

Review on variants of Power Aware AODV

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Abstract— Mobile Ad-Hoc Network (MANET) is a self-configuring network of mobile devices connected through wireless. Nowadays mobile devices in mobile Ad-hoc network are battery operated. Battery is an important factor in MANET. Dynamic topology of mobile ad-hoc network and limited battery capacity are constrained on network life time. In this paper, we have presented variants of power aware techniques in an on-demand reactive routing protocol i.e. AODV which aims to prolong network lifetime. AODV is reactive protocol and it establish route on demand.

I. INTRODUCTION

It's simple but important premise that in network lifetime in MANET, MANET is a set of mobile devices roam around arbitrary, and communicate with others in multi hop fashion without any centralized administration .MANET is very flexible network and suitable for application such as military, disaster and outdoor rescue. Dynamic topology of MANET lead to enormous control overhead for routing and maintenance compared with traditional network MANET agonize from the constraint in bandwidth, computational capacity and battery etc. make its routing protocol much more complex than that of wired network.

In order to facilitate communication within the network, the routing protocol is used to discover routes between nodes. The primary goal of such an ad hoc network routing protocol is to provide correct and efficient route establishment between pair of nodes so that messages may be delivered in time [1].

Based on routing update mechanism MANET routing protocol classified in to three categories. 1) Reactive (on-demand) 2) Proactive (table driven) 3) Hybrid. In proactive routing protocols nodes typically try to create routes proactively before there is a need to traffic from specific destination .nodes usually accomplishes that by sending periodic Routing updates .In addition routing updates are also sent whenever topology changes such updates ensure that nodes are having up- to- date paths to other nodes. [2]

Reactive protocols on the other hand set up routes between two nodes only when there is a need to send actual traffic between those two nodes. Nodes using reactive routing protocols usually accomplish that by flooding the network with route request (RREQ) messages, requesting information on the route from the source to the destination. These route request messages originate at the source and flooded throughout the network when the source needs to send data to the destination. Eventually, the destination (or a node that has recently communicated with the destination) receives the route request message and responds to it with

the necessary path information. Ad Hoc On-demand Distance Vector (AODV) is one of the reactive protocols. A reactive protocol is much more appropriate for such situations since it incurs lower overhead in terms of the bandwidth used due to avoidance of entire vector exchange. In fact, reactive routing protocols reduce routing overhead in periods or areas of the network where there is little data traffic [2].

In MANET, energy consumption is the summation of power incurred in transmitting packet and receiving packet. If power used in transmitting packet is x and receiving packet is y then total energy consumption z is given as,

$$Z = x + y \quad (1.1)$$

Whereas, power degradation is inversely proportional to the distance.

$$P \propto d^{-a} \quad (1.2)$$

Where P is power and d is distance where a is some constant for distance cover.

In MANET, link stability is an important factor because if link is connected between two nodes and also if remaining battery is low, then also node can send packet but if link is not connected then it is not possible to send a packet. We will select outgoing edge of the node having enough battery power. The wireless ad-hoc network in consideration is modeled as a directed graph $G = (V, E)$, where V is the set of all nodes with its residual battery and E is the set of all directed links with its lifetime (i, j) where $i, j \in V$. A path $L = v_1, v_2 \dots v_n$ exists between the source node, $S = v_1$ and the destination node, $D = v_n$. For power aware route selection outgoing edge (OE) will be selected on the basis of link lifetime and residual energy. But as described earlier, link stability is more important than residual energy. So, we can take more weight-age of link stability into consideration with compare to the residual battery capacity for selection outgoing edge which is given as,

$$\text{No of OE} = \max \left(\sum_{i=1}^{I=1} (70\% (E_{(i,j)}) + 30\% (V_{(i,j)})) \right) \quad (1.3)$$

The goal of this paper is to review basic variants of power AODV protocol.

