Study of Modified AODV Protocol

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ABSTRACT

Recently there has been substantial work done in the field of developing an energy efficient and reliable routing protocol for enhanced performance in Ad hoc networks. The field is maturing exponentially and is becoming one of the key research areas in the field of Communications with an objective of improving the quality of Ad hoc networks. The Ad-hoc on-demand distance vector (AODV) routing algorithm is a routing protocol designed for Ad-hoc mobile devices. AODV is a combination of DSR and DSDV. It has basic on- demand mechanism of Route Discovery and Route Maintenance like DSR, and the use of hop by hop routing, sequence numbers and periodic beacons like DSDV.In this paper we have studied and analyzed the enhanced versions of AODV protocol to improve the Quality of Service (QoS).

Keywords: MANET, AODV, RAODV, ES-AODV, SP-AODV, MRAODV, LBAODV

I. INTRODUCTION

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. 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.Among the number of routing protocols used in network layer we use AODV.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 [1].

The route table is used to route data packets destined for a 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 [2]. If an intermediate node moves or dies within a 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 [3]. In basic AODV message flow process due to death of intermediate node we must again perform root re-establishment process. This causes excessive energy consumption & degrades the performance of thenetwork.

II. LITERATURE SURVEY

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

In [4] 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 toAODV.

In [5] 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 toAODV.

In [6] 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].

In LBAODV protocol [7], all the discovered paths are simultaneously used for transmitting data. Due to this, data packets are balanced over discovered paths and energy consumption is distributed across many nodes.In route discovery the source broadcasts RREQs. When destination receives RREQs, it reverses the route record from the received RREQs and uses this route to send RREPs to the source. When a node receives multiple RREPs from another node, it increments the number of route reply, *Count Reply,* received from this node in its *route table* field which means how many routes from this next hop to the destination exist. Each node that receives data packets sends them to the next hops according to their *Count Reply* values. More is the count reply greater is the amount of data sent andvice-versa.This protocol helps to achieve better packet delivery ratio and distributed energy consumption. Due to simultaneous transmission of data packets source to destination delay may bereduced.

In Robust AODV [8] with Local Update, the route is built on demand and maintained by locally updating route information. Multiple back up routes are built around active route and the highest priority back up route will be switched to become new active route when the current active route is less preferred. The route discovery process is almost same as in original AODV protocol except that all the routes are back up routes. Route entries are updated whenever a link breakage is detected and if backup route exists we switch to a new route. The broadcasted route update message which replaces the AODV hello message contains all the necessary routeinformation.This protocol works best in case of high mobility. It is preferred when the energy of node is not a matter ofconcern, but a strong and reliable network is desired. Disadvantage of this protocol is the complexity in implementation and high-power consumption.

In Reverse AODV (RAODV) [9], destination node uses reverse RREQ to find source node. It reduces path failure correction messages and can improve the robustness of performance. Therefore, success rate of route discovery may be increased even in high mobility situation. When broadcasted *reverse request* packet arrives to intermediate node, it will check for redundancy. If it already received the same message, the message is dropped, otherwise forwards to next nodes and when the source node receives first *reverse request* message, then it starts packet transmission, and late arrived R-RREQs are saved for future use. Even if packet delivery ratio is increased there are other disadvantages. Due to multicasting by destination there is considerable amount of energy wastage of nodes in the network and as well control packet overhead increase.

In Modified Reverse AODV (MRAODV) stability estimation method is used for route selection and to increase performance. In the proposed routing algorithm, when a source node wants to communicate with a destination node, first it broadcasts a RREQ packet. This stage is like that of AODV algorithm. When destination receives a RREQ message, it broadcasts R-RREQ message to find source node. Each intermediate node which receives the R-RREQ message, calculates its route stability for each route using equation given below and this stability is used for selecting thepath.

$RS_r = \Pi ns_i$ (1)

Where RS_r is the route stability of the route r.
L_r is the set of available routes and ns_i is the stability of node i.

The stability of each node can be calculated by following equation,

$ns_i = (t-t')/(L_n - L_n')$ (2)

Where L_n denotes the location of node ni at the time t. For t computation of stability for each node we need to obtain t-t' delay.

Semi-Proactive AODV (SP-AODV) [10] is a combination of pro-active and reactive dynamic routing protocol. It is node centric rather than based on zones or areas as in hybrid approaches of routing protocol. The efficiency of this protocol lies in the fact that some nodes which are often used will dynamically update some sections of their routing table like pro-active protocol and other nodes which are used less operate like reactive routing protocol. The results showed that the routing protocol has more packet delivery ratio and less end-to-end delay compared to AODV. Furthermore, control packet overhead in SP- AODV is less than AODV in low and medium mobility of nodes; however, it is more than AODV in high mobility of nodes.

In Energy Saving AODV (ES-AODV) [11] protocol, the power-controlled mechanism is adopted to adjust the emission power of node dynamically and to improve the energy saving performance of AODV routing protocol in mobile Ad Hoc networks. ES-AODV protocol focuses on the local repair and minimizes the probability of using source node for the route rebuild. ES-AODV protocol comprehensively evaluates excess energy of nodes, each node in the link calculates its weight which is in inverse proportion with its energy. The routing protocol always chooses the smallest cost link for data transmission. Energy consumption of nodes in the network could be effectively balanced and the average survival time of nodes in the network can be improved. The ES-AODV protocol makes full use of the backup route information which is cached during the stages of route optimization to repair the broken link.

Even with suitable increase in node's speed, its lifetime is better as compared to AODV at same speed. Also increase in number of nodes' reduces the power of communication between nodes, which directly affects the rate of energy consumption and thus prolong nodes' lifetime.

Energy Multipath AODV (EM-AODV) proposes a new adaptive approach which considers the metric "residual energy of nodes" instead of the number of hops in the process route selection. In this we define the rate of energy consumption for each node to estimate its lifetime and as well define a cost that fits this lifetime and the energy level. This information is used for calculating the cost of routes and the path with minimum cost is selected. EM-AODV improves the performance of AODV in most metrics, as the packet delivery ratio, end to end delay, and energy consumption.

III. MODIFIED AODV PROTOCOL

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 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 [12].

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 ofthe 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 [13].

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 [14].

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.

Eresidual = Einitial – Econsumed

Where **Einitial, Econsumed** 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 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 [15].

IV. CONCLUSION & FUTURE SCOPE

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. With the appropriate increase in the mobility or no. of nodes, there is considerable improvement in the nodes lifetime as that of AODV. We observed that if the packet overhead was less the efficiency of the protocol improved quite considerably. And as well if the mobility of the node was increased there was a sudden dip in performance. Overall, we concluded that there was need of a protocol which could adopt itself to the high mobility of nodes to perform optimally. The non- existence of a good routing protocol is a matter of great concern. We suggest that extensive amount of research needs to be done in this field to develop highly reliable and highly performing new protocol forrouting.

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