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MODIFIED AODV PROTOCOL FOR ENERGY EFFICIENT ROUTING IN MANET

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ABSTRACT

Mobile ad Hoc network is a collection of wireless mobile nodes that works without any fixed infrastructure. Mobile nodes in MANET are featured with limited battery power & performance of routing protocol degrades if battery power of nodes gets exhausted. This issue not only affect lifetime of node but also its ability to forward packets. So in MANET routing protocol should provide energy efficient multi-hop route between source & destination pair. AODV routing protocol prefers shortest path for route establishment. But this may lead to repeated selection of certain nodes which in turn exhaust battery power of such nodes faster than others. This will result in partitioning of network & will degrade performance of network. Thus routing protocol should consider residual energy of the nodes for route establishment. In modified AODV protocol first source node will determine threshold value of energy i.e. the amount of energy required to complete the communication event without any link break. The packet structure of RREQ is modified & threshold value is inserted in it. Then we propose modified AODV algorithm which aims to maximum utilization of battery power of nodes based on residual energy of nodes. Simulations are performed to study the performance of energy efficient modified AODV protocol using network simulator NS2. The simulation results show better performance in terms of throughput & average energy consumption as compared to existing AODV.

KEYWORDS: MANET, AODV, Energy Consumption, Energy efficient routing, RREQ

INTRODUCTION

Mobile ad hoc network is continuously self configuring infrastructureless network of mobile devices connected without wires. Application areas of MANET are disaster relief operations, urgent business meetings, mine site operations & military & police exercises. Each mobile node in MANET can act as host or router. Being router nodes in MANET have to forward traffic unrelated to its own use. The nodes in MANET are battery operated thus routing protocol should be selected in order to properly utilize battery power of nodes. MANET's are more sceptical to attacks due to dynamic changing network topology & lack of centralised monitoring. Mobile nodes can enter or leave network therefore any malicious node can join the network without being detected. Thus security & energy efficient routing are two important issues in MANET. Here in this paper we focus on energy efficient routing.

A Mobile Ad hoc Network is a group of wireless mobile computers in which nodes cooperate by forwarding packets to each other to allow them to communicate beyond direct wireless transmission range. In mobile Ad hoc Network (MANET) mobile nodes communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. So there is need of routing protocol. Therefore routing protocol plays an important role in MANET.

Routing protocols in MANET are divided in following types.

Proactive routing protocol: In proactive routing protocol nodes periodically sends messages to each other in order to learn the network & maintain the routes.

Reactive routing protocol: Reactive routing protocols are based on finding routes between two nodes when required.

Hybrid routing protocol: Hybrid routing protocol involves mixture of above two routing protocols for a better solution. In MANET shortest path may not be the best path for routing so at the network layer routing protocol should select route that reduces total power needed to forward packets through the network.

Proactive routing protocols keep on exchanging control messages even though there is no any change in the topology of the network to maintain full knowledge of the network at each node. This leads to increased overhead in proactive routing protocols as compared to reactive routing protocols. Moreover proactive routing protocols are more energy consuming than reactive routing protocols. Hence reactive routing protocols are most widely used. Among reactive routing protocols AODV is the energy efficient one. Thus here we consider AODV protocol for routing.

The rest of the paper is organized as follows .Section 2 gives a brief discussion on related work in energy efficient routing protocol. Section 3 gives description of AODV routing protocol & its limitations. Section 4 gives description of proposed modified routing protocol. Section 5 includes simulation parameter setup Section 6 includes results & analysis. Finally section 7 gives conclusion.

RELATED WORK

This section lists some of the energy efficient routing schemes based on AODV protocol proposed by researchers in the field.

In [1] authors discuss about three major issues i.e. battery management, transmission power management & system power management that affect the overall lifetime of the network. In this paper energy aware routing [EAR] scheme is proposed to minimize energy consumption at the nodes to maximize network lifetime. Transmission power control approach is used to adjust the power levels at node. Initially common transmission range is used for route discovery then new power levels are calculated between every pair of nodes based on distance. Using simulation results authors show that EAR has superior performance as compared to common range AODV in terms of energy consumption & improved network lifetime. Authors observe 10%-20% increase in network lifetime & 10% reduction in total energy consumption using EAR. Number of alive nodes left at the end of simulation is also increased by 10% in EAR as compared to AODV.

In [2] clustering mechanism is explained which have impact on energy usage & network security. In this paper a new trust based algorithm is proposed that ensures detecting of colluding nodes & defending internal attack made by colluding nodes. The algorithm involves hexagonal cluster formation which reduces energy requirement by the nodes. The local forwarding nodes discover routes & also involves in calculating trust. To calculate trust value of each node the trust of its one hop neighbors is calculated & stored & maintained in cluster head. The proposed algorithm is trust & energy efficient accurate with a small communication overhead as compared to AODV.

