Variants of AODV Routing Protocol : A Review

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***Abstract* – In recent years mobile ad hoc networks have become very popular and lots of research are being done on different aspects of MANET. Mobile Ad Hoc Networks (MANET), is a self configuring network of mobile devices (laptops, sensors, etc.) without centralized infrastructure (access points, bridges, etc.) and predetermined topology. Different aspects taken for research are routing, synchronization, power consumption, bandwidth considerations etc. The routing technique is the most challenging issue. There are various strategies proposed for efficient routing which claimed to provide better performance and different routing protocols which makes it quite difficult to determine which protocol is suitable for different network conditions .This paper provides an overview of variants of AODV routing protocol.**

***Index Terms* – Mobile Ad Hoc Networks, Ad-hoc On-demand Distance Vector Routing, Route Request, Route Reply.**

I. INTRODUCTION

A mobile ad hoc network (MANET), sometimes called a mobile mesh network, is a self- configuring network of mobile devices connected by wireless links. In other words, a MANET is a collection of communication nodes that wish to communicate with each other, but has no fixed infrastructure and no predetermined topology of wireless links. Each node in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. The major challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Routing is the process of selecting paths in a network along which to send data packets. An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad-hoc network. In ad hoc networks, nodes do not start out familiar with the topology of their networks; instead, they have to discover it. The basic idea is that a new node may announce its presence and should listen for announcements broadcast by its neighbors. Each node learns about nearby nodes and how to reach them, and may announce that it can reach them too. The routing process usually directs forwarding on the basis of routing tables which maintain a record of the routes to various network destinations .Thus, constructing routing tables, which are held in the router's memory, is very important for efficient routing.

Ad hoc On-Demand Distance Vector (AODV) Routing is a routing protocol for mobile ad hoc networks (MANETs) and other wireless ad-hoc networks. AODV is capable of both unicast and multicast routing. It is a reactive routing protocol, that is it establishes a route to a destination only on demand. In contrast, the most common routing protocols of the Internet are proactive, they find routing paths independently of the usage of the paths. AODV is, as the name indicates, a distance-vector routing protocol. AODV avoids the *counting-to infinity* problem of other distance-vector protocols by using sequence numbers on route updates, a technique pioneered by DSDV. In AODV, the network is silent until a connection is needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node. When a node receives such a message and already has a route to the desired node, it sends a message backwards through a temporary route to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes. Unused entries in the routing tables are recycled after a particular time. When a link fails, a routing error is passed back to a transmitting node, and the process repeats. Much of the complexity of the protocol is to lower the number of messages to conserve the capacity of the network. For example, each request for a route has a sequence number. Nodes use this sequence number so that they do not repeat route requests that they have already passed on. Another such feature is that the route requests have a "time to live" number that limits how many times they can be retransmitted. The third feature is that if a route request fails, another route request may not be sent until twice as much time has passed as the timeout of the previous route request.

The AODV Routing protocol uses an on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path. The source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. The major difference between AODV and other on-demand routing protocols is that it uses a *destination sequence number* (DestSeqNum) to determine an up-to- date path to the destination. A node updates its path information only if the *DestSeqNum* of the current packet received is greater than the last *DestSeqNum* stored at the node. A Route Request carries the source identifier (SrcID), the destination identifier (DestID), the source sequence number (SrcSeqNum), the destination sequence number (DestSeqNum), the broadcast identifier (BcastID), and the *time to live* (TTL) field. DestSeqNum indicates the freshness of the route that is accepted by the source. When an intermediate node receives a Route Request, it either forwards it or prepares a Route Reply if it has a valid route to the destination. The validity of a route at the intermediate node is determined by comparing the sequence number at the intermediate node with the destination sequence number in the Route Request packet. If a Route Request is received multiple times, which is indicated by the BcastID- SrcID pair, the duplicate copies are discarded. All intermediate nodes having valid routes to the destination, or the destination node itself, are allowed to send Route Reply packets to the source. Every intermediate node, while forwarding a Route Request, enters the previous node address and its BcastID. A timer is used to delete this entry in case a Route Reply is not received before the timer expires. This helps in storing an active path at the intermediate node as AODV does not employ source routing of data packets. When a node receives a Route Reply packet, information about the previous node from which the packet was received is also stored in order to forward the data packet to this next node as the next hop toward the destination.

