REVIEW OF ENHANCED AODV ROUTING PROTOCOL FOR MOBILE AD HOC WIRELESS NETWORKS

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Abstract—A mobile ad-hoc wireless network (MANET) is a self-configuring infrastructure-less network of mobile devices connected by wireless. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Mobility causes a number of issues in mobile ad hoc networks. To overcome this problem, we have taken overview of different mechanisms proposed by different authors for the enhancement of most commonly used ad hoc on-demand distance vector routing protocol (AODV). In this paper we provide review of piggyback mechanism and weighted neighbor stability algorithm to achieve better route cost and smaller delay respectively. Also we have tried to compare AODV and PWAODV protocols with some experimental results.

Index Terms— Piggyback technique, Neighbor change ratio (NCR), Mobile Ad hoc wireless network (MANET).

I. INTRODUCTION

Recently, the mobility model is considered generally as an important aspect in the area of wireless network, specifically in Ad hoc networks. Node mobility is one of leading factors causing reduced performance in mobile ad hoc networks and limiting network scalability. Selecting stable paths is an effective way to moderate the impact of node mobility.

Then the probability of breaking of links may increase and the interruption will lead to higher route cost and longer delay due to frequent route repair. So mainly discovering the stability of links has become necessary and important. This technique uses a Neighbor Change Ratio mobility metric and does not require any GPS supporting hardware function or cross layer support which is very complex, critical and expensive. The method selects paths which have small hop counts and stable local topologies. An extension to the AODV routing protocol is used as an example of using the Neighbor Change Ratio metric. But the nodes still need to broadcast Hello packets periodically in meanness of forwarding control packets or data packets which have carried the neighbor messages of their neighbors. To resolve the matter, we introduce the piggyback technique into the neighbor stability algorithm, Hello messages will not need to be broadcast if node has transmitted the packets such as control and data packets in Hello interval. As this the route cost will be reduced impressively.

Using of above techniques instead of the GPS auxiliary hardware or the cross-layer thought we can avoid many problems.

II. RELATED WORK

A. Mobile ad-hoc wireless network (MANET)

A mobile ad-hoc network (MANET) is a self-configuring infrastructure-less network of mobile devices connected by wireless. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Mobile Nodes move randomly and therefore topology of the network changes dynamically. The routing protocols should be able to suffer with dynamic environment. These routing protocols may generally be categorized as Table-driven OR Proactive routing protocols & Source-initiated (demand-driven) OR Reactive routing protocols. Mobility is the main cause of topology change. Change in topology has an impact on performance of routing protocol.

B. Reactive routing protocols

MANET Reactive routing protocols, where each node forms path only when it is needed. source-initiated on-demand only. e.g. Dynamic Source Routing (DSR) [1-2][5], Ad hoc On Demand Distance Vector Routing (AODV) [1-3]. Basic routing protocols don’t find stable routes. They generally select routes based on hop count, but not expected lifetime of the route. In reactive type routing, many protocols are proposed which modify basic routing protocols to find stable routes.

Ad hoc On-Demand Distance Vector (AODV) routing is a routing protocol for mobile ad hoc networks and other wireless ad-hoc networks. AODV provides unicast routes to destinations within the ad-hoc network. It uses a hop by hop method for route discovery. It uses destination sequence numbers to ensure loop freedom at all times avoiding problems associated with classical distance vector protocols. It is jointly developed by C. Perkins, E.M. Belding-Royer and S. Das. It is an on-demand and distance-vector routing protocol, meaning that a route is established by AODV from a destination only on demand. It
is desired that routing protocols should select stable paths i.e. which are less likely to break. In this work, we have implemented one such protocol. Different mobility patterns lead to different performance of routing protocols. Kurnal Patel, Tejas Vasavada[4] found that stable AODV routing protocol works better than normal AODV routing protocol under all mobility models having different mobility.

Neighbor change ratio [11] in this paper a new simple method for selecting stable paths is proposed. This method uses a Neighbor Change Ratio metric. The resulting NCR-AODV protocol is simulated under various mobility and traffic scenarios. The results show that the NCR-AODV protocol has a lower long path break probability and improved network performance compared to the AODV protocol. To minimize the flooding of Hello packets by using a piggyback technique[6]. To minimize route cost, it is important to find out a route which endures longer lifetime. In [6], one such stable routing protocol is proposed. It modifies AODV protocol. An improved AODV i.e PWAODV (Piggyback and Weighted neighbor stability Ad hoc On-demand Distance Vector routing) protocol with lower route cost and smaller delay is presented. Here PWAODV[6] is compared with AODV & NCR AODV[11].

