring nodes which are easily separated by the sequence numbers. Nodes along the route will keep their routing table updated. Otherwise, the nodes will discard the entries after a particular time.

3.3 Description EAODVLRT Algorithm

In a wireless network, a route is searched from source to destination by broadcasting the route request message by the source node. The broadcasting can be done by using the perimeter routing [7, 8]. Through the perimeter routing the sender can only broadcast the RREQ packet to the outer boundary in counterclockwise direction. When broadcasting is done in perimeter mode, overlapping of links between the neighbor nodes can be avoided by constructing a planer graph using RNG or GG [9, 10]. The major drawback of AODV is that it suffers with a lot of link failures [11]. To overcome this problem local repair technique can be used [4, 12]. In AODV route is searched for two times by default in the previous AODV model but in EAODVLRT protocol it can be maximized to seven times in the particular route. In mobile ad hoc network, the mobility of each nodes can be assumed as random way point mobility model [13, 14] with the static pause time. In Fig. 2 shows the generalized work flow diagram of EAODVLRT which will show the above steps in the diagrammatical form.

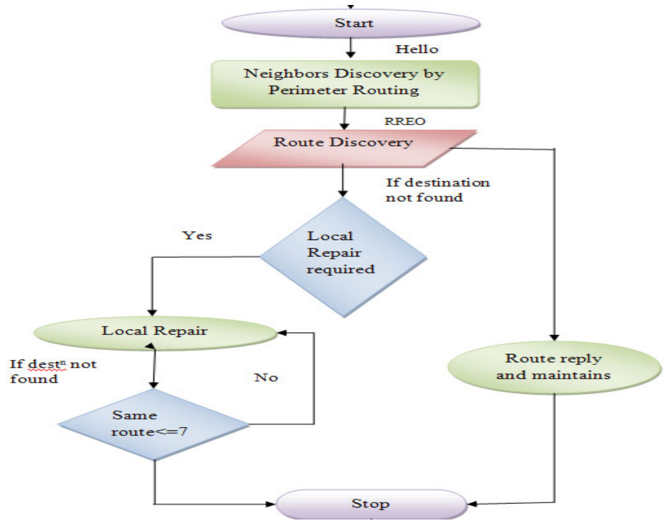

Fig. 2. Generalized work flow diagram of EAODVLRT

3.4 Perimeter Algorithm

The main idea behind perimeter forwarding is to forward the packets using the right hand rule across the faces in the planar graph that intercept the line L_pD (Fig.3). The algorithm used for perimeter forwarding [15, 16] is given below:

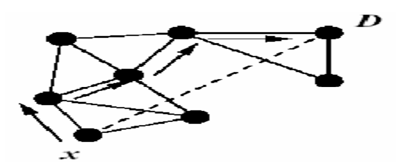

Fig. 3. Perimeter Forwarding

The PERIMETER-INIT-FORWARD [23] algorithm forwards a packet p to a node a_{min}, where,

(a_{min}, self) is the first edge encountered countered clockwise from the line L_pD by perimeter routing where p is packet which are send to the destination .

4 Simulation Model and Results

In this section, a series of simulation experiments in NS2 [17] network simulator will be conducted to perform an evaluation analysis on the performance ability of EAODVLRT with the discussed mechanism. We choose ad hoc on demand distance vector (AODV) routing algorithm as the underlying protocol for our base case simulation.

4.1 Simulated Network Scenario and Model

The values of AODVLRT have been taken from base paper [1] which we have implemented. Table 1 show the simulation parameter used in the evaluation.

Table 1. Simulation Environment

Dimension of simulated area	1500×600m
Simulation Time	300 sec
Mobile Nodes	50
Transferring Mode	Unicast
Pause time	0,50, 100, 150, 200, 250,300 (m/s)
Traffic	CBR
Packet Size	1024 bytes
Routing Protocols	AODV, Enhanced AODVLR
Transport Layer agent type	TCP
Maximum speed	35
Transmission range	250ms
Mobility	Random
Bandwidth	1 megabits/sec

1.1 Performance Metrics

- **Packet Delivery Ratio**

Packet Delivery Ratio = packet received / delivered packets

- **Average End To End Delay**

Average End to End Delay = Total end to end delay/number of packets received

- **Routing Overhead**

Routing Overhead = Total routing packets / transmitted data packets.

- **Average Throughput**

Average Throughput = Total received packets / simulation time.

1.2 Simulation Results and Technical Analysis

This section presents the simulation results and their analysis for 50 nodes network simulation scenario on a rectangular area 1500*600 m^2.

Routing message overhead

From Fig (4), it could be noticed that EAODVLRT [5] has lower routing message overhead by on average 42% less that the AODV.

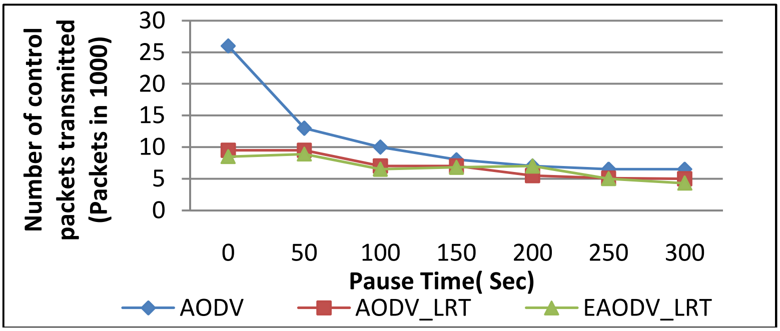

Fig. 4. Routing Overhead Analysis

This result demonstrates the effect of local repair trial using perimeter routing in EAODVLRT on reducing routing message overhead. This is due to the fact that when the node mobility is increased, the frequency of topology changes is also increased.