II. VARIANTS OF AODV PROTOCOL

A. *Maximize network life time using Energy Mean – aware algorithm*

There are many AODV variants for improvement in

network lifetime in MANET. This variant using the energy mean aware algorithm for improvement network lifetime. This variant of AODV protocol can achieve better load balancing among nodes, which is give a longer network life time. In traditional AODV build a route path by using basic route discovery algorithm without considering energy status of node. Energy reduces dramatically if node holds many paths which will force to the node to fail participate in the network. Improved the lifetime of network by reducing energy concentration on certain node which disturbing to network. This protocol increased network lifetime through the delaying method of RREQ flooding by considering the node's energy state and entire node's Energy mean value. In this protocol variant adjust RREQ delay time according to node energy status and entire network Energy Mean value[6].

Assumption- In this algorithm energy mean value is fixed. Energy Mean value can be computed using different methods and distributing additional control packet.[6]

B. Power-Aware Ad-hoc On-demand Distance Vector routing protocol (PAW-AODV)

PAW-AODV uses the overall resources of the system more efficiently than standard AODV protocol choosing routes based on power-based cost function. In this scheme first every node selects the route which requires lower transmission power. After that every node will send information of path cost to its neighbors. Path cost function is calculated using remaining residual battery power of node and it is the summation of every node cost in network. If the battery power of node is change than path cost is also send so that path cost change notification is change to every node of network. If path cost function is periodically change it generates a network overhead so that this variants proposed zoning concept

This concept defines a few zones based on a specific range of the node's available power and then assigns a fixed node cost to each zone.

- 1) *White zone:* when node has full battery power then it process simply as AODV.
- 2) *YELLOW zones:* when node has sufficient power then forward power.
- 3) *RED zones:* when node has low battery then node does not send packet.

In route discovery process source broadcast RREQ packet to its neighbor this mechanism is additional field this field contains route cost of source to destination. This filed is initially zero. When the RREQ packets are pass through those nodes cost are added to RREQ packet. Intermediate check sequence id and broadcast id it is same then discard the packet. for reverse route set up PAW-AODV compare total route cost with accumulated route cost from source to destination if it is greater than then update reverse route information in RREQ packet and also route table entry. When destination send reply back using RREP packet it has necessary information in rout table. When RREP send node include reverse route cost, forward route cost, and node cost field. Whenever the node entering into red zone than its sets not node cost is high but send also RERR low power indication to all its process node and alert to all node to stop forwarding packet so that network lifetime increase.[3]

C. AODV+GE maximize lifetime of network

Blind flooding in AODV Protocol is increase contention network overhead and collision.. Gossip based approach is removing this problem. AODV+GE is improvement in gossip based (AODV+G) approach and it also consider remaining energy of node. AODV+G is working on probability of forwarding packet. We can give two type of probability either static or adaptive. Static probability is fixed and adaptive probability is given in to route discovery process. In AODV+G is set predefine critical probability value. after receiving packet to node AODV+ G is compare the node probability with critical probability if node has higher probability than critical probability then it forward packet otherwise it is discard same concept in energy gossip based approach in this approach probability is given based on remaining energy. If the node remaining energy is higher than it gives higher probability and remaining energy of node is lower than it gives lower probability so that it is avoid the lower probability node to forward packet and improve network life time[12].

D. DEEAR (Distributed Energy-efficient AODV Routing) protocol

In DEEAR increase the network lifetime by compromise energy consumption without sending additional control packet. In AODV protocol is send RREQ packet send for forward path from source to destination and destination will reply with RREP packet. DEEAR save energy at the cost of reduced route update. DEEAR does not send additional control packet. DEEAR calculate average residual energy level of network which doesn't require any additional control packet.

Intermediate node can control rebroadcast time thus it can control flooding. DEEAR compare the residual power of entire network with intermediate node residual battery power if the node battery power is larger than rebroadcast RREQ packet because on demand routing protocol drop duplicate RREQ packet without rebroadcast them

To calculate to mean residual battery power using periodic control packet. But it consume more energy because of transmitting and receiving packets of node. So we can reduced energy wastage to added additional field in RREQ packet.