III. AODV PROTOCOL OVERVIEW

The AODV routing protocol is a reactive type on-demand routing protocol; therefore, routes are determined only when required. If Hello messages are used for checking local connectivity, each active node periodically broadcasts a Hello message that messages are received by all its neighbors. Because nodes periodically send Hello messages, if a node fails to receive several Hello messages from a neighbor, a link break is identified.

It broadcasts a Route Request (RREQ) for destination when a source has data for transmission to that an unknown destination. Route to the source is created only when each intermediate node, when a RREQ is received. If the receiving node has not received this RREQ earlier or is not the destination or it does not have a current route to the destination, it rebroadcasts the RREQ. If the receiving node is the destination or has a current route to the destination, it generates a Route Reply (RREP). The RREP is unicast in a hop-by-hop fashion to the source. As the RREP transmits, each intermediate node creates a route to the destination. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. When the source receives the RREP, it records the route to the destination and can initiate sending data.

The node removes the route entry from its routing table when route is not used for some period of time and a node cannot be sure whether the route is still valid or not. As data transmits from the source to the destination, each node along the route updates the timers associated with the routes to the source and destination, maintaining the routes in the routing table. Afterwards If data is flowing and a link break is identified, a Route Error (RERR) is sent to the source of the data in a hop-by-hop fashion. As the RERR transmits towards the source, each intermediate node invalidates routes to any inaccessible destinations. When the source of the data receives the RERR, it invalidates the route and reinitiates route discovery if required.

IV. BRIEF REVIEW OF TECHNIQUES

U By default AODV Link stability algorithm involves Every node broadcasts hello packet to every other node. Neighbor node receives this hello packet and update link table or neighbor table. If for some time node not receives hello packet it removes that node link from link table. If again after some time node receives hello packet it update expiry time of that node in link table. But the problems are arise due to this default AODV link stability Algorithm, broadcasting periodic Hello messages, increase route cost & increase energy consumption and bring the weakening of the entire network.

In this paper two mechanisms are introduce in the ad hoc on-demand distance vector routing protocol (AODV) which provides review of piggyback technique and weighted neighbor stability algorithm to achieve better route cost and smaller delay respectively.

A Piggyback Technique:-
The idea of piggyback is come into picture by the way that Hello messages will not need to be broadcasted if a node has transmitted the packets such as control or data packets in a Hello interval. First send hello packet while starting network, if node has already transmitted the control or data packet then no need to send Hello packet for Hello interval Else send hellow packet separately. In AODV protocol, by using this method, we can reduce the battery consumption that is we can get benefit from lower route cost.

Some periodic Hello messages are dismissed when control packets or data packets which include many messages of nodes to its neighbors are transmitted correctly. Really, such redundancy will increase route cost and energy consumption, even bring the weakening of the entire network.

B Weighted Neighbor stability algorithm:-
The basic idea is as follows, Each node periodically broadcasts a hello message to detect the local connectivity and maintains its neighbor set. The destination selects a stable path to forward data. The following two factors are important to decide path stability. First, a node which has a stable local topology should be selected. If the path is made of nodes with fast changing local topologies, the probability of path breaking will increase. Second, a shorter path should be selected since a long path is more likely to be broken in a dynamic network topology. The Neighbor Change Ratio (NCR) of each node is calculated by comparing the difference between node's neighbor sets in different time periods. A new route metric is proposed as the cumulative product of the Neighbor Change Ratios of all the nodes along a path. The path which has largest value of NCR is selected by destination node. The selected path has a smaller hop count and less local topology changes. The larger the value of NCri, the more stable is the local topology of node i. The smaller the value of NCri, the more changing is the local topology of
node i,
\[
NCR_i(t) = \frac{|S_{i,t-T} \cap S_{i,t}|}{|S_{i,t-T} \cup S_{i,t}|}
\]  
(1)

where \(S_{i,t-T}\) and \(S_{i,t}\) mean the neighbor sets of node \(i\) at \(t-T\) and \(t\). \(T\) represents a Hello interval. The network topology becomes more stable when \(NCR\) value of path is larger.

\[
NCR_{path} = \prod_{i \in \text{path}} NCR_i(t)
\]  
(2)

The \(NCR_{path}\) is a cumulative product of the \(NCR\) of all nodes along the path. The value interval of \(NCR\) is \([0, 1]\). With the cumulative product method used, the destination tries to select a stable path with a smaller hop count and more stable local topologies along the path.