In [3] secured AODV routing protocol SAODV is introduced to secure routing packets of AODV protocol in MANET. The security mechanisms that the protocol uses are Hash chains, Digital signature & Protocol enforcement mechanism. Hash chains are used in SAODV to authenticate the hop count of the AODV routing messages. The proposed algorithm gives better performance in terms of overhead & end to end delay as compared to authenticated routing protocol in AODV [ARAN].

AODV routing protocol prefers shortest path for routing packets but this leads to frequent selection of certain routes. So the battery power of intermediate nodes in such routes will exhaust faster than others which leads to node breakdown. So in [4] Modified Energy Constrained Based MECB protocol is proposed which takes into account remaining energy of nodes. The MECB algorithm compares remaining energy of nodes & selects the node with maximum remaining energy for route establishment. Thus MECB algorithm selects more reliable & energy efficient route than AODV. The results are analyzed using performance metrics.

EXISTING AODV

Among the number of routing protocols used in network layer we use AODV. The Ad hoc On-Demand Distance Vector (AODV) routing protocol is intended for use by mobile nodes in an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. The nodes maintain routing table entries of all reachable nodes in the network. AODV identifies link breakages & allows nodes to respond to link breakages. The entries in routing tables are of the form: < Destination, Next Hop, No. of hops, Sequence Number>. Sequence number is used to maintain freshness.

The route table is used to route data packets destined for a particular node and to respond to ROUTE REQUEST. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the message types defined by AODV. If the endpoints of a communication connection have valid routes AODV does not play any role. When a route to a new destination is needed, the node broadcasts a RREQ to find a route to the destination .Each node receiving RREQ have two choices. If it is destination node it will unicast RREP to source node & if it is not destination node it will forward RREQ to next node. Each node receiving the request caches a route back to the originator of the request, so that the RREP can be unicast from the destination along a path to that originator. If more copies of same RREQ are received later then it will be discarded. If an intermediate node moves or dies within a particular route the neighboring node detects the link failure & sends link failure notification to upstream nodes until it reaches the source node. Then it is the source node who decides whether to reinitiate the route establishment procedure or not.

AODV mechanism limitation

For route establishment AODV prefers shortest path. If the same route is selected repeatedly this may lead to selection of the nodes in the route with less energy and such nodes may become inactive due to battery run outs, while communication is going on. This leads to link failure occurrence. AODV also involves the link recovery mechanism. If link is not recovered, reprocess of route establishment takes place. In basic AODV message flow process due to death of intermediate node we have to again perform root re-establishment process. This causes excessive energy consumption & degrades the performance of the network.

MODIFIED AODV

To overcome the problem of link breakage in active communication due to battery run outs, we propose modified AODV algorithm. In modified AODV protocol there is one additional field called energy field that is added to basic RREQ packet structure of AODV. This field contains threshold value of energy for a particular communication event. Threshold value is the amount of energy set by source node to complete the data transfer without any link break due to battery run out.

The algorithm of modified AODV protocol is as follows:

1] For route establishment source node will broadcast RREQ containing additional energy field. This energy field contains amount of energy required to complete the communication event successfully without any link break.

2] Each node receiving RREQ will compare its own residual energy with the value in the energy field.

3] If residual energy of a node is greater than threshold value then only that node is selected as intermediate node for route establishment otherwise node will drop RREQ.

4] When RREQ reaches destination node it will unicast RREP to source node. If destination node receives more than one RREQ then destination node will select the route with minimum energy consumption.

5] Once route is established source node will start sending data packets.

Modified AODV decreases chances of no route error due to death of node because of lack of energy during communication process going on. Hence modified AODV can increase reliability in terms of the guaranteed life of

the node as there are no chances of node death until entire data is sent. Ultimate outcome is due to avoidance of repetitive route establishment energy-efficiency increases.

To achieve the goal of uniform energy consumption among nodes and prolong MANETs' lifetime, we consider the residual energy as a routing metric for selecting a node to construct a route between the source-destination pairs.

RREQ packet structure Modification:

The original packet structure of RREQ packet is altered for exchange of requirement of energy for specific communication event from source node. This new structure involves the addition of one extra field in the RREQ packet which will contain pre-calculated energy requirement information. When particular source node broadcasts RREQ, that node will also add the energy requirement in this field along with normal filling process of fields in RREQ packet structure. Source node is provided this capability to calculate the required amount of energy for communication of specific events information sending to sink node.

As RREQ is of broadcast type, every node in the network will receive this packet. If RREQ receiving node is not destination node it will forward this packet further to its neighboring node in again broadcast type provided it satisfies the condition.

Every receiving node will check the required energy for specific communication event received from this RREQ packet and calculate its residual energy for comparison. After comparison if it satisfies the conditional criteria it will forward this packet further else will drop this packet.