- 1) Average residual power
- 2) Number of hops.

When source broadcast RREQ it add its power and set no of hop is equal to one. After neighbors are receiving RREQ packet. It calculate new average residual power before the neighbor rebroadcast again it update average residual power and increment hop by one. After it will compare average residual battery power of network with residual power of node. If residual battery power is smaller than average residual power than retransmission time is large otherwise node select as member of route which results better energy balance in overall network [4]

E. Maximize life time of network using channel free time (CFT)

Another variant of AODV is AODV+SIBA is maximizing life time using channel free time .Full form of SIBA is

Sufficient Intermediary Bandwidth Aware. In this approach mainly concentrate on Congestion. In this approach avoid the packet sent on high traffic area and improve the battery life time.[5]

AODV+SIBA routing protocol reduced congestion using channel free time. Due to sharing common channel among multiple nodes congestion, long delay and network overhead are increase. So we need to develop mechanism by which we can improve network life time and link stability. If sufficient bandwidth is available for communication then new data will be accepted for transmission otherwise discarded. So it reduce to congestion. Calculating residual bandwidth is difficult task because of collision and shared medium among multiple neighbors. Every node has not detail information about its neighbors. So traffic can be unknown. We can use RTS/CTS protocol for find channel free time to solve the problem of traffic. In RTS/CTS sender send RTS signal to its neighbor after receiving RTS neighbor will respond by sending CTS if channel is free. Also RTS/CTS are avoid congestion using DIFS and SIFS delay frame. CFT is calculated on mac layer and its helps to select route which has not congestion. Congestion has two type statuses (1 forward level (2 drop level. If CFT is greater than predefine threshold then packet are broadcast to next neighbor otherwise discard.[5]

F. Maximize network life time using latency aware algorithm

Nowadays, latency is important factor to improve network lifetime. In real time data transmission if we are set appropriate latency for particular application it will improve network life time. In original AODV do not take care of latency in latency aware algorithm is give importance of residual battery and latency to improve network life time.

It is easy to implement the operating principal of minimum hop count routing but it don't take account the contention and queuing delay of the intermediate nodes. It is feasible that only require inter mediate nodes are included for routing source to destination .in this scheme number of intermediate node are less than conventional AODV when transmission range is increased.[7]

After receiving the message intermediate node will compute probability of errors. The probability of error for received signal will be compare with the predefined values of lower probability limit and upper probability limit. If probability error is less than lower probability limit then it will not forward the packet. If probability of error is between upper and lower probability error limit then intermediate node will take part in forwarding packet. If probability of error is greater than upper probability error than received signal will be discarded by intermediate node. Intermediate node request to source for retransmission of that signal same as the intermediate node responds to other request for route discovery. So that this scheme uses large transmission range through less intermediate node than conventional AODV and avoid the unnecessary node.

G. Maximize lifetime using ant colony

Ant colony optimization is based on reactive routing .it is make strong path if there is no link error. To establish best path or path between source and destination using ants the source chooses according to its goal function and initiate the

sending packets. After that some control packets are sent to control path and to detect the broken link. [11]

We can improve network life time using ant optimization first we will send ants all over the network from source to the network. Where ants are pass it will puts pheromone. We are creating routing table which store the value of link expiration time, residual battery, and pheromone. Pheromone value is depend on distance if the distance is long then pheromone value is low and if distance is short then pheromone value is high so pheromone value is help to find out shortest path of network .link expiration time is calculate some mathematical formula. Ant algorithm also maintain broken link and control path we are sent packet only some predefined battery level. If the battery level is higher than predefined battery level then forward packet otherwise it is discarding. So we can improve the lifetime using ant colony and maintain broken link also consider link stability in AODV.[11]

H. Maximize network lifetime using link stability and energy aware algorithm (LSEA)

Link stability and energy aware algorithm is considered link stability and residual energy. In original AODV is only concentrate on battery life of node .LSEA is improved version of AODV.LSEA has better life time than original AODV.