The destination selects the path with the largest value of \(NCR_{path}\) to forward data. Note that the \(NCR\) is a normalized representation of the change degree of local topology. Each node(i) periodically broadcasts a hello message to maintain local connectivity information which will be used to calculate noad’s Neighbor change ratio (NCRi). Maintaining a local connectivity information and calculating noad’s \(NCR\) value are playing important role in this algorithm. It includes two parts as follows:

I) Maintaining local connectivity information

The node determines local connectivity by listening for packets sent from its neighbor set. In every hello_interval, the node checks whether it has sent a broadcast packet within the last hello_interval. If it has not, it may broadcast a hello message with TTL=1. If within the past period of allow_hello * hello_interval, the node does not receive any packets (including hello message), the node will reflect the link to this neighbor has been broken and will remove this node from its neighbor set.

III) Calculating node’s Neighbor Change Ratio

We modify the statistical method of the neighbor set in order to reduce the effect of unpredictable broadcast packets to the neighbor set. Still The expression of \(NCR\) remains the same as in defining Equation (1)above. \(S_{i,t-1}\) is the set of neighbor nodes which have performed during the interval of \([t-1 - \text{allow}_\text{hello} * \text{hello}_\text{interval}], S_{i,t}\) is the set of neighbor nodes which have performed during the interval of \([t2 - \text{allow}_\text{hello} * \text{hello}_\text{interval}], t2-t1=T, \); where \(T=\text{hello}_\text{interval}\). As a result, the observing period of the neighbor set has been extended., but not yet specified for an issue should be cited

V. NCR-AODV ROUTE PROTOCOL

In order to applying Neighbor stability algorithm for selecting stable paths based on the Neighbor Change Ratio, we enhance the performance of AODV on-demand route protocol [9] with the new method. The new route protocol is called the NCR-AODV route protocol. There are four differences between NCR-AODV and AODV:

I) When the intermediate node forwards RREQ packets, The \(NCR_{path}\) field is added in the RREQ (route request) packet. RREQ packet will update the \(NCR_{path}\) field according Equation 2.

II) NCR-AODV does not allow the intermediate nodes to replay with RREQ packets directly to avoid the problem of old neighbor change ratio. This prevention guarantees the use of recent \(NCR\) information.

III) When \(NCR_{path}\) in the following RREQ packet is larger than the previous one then and only then the intermediate nodes forward the repeated RREQ packet.

IV) Each node updates the route table entry only when the current destination sequence number is larger than the previous path, or the current destination sequence number is the same as previous path but the current \(NCR_{path}\) is larger than in the previous path.

The route discovery and maintenance methods of NCR-AODV are as follows:

If nodes does not have a valid route to that destination, it broadcasts a RREQ packet to its neighbors When a source node needs to send packets to a destination node. The fields of the RREQ packet contain the source and destination addresses, the sequence number, the hop count, \(NCR\) path, etc. The flag in RREQ packet is set to true at destination node only, which indicates that only the destination node may respond to this RREQ packet. Only the destination node replying with the RREP packet here intermediate nodes that is nodes on the route to the destination node are prohibited to responding with the RREP packet. Each intermediate node first records the current \(NCR_{path}\) value and sets up a reverse route to the source node. When it receives the RREQ packet. The destination of the reverse route is the source node which first generates and broadcasts the corresponding RREP packet and the next hop of the reverse route is the neighbor node from which it received the corresponding RREQ packet. Then the intermediate node updates the RREQ packet and forwards the RREQ packet to their neighbors. This process continues until the destination node is reached. Multiple duplicate RREQ packets may be received from different neighbors. Only when the destination sequence number in the following RREQ packet is the same as the previous one and \(NCR_{path}\) in the following RREQ packet is larger than the previous one, the intermediate node will update its routing table and forward the repeated RREQ packet. Once the first RREQ packet has arrived at the destination node, the destination node sets up the reverse route to the source node and unicasts a RREP packet back to the neighbor from which it received the corresponding RREQ packet. If the sequence number in the repeated RREQ packet is larger than that in routing cache or the sequence number in the repeated RREQ packet is the same but the \(NCR_{path}\) is larger than that in route cache, the destination modifies the reverse route and unicasts a new RREP packet. The RREP packet is forwarded to the source node along the reverse route. When the node receives the RREP packet, it sets up the forward route. The destination of the forward route is the node which first generates the RREP packet, the next hop of the forward route is the node from which it received the corresponding RREP packet.