The main advantage of this protocol is that routes are established on demand and destination sequence numbers are used to find the fresh route to the destination. The connection setup delay is lower. It creates no extra traffic for communication along existing links. Also, distance vector routing is simple, and doesn't require much memory or calculation. But it has some disadvantages also. AODV requires more time to establish a connection. Also, intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead. Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption. So research work is still going on by modifying the basic AODV routing protocol.

II. RELATED WORK

AODV [1] is a single-path, reactive routing protocol. Route discovery is using a route request (RREQ) route reply (RREP) cycle. When a source node has data to be sent to a destination node and does not know the route to the destination node, floods a route request (RREQ) packet throughout the network. Several RREQ packets, each travelling on a different path, will reach the destination. The destination node replies (RREP packet) only to the first RREQ packet and drops subsequent RREQ packets with the same source sequence number and broadcast ID. The RREQ packet that arrived at the earliest is likely to have traversed a path with low delay and/or hop count .Some modification is done in AODV routing protocol according to the application. Different variants of AODV routing protocol is discussed below.

In [2], analyzes the mathematical model of mobile Ad Hoc networks by considering a weighted value of the ratio between sustainable energy and the total consumed energy of nodes in order to find a balance point between them. And it proposes a solution to the problem of energy efficient and load balance. Finally it also presents an improved routing protocol based on the energy and bandwidth. First the node chooses the route that has the maximal weight value as the best route to forward data packets. If the maximal weight value is corresponding with several routes, it chooses the route that has the least hops as the best route. Adding four fields in the message RREQ: energy weight, load weight, the remaining energy threshold and overload threshold. It can calculate the node's current available energy and available bandwidth.

In [3], a protocol with an enhanced route discovery mechanism that avoids the congestion in the route is proposed. The proposed protocol selects route on the basis of traffic load on the node and resets path as the topology changes. Instead of transmitting entire data through one route, new efficient paths are discovered from time to time during transmission. At the destination the average Load ratio is calculated by dividing the reserved field value with the number of hop count. The destination decides on the basis of average value that to which route it has to send reply. A node which have traffic load on it cannot be made more congested by selecting it in the new route. In this way a node which normally must be selected as in case of basic AODV is avoided so load is shared with other nodes. Instead of transmitting whole data through one route, new efficient paths are discovered from time to time during transmission.

In [4], proposed a link stability based on reverse-demand routing protocols M-AODV (Modified Ad Hoc on-demand).AODV only maintain one path on source node to the destination node. When communication path is disconnect, the source node must startup route discovery process over again, which causes degrade of the routing performance, like high power consumption, long end-to-end delay and inevitably low packet delivery ratio. At the same time AODV routing protocol will remove the link when it's timeout, even it is no failure. In the SR-AODV (Stability Reverse AODV)protocol, the network node sends periodic hello packets, hello packets received by the establishment of a neighbor node list, record ill and the corresponding neighbor receiving time and receive power. After the use of hello packets received on this neighbor list updates. When the source node receives a route with the stability of R-RREQ, link stability of the source node to destination node is calculated. Then choose a stability highest communicate from multi-path, and the rest of the link is saved as a backup link. When a route established between source and destination, data transmission stage can be started. In high mobility environments, link failure is a common phenomenon which can be occurred. The SRAODV routing algorithm is suitable for these environments. Here, add link stability parameter to R-AODV algorithm to select the best route between available routes set, when active route fails.

In [5], an Efficient Flooding Algorithm has been proposed that makes use of the nodes position to rebroadcast the packets and efficiently spread the control traffic in the network. The proposed algorithm is applied on the route discovery process of Ad-hoc On Demand Distance Vector (AODV) protocol to reduce the number of propagating Route Request (RREQ) messages. The RREQ has been modified by assigning a list to the RREQ contain fourth Candidate Neighbours to Rebroadcast the RREQ (CNRR). The main aim of this work is to design an efficient flooding algorithm for mobile ad hoc network to improve the network performance by eliminating the redundant retransmission, therefore reducing the chances of contention and collision among the neighboring nodes. The key concept of the proposed algorithm is to partition the radio transmission range of the mobile node into four zones. Then, one node per zone is selected to forward the RREQ. The selection process is performed by determining the closest node to the edge of the zone to provide more coverage area.