In this scheme link expiration time between two mobile nodes $i(x_i, y_i)$ and $j(x_j, y_j)$ is defined by the following equation:

$$LET = \frac{-(a + b) + \sqrt{(a^2 + b^2) \cdot r^2 - (ad - bc)}}{a^2 + c^2}$$

Where,

$$a = v_i \cos \theta_i - v_j \cos \theta_j$$

$$b = X_i - X_j$$

$$c = v_i \sin \theta_i - v_j \sin \theta_j$$

$$d = Y_i - Y_j \tag{1.4}$$

LSEA is unlike our previous work in a way that on receiving RREQ at any node it decides immediately to forward the RREQ or not depending on its residual energy .it is also depend on link lifetime. Rather than all nodes forward any RREQ and give opportunity to select to RREQ contain nodes with good link life time or the nodes having good power level. so that in LSEA the question arises why the node forward RREQ when the link life time with RREQ sender going to be cut off and can't reach the RREQ sender back to retransmit a RREQ or the node energy level is inferior and this node going to end soon. Additionally sending of any RREQ will resulting more overhead and at last only one RREQ will select to construct path.[8]

In Fig 2, S has no routing information of D. it tries to send data to D. In conventional AODV S broadcast the RREQ packet to N1,N2 and N3.But LESA will check link life time and node energy level. N1 has good energy level and good link life time. LESA will check N2 but N2 has poor energy level so that LESA don't forward packet

through N2 and also N3 because N3 has sufficient energy level to forward packet but it has a poor link life time the RREQ is sent through node N1 as it satisfied our requirement for energy level and the link lifetime[8]

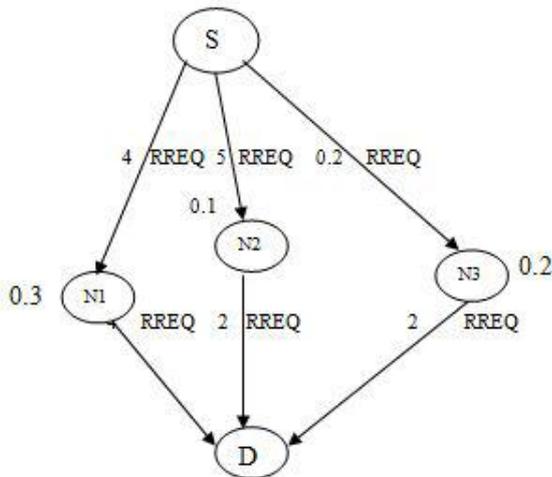


Fig 1: Example of LSEA

– Steps:

- 1) *Step 1:* sender broadcast RREQ to intermediate node.
- 2) *Step 2:* if intermediate node has valid route to destination then sent packet to destination.
- 3) *Step 3:* if intermediate node has not valid route then check the link life time and residual energy of node if it is satisfied than again rebroadcast RREQ otherwise discard the packet.

I. Maximize network life time alternate link maximum energy level ad hoc distance vector scheme for energy efficient ad hoc network routing

In this variant algorithm is adaptive nature .it is also consider broken link. The following algorithm takes decide the route on the basis of energy and selects the route which has higher aggregate energy. If there is broken link in the route. The routing table selects another path for continue routing to source to destination.

The routing table will initiate path discovery process when source node wants to communicate to another node of which it has not routing information. Each node in the ad hoc network maintains two separate counters: a node sequence number and a broadcast ID. Path discovery process is initiate when broadcasting a route request packet (RREQ) to its neighbors. Each of the neighbors will sends a route reply (RREP) back to the source otherwise rebroadcasts the RREQ to its own neighbors until the destination is reach. If an Intermediate node receives a RREQ with the same broadcast ID and source address will discard RREQ. The RREQ packet contains the important fields are Source address, Source sequence number, Broadcast ID, Hop count, Destination address and Destination sequence number RERR packet maintenance the route in AODV if any node is damage then along with RERR packet destination sequence number and a hop count of infinity is sent back via separately maintained links to all sources using that failed link. The source can rebuild a path

by sending a RREQ packet if the route is needed then source is reconstruct path using RREQ packet [9]