Throughput

The throughput resulted from AODV, AODVLRT and EAODVLRT has been presented in Fig 5. It can be found that EAODVLRT has higher throughput than AODV routing protocol by an average 1.66% which is a small increase. This result demonstrates that the effect of the modifications in EAODVLRT doesn't appear in

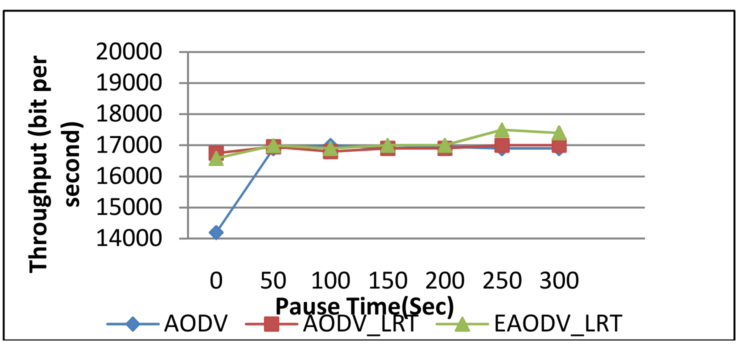

Fig. 5. Throughput Analysis

small sized networks. The number of packets dropped or left wait for a route affect the throughput as the increase in the number of packets dropped or left wait for a route reduce the throughput. The number of packets dropped or left wait for a route reduce the throughput.

Average End to End Delay

Fig (6) presents a graph of average end to end delay of AODV, AODVLRT and EAODVLRT routing protocols. It is clear that EAODVLRT gives average end to end delay higher than the AODV by on average 28% with difference. The result demonstrates the high effect of local repair trial in EAODVLRT on the delay of the small size of networks which resulted from broadcasting RREQ with TTL as in local repairs. The figure shows that when nodes pause time increases, the end-to-end delay of data packets also increases. This is because the paths between sources and required destinations frequently changed and established.

The increase in the number of broken links will led to increase the delay of transferring packets on a route until finding a repair to the route. The number of broken links affected by the route length as longer routes means the higher chances for broken links. In the same time, the number of broken links affected.

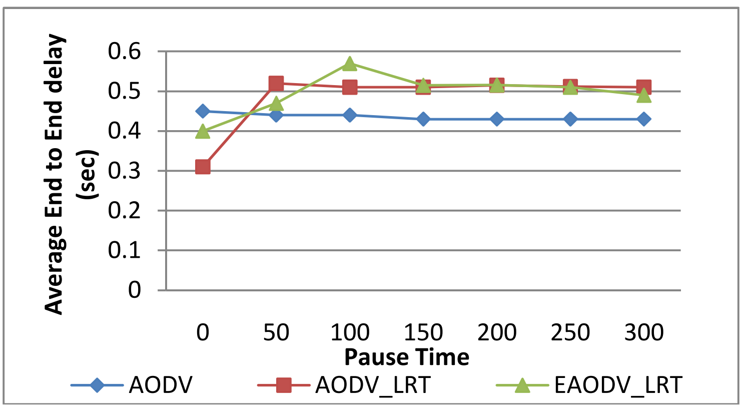

Fig. 6. Average End to End Delay

Packet Delivery Ratio

Fig 7 presents a graph of packet delivery ratio of AODV and EAODVLRT routing protocols. It is clear that EAODVLRT gives average packet delivery ratio 71.98%.If we look at this graph, which is for packet delivery ratio of both the protocols, the packet delivery by EAODVLRT is better than AODV. Results shown above concluded that EAODVLRT has packet delivery ratio which is better as compared to AODV Protocol.

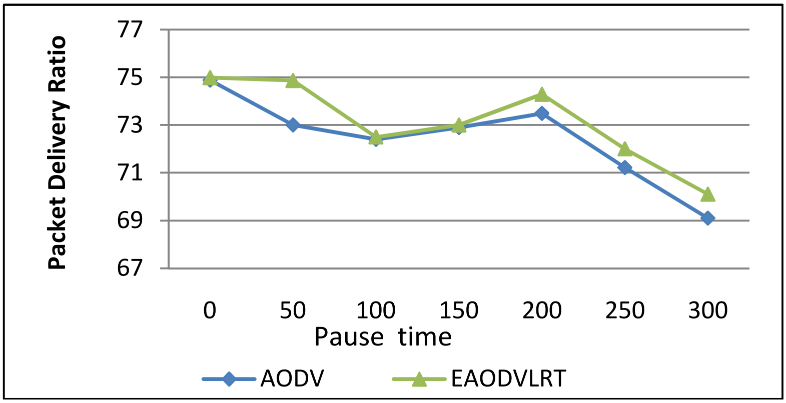

Fig. 7. Packet Delivery Ratio

5 Conclusions

This paper presents a novel approach to minimize routing overheads of AODVLRT. It also analysis enhanced AODVLRT with the existing local repair technique. This approach based on perimeter routing is used to minimize flooding process in EAODVLRT. In this paper we considered the mobile adhoc network routing protocol. Then this work analyzed the issues regarding AODV Local Repair in MANETs while exploring some existing Repair (AODVLRT) technique in literature. This technique consists of three modules. First, broadcasting and can be done by using the perimeter routing. Secondly, flooding is minimized by using local repair method and lastly, number of intermediate nodes from particular source to destination has being increased. This thesis is improved the performance of existing on-demand routing (AODV) protocols by reducing the RREQ overhead during the rout discovery operation. For its implementation and the analysis outcomes NS2 network simulator is used. For analyzing the performance of proposed schema (EAODVLRT) with the existing AODV comparisons had being done. The simulation results show that proposed schema gives the best performance in terms of packet delivery ratio, throughput and number of overhead which is used to compare the performance of these techniques.

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