In [6] ,proposed a new routing protocol called AD-AODV based on the famous AODV protocol. By introducing a new metric M whose value depends on the hop number and average mobility of a given route, improve the routing mechanism of AODV and enable AD-AODV to select the most stable route. Every node in a mobile Ad-hoc network counts the number of nodes that join and leave its range respectively in a certain period of time (hello interval). Taking advantage of these two numbers and the amount of this nodes neighbours, obtain every nodes relative mobility. A route containing high speed nodes is not suitable to be the transmission route even if it has the least hops. Route average mobility is a important parameter that assists the destination node to make a rational decision. To take both route hop and route average mobility into consideration, define a new parameter M, which is the sum of average mobility and hop count. The destination node calculates each routes M and select the smallest one for data transmission. A destination node will refresh the routing table and note down the smallest value of M.

In [7], an innovative idea to be made in Mobile Ad-hoc Network which provides an ease towards the packet transferring rate is proposed . So far in literature it is given many more ideas regarding the accretion of efficiency in MANET. This work proposed an easiest method to be adopted in present Ad-hoc network. This method is gives as SaP(Short alternate Path) protocol, a simplest method to improve the working of MANET. The packets are transferred to the destination with the route that they have found through route request mechanism. When the transmission takes place all the nodes keep checking the next node whether they are capable of receiving and transmitting the packets. If the node finds any node weak or about to fail, then the nodes salvages the packets it transmits. Once of the node fails it starts finding the alternate node. This alternate node is such that the node is near to the next node of the failed node in the route and the node finding the alternate path. Thus after discovering this node it transmits the packets to the destination without changing the route it first discovered.

In [8], proposed an EEAODV routing protocol which is an enhancement in the existing AODV routing protocol. The routing algorithm which is adopted by Energy Efficient Ad Hoc Distance Vector protocol (EE-AODV) has enhanced the RREQ and RREP handling process to save the energy in mobile devices. EE-AODV considers some level of energy as the minimum energy which should be available in the node to be used as an intermediary node . When the energy of a node reaches to or below that level, the node should not be considered as an intermediary node, until and unless no alternative path is available.

In [9], suggested a new method is knowledge based learning algorithm. AODV protocol is most commonly used for the data transfer. But there is a problem in AODV routing protocol i.e. link failure problem which is responsible for degrade the performance of the network. So proposed a KBL (knowledge based learning algorithm) technique for the better performance of the Ad-hoc Network. In the proposed work consider a new path for transferring data. To find out the best path first assumption is based upon the signal strength. Source node check the visibility of the adjacent nodes and those nodes further checks the visibility of their adjacent nodes. The path which has the maximum average value is selected as the final path. So this will overcome the problem of link failure. Follow that path only which has the highest signal strength. The path which has the minimum hop count is considered as the final path. Third assumption is based upon the sequence number. The fresh sequence number nodes path will be select as final path. So in this way with the help of signal strength best path will be select in enhanced AODV. This will help to improve the performance of system than simple AODV.

In MANET congestion is main issue. When many number of nodes transmitted packets across the network then network increases congestion which may leads to packets losses. The proposed system in [10] modifies the existing AODV algorithm by using congestion control phenomena. In this system the node waits for acknowledgement for the threshold period of time. If the acknowledgement not received with in threshold period then the node broadcast again to select alternate path. In the existing work there is no phenomenon to handle the congestion effectively. The proposed system modifies or enhances the existing AODV algorithm by using congestion control phenomena. In this system the node transmit packets and waits for acknowledgement for the threshold period of time. If the acknowledgement not received with in threshold period then the node broadcast again to select alternate path. Due to this threshold period of time the proposed system detects and control congestion very fast than existing system.

In [11], proposed a modified version of AODV termed as AODVHPR where certain nodes are assumed to be high energy transmission nodes known as High Power Routing (HPR) nodes, utilized for routing. This work proposes a modified version of AODV termed as AODVHPR where certain nodes are assumed to be high energy transmission nodes known as High Power Routing (HPR) nodes, utilized for routing. The route is established only through HPR nodes which are capable of communicating to long distance. In proposed routing scheme, the HPR nodes only will be allowed to forward the RREP and RREQ messages. In other words, between S and D, a route can be established only through HPR nodes. As the focus of the proposed system is just on minimizing flooding and thereby reducing routing overhead.