Residual energy calculation:

As every node in WSN is exhaustible battery operated device, battery consumption should be minimum for increasing lifetime of network. As every operation of node requires energy, like transmission and reception of packet, total load carried out for entire communication is responsible for energy consumption provided through battery supplies.

Hence residual energy provides the information about energy remaining in the battery & which is used as routing metric in modified AODV algorithm.

$$\mathbf{E_{residual} = E_{initial} - E_{consumed}}$$

Where $\mathbf{E_{initial}}$, $\mathbf{E_{consumed}}$ indicate the initial energy of the node and consumed energy of the node till time.

If residual energy of the node is less than that of required then this node will drop RREQ and hence will get hidden from destination node. Hence, when destination node generates route reply (RREP) packet, as it is of unicast type, will not involve this particular node in the route. And at the same time whichever node is selected in the route will be considered reliable for entire communication completion.

This modification will result in less routing overhead thereby avoiding additional control packet communication in the network and increasing energy efficiency.

SIMULATION SETUP

The existing AODV & proposed modified AODV protocols are successfully simulated using network simulator 2 & results are compared with the help of performance metric. The required simulation parameters are listed below.

No of Nodes	10-90
Traffic Model	CBR
Data Packet Size	512 bytes
Simulation Time	100 sec
MAC Layer Type	IEEE 802.11
Radio Propagation Model	Two Ray Ground
Radio Range	250m

Table 1: Simulation parameter setup

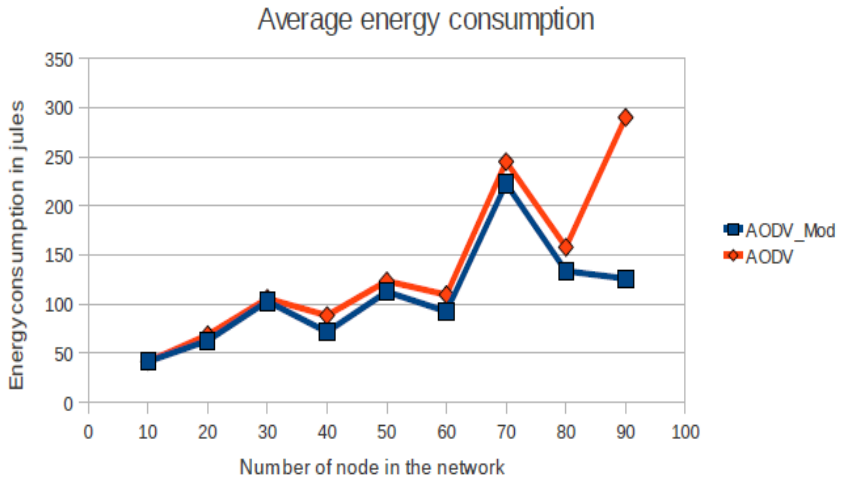
RESULTS & DISCUSSION

The simulation is conducted with 10 to 90 nodes to evaluate & compare the performance of both AODV & Modified AODV. The performance metric used for comparison are as follows:

1] Average Energy Consumption:

Average energy consumption is the consumed energy by the network for all packets received by the destination. The following table lists the values average energy consumption of AODV & Modified AODV after simulation. With the help of these values graph is plotted for energy consumption for varying number of nodes. From figure we can conclude that modified AODV has less energy consumption than existing AODV.

No of Nodes	AODV	MOAODV
10	41.7959	41.7913
20	68.9156	62.9837
30	105.856	102.9882
40	88.4659	71.8087
50	123.5951	112.8
60	109.73	92.5487
70	244.944	222.74
80	158.021	133.833
90	289.6623	126.1086



2] Throughput:

Throughput can be defined as total number of bits forwarded to higher layers per second. It is measured in bps. Following table lists simulation results for 10 to 100 nodes. With the help of values in the table graph for throughput is plotted.

No of Nodes	AODV	MOAODV
10	649.3058	674.0719
20	651.3257	676.1522
30	651.3657	676.1989

40	646.5789	675.079
50	647.7189	695.5121
60	656.9789	700.1921
70	657.2856	705.7455
80	654.8185	717.478
90	658.8383	703.6785
100	675.4583	706.305

CONCLUSION

In this paper we have discussed that how energy efficiency is one of the important issue in MANET. From the study it is seen that in existing AODV if during data transfer process if any node in the route dies due lack of energy then the route is lost & source node again have to perform route establishment procedure. In network if it occurs often then network will consume more energy which degrades the performance of network. Thus to overcome this problem we have proposed Modified AODV algorithm which takes into account only those nodes having residual energy more than threshold set by source node for route establishment. Thus this algorithm ensures that the nodes participating in route establishment may not die due to battery run outs. The simulation results shows that modified AODV algorithm performs better than existing AODV in terms of energy consumption & throughput.

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