RREQ handling for ALMEL_AODV

– Steps:

- 1) *Step1:* source node broad cast RREQ to its neighbor
- 2) *Step2:* insert its broadcast id to RREQ packet.
- 3) *Step 3:* check if the route present for that node if route present than check the sequence number of node otherwise add new route. After that check energy of that node if energy is more than the predefine energy than add reverse path in to route table otherwise discard RREQ
- 4) *Step 4:* if the current node is destination then add more forward path to route to destination. Otherwise send RREQ packet send to next hop and find out destination.
- 5) *Step 5:* if the forward path link is fail then find the alternate link in to route table.

J. Maximize life time using energy constrained routing protocol for MANET.

This approach is concentrate on delay and also battery usage of overall of network. In AODV RREQ packet broad cast by source to throughout network until destination is find. After receiving RREQ packet destination give the reply using RREP packet. ELBRP is used same concept like AODV but its consider delay when packet forward to it neighbor if its delay is inversely proportional to its energy level so when energy level of node is high then its delay is low to packet forwarding. So that high energy node send packet first and all other packets comes from low energy node are discarded so overall network life time improve. Look the fig 10.1 communicate from A to T gives shortest path is (A, B, D, T) in to request delay mechanism is choose path (A, B, E, T) because higher energy node can send packet fast[10] .

Because of zero time to live some RREQ packets are retransmitted again which makes routing load and more congestion .there is no necessary to compute delay at every energy level. This variant is divided energy level in to four phases. The four states are very danger, danger, sub safety, and safety. We compute delay function at sub safety energy level and if the node enters in danger mode than the node should be sleep. There is not necessary to compute delay for other two states. If the node has left energy zero than it is dead. The sleep nodes should wake up only there is one route between source and destination.[10]

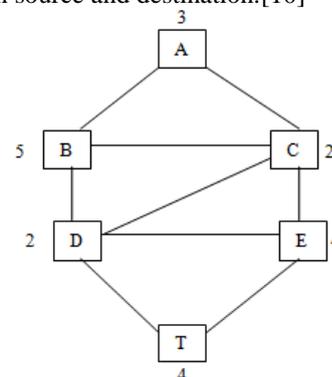


Fig. 2: Example of ELBRP

ELBRP has not increased the complexity of the original algorithms or protocols, when the links of G are all bi directional, the complexity of the algorithm is $O(n)$; when the links are part of unidirectional, the complexity is $O(n^2)$, where n is the all number of the network. Let n_i be the number of neighbor of node i. on the basis of analysis ELBRP we infer that life time of node is multiplication of Transmission energy required by transmit data from one node to another node and rate which information is transmitted from one node to another node [10].

K. Energy Efficient AODV

In this algorithm, providing path from source to destination is efficient, stable and long Network life time. Basically this algorithm designed for large mobile ad hoc network. The main aim of this algorithm is to handle low, moderate, and relatively high mobility rates as well as handle variety of data traffic levels. so that it can improve the performance of traditional proactive protocols. This protocol provide three operations such RREQ(route request),RERR(route error) and LRR(local repair). In this scheme, power oriented action start only when RREP(route reply) and select shortest path for data transmission, by which we can reduced overhead and end to end delay. it is working such as Source node broadcast RREQ packet with energy threshold and estimated distance then at intermediate node it check if energy level is greater than specified threshold and time difference between the current time and last packet forwarded through neighbor node time is less than the estimated distance then sent reply. Source node check all reply messages and select shortest route for forwarding data. if source does not any reply, it select minimum distance neighbor node for forwarding data and other node are used for link failure. source send RREQ packet through active route and destination node reply through reverse path[13].

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