In [12], solution is termed as Improved Optimum Angle Selection AODV (IOASAODV) routing algorithm is proposed. The topology change leads to frequent breakage of link. In this paper a new algorithm is proposed which avoid the congestion and repair the broken link by choosing a set of limited nodes for alternate route based on the quadrant position, battery status, queue length, and forwarding region. The proposed solution is termed as Improved Optimum Angle Selection AODV (IOASAODV) routing algorithm. This algorithm selects a limited set of nodes in order to find a new alternate route based on battery status, queue length, quadrant position, and forwarding region.

In [13],proposed Gossip based Balanced Battery Usage Routing Protocol to Minimize Energy Consumption of MANETs a gossip based balanced battery usage routing protocol (GBBU) which integrates minimum residual energy and node degree as cost metric to minimize and distribute energy consumption of MANETs based on Ad hoc on demand distance vector (AODV). The algorithm combines minimum remaining energy and node density or number of neighbor nodes as a cost metric to minimize energy consumption of MANETs. In GBBU-AODV scheme, the gossiping probability for each node is calculated based on the minimum residual energy from source to the node itself. Thus the algorithm protects small residual energy nodes as part of data communication route by assigning small rebroadcasting probabilities for each intermediate node on the path. GBBU-AODV has better energy consumption per packet delivered, delivery ratio, average end-to-end delay and network lifetime than both AODV and gossip routing protocols.

In [14], suggested an algorithm to finds the transmission energy between the nodes relative to the distance and the performance of the algorithm is analyzed between two metrics Total Transmission energy of a route and Maximum Number of Hops. Nodes in Mobile Ad Hoc Networks are limited battery powered. That’s why energy efficient routing has become an important optimization criterion in MANETs. The conventional routing protocols do not consider energy of the nodes while selecting routes which leads to early exhaustion of nodes and partitioning of the network. The proposed algorithm finds the transmission energy between the nodes relative to the distance and the performance of the algorithm is analyzed between two metrics Total Transmission energy of a route and Maximum Number of Hops. The proposed algorithm provides energy efficient path for data transmission and maximizes the lifetime of entire network.

In [15] proposed scheme is able to promptly remove attackers from the network with low operating traffic even in the existence of malicious nodes carrying out false accusations but increase in the number of malicious nodes results in a slight increase in the amount of control traffic. This method can revoke a suspicious misbehaved node by only one accusation from any single node with valid certification in the network. This scheme can revoke an accused node based on a single nodes accusation, and reduce the revocation time as compared to the voting-based mechanism.

In [16], proposed a resilient routing algorithm that is more suitable for a Mobile Ad Hoc Network . In the route discovery phase, it differs from AODV, which only establishes one routing path from a source node to the destination node, whereas resilient AODV establishes as many routes as possible. Thus, when the primary route breaks, the node can immediately adopt an alternative route without further route research effort. For any pair of transmission nodes, multiple forward and reverse routes, if they exist, would be kept in the routing table of every node. In sparse MANETs, route fractures frequently a fracture on a primary route is found by an intermediate node, the alternative route stored in the node is immediately used to replace the fractured route. The proposed AODV based routing algorithm in this paper is called Resilient AODV, which modifies RREQ, RREP and RERR messages in AODV, while including two new routing messages, RNTP(Route Note Packet) and RCEP (Route Check Packet). The two new messages RNTP and RCEP are applied in order to avoid loop-routing while the modified RERR procedure is executed in RAODV. This improve the packet loss rate and transmission delay, especially in sparse MANETs.

III. CONCLUSION

In this paper we presented an exhaustive survey about existing AODV routing protocols, most of its conclusions pointed that, not a routing protocol can adapt to all environments, whether it is Table-Driven, On-Demand or a mixture of two kinds, are limited by the network characteristics. While it is not clear that any particular algorithm or class of algorithm is the best for all scenarios, each protocol has definite advantages and disadvantages and is well suited for certain situations. More and more efficient routing protocols for MANET might come in front in the coming future. There are still many issues and challenges which have not been considered. This will be subjected to further investigations.

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