When an established path is broken due to node mobility,
to do local repair the upstream node of the broken link broadcasts a RREQ packet. If it does not receive the RREP packet from the destination within a certain period, it sends a RERR (route error) packet to the source node. The source node decides whether to reinitiate the route discovery process or not. The intermediate node is not allowed to reply to the RREP packet directly.

VI. PWAODV ALGORITHM AND PROTOCOL

A For the IEEE 802.11 MAC, the delivery ratio of a one-hop unicast packet is 9.8%, and the delivery ratio of a one-hop broadcast packet is 92.6% [8]. As a result, it is very important to consider the effect of unreliable broadcast packets when the detection scheme of node’s neighbor change ratio and piggyback technique are designed. If idea of piggyback technique is added in to the NCR-AODV protocol we get the concept of PWAODV. Considering all of these techniques, such as piggyback technique and weighted Neighbor stability algorithm, we propose an enhanced AODV protocol.

A. Algorithm of PWAODV:

The main features of PWAODV are the following two points: First, introduce piggyback technique into AODV protocol to reduce the network overhead. Then add the weighted neighbor stability algorithm to achieve more stable route whose delay time must be smaller. In PWAODV. A provision is made for, to avoid the occurrence like this, the node neighbor sets will be computed over several successive periods. For example, we can set a*T as the observation period of neighbor set, and define the set of neighbors in as S_i,tm. So we will gain a NCR by using two times with T interval, such as NCR(t1,t2) at t2, and NCR(t2,t3)=NCR(t1+T,t2+T) at t3=t2+T, in the same way we get the Kth NCR:

\[ NCR(t_k,t_{k+1}) = NCR(t_1+(K-1)T,t_2+(K-1)T). \]

All of these NCRs will be stored in the routing table, and if the number of NCRs exceeds the buffer capacity of the table, the oldest NCR will be covered and updated. For understand the importance of current time and past time, given by \( \lambda = \beta + \delta \leq 1 \). According to formula (3), we can regulate the importance of NCRs at the current time and past time by adjusting the value of \( \lambda \). The bigger the value of \( \lambda \) is, the more important the NCR at the current time is; otherwise, the average of NCRs at historical time is more influential.

B. PWAODV protocol

As the same as AODV, our protocol also broadcasts a RREQ if the source node needs to send a data and no valid route. But the difference is that in PWAODV the NCRpath will be copied in the routing table when the intermediate node receives the RREQ firstly. Then, for the same RREQ received later, just update the routing table and reverse path only if the item of NCRpath is greater. In this way, the RREQ reaches the destination node and the final path will be the most stable one. Next, the destination node will reply a RREP and reply again only if the later received RREQ has greater sequence or equivalent one but greater NCRpath[11]. here the enhanced AODV is implemented based on the version of ns-2.32[8], deals with following steps: first, in AODV protocol, we introduce the piggyback mechanism[6] to prevent the flooding of transmission of Hello messages, and in the RREQ and RREP packets add the parameter of weighted neighbor stability algorithm as a NCRpath. which will be updated when intermediate nodes forward packets; then we only cache the recent Kth NCRs in the table by covering and updating the oldest NCR; at the end, we select the route with the largest sequence of destination node or equal sequence but more stability and also between less hops to send the data.

VII. SIMULATION ENVIORNMENT

For the simulations, we have used NS-2 (v-2.32) network simulator[8]. We used the IEEE 802.11 standard MAC layer. We assume that 50 nodes. The mobility model is random waypoint model, with 5 different maximum speeds (0.5,10,15,20m/s) and pause time varying from 0s to 900s. The data rate of 1Mbps. The parameters of the detection scheme of node’s Neighbor Change Ratio are set as follows. The allow_hello parameter is set to 3 and the hello_interval parameter is set to 1 second. A detailed list of configuration parameters is given in Table

| TABLE I |
|-----------------|-----------------|
| Area            | 1500m*900m      |
| Node-Placement  | Random          |
| Mobility Model  | Random Way Point|
| Simulation Time | 900s            |
| Routing Protocol| AODV            |
| Transmission Range| 250m         |
| CBR Packet Size | 512 bytes       |

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I) Simulation Metrics

There are so many factors on which the performance of both AODV and enhanced AODV were analyzed, following performance measures are investigated.

• Route cost
  Route cost is defined as the ratio of the total number of bytes of transmitted control packets and the total number of bytes of transmitted data packets. Route cost is analyzed with the different maxspeed(m/s) and with different Pause time(s).

• End-to-End Delay
  It refers to the time taken for a data packet to be transmitted from source to destination. The end-to-end delay is analyzed with different maxspeeds(m/s) and with different Pause time(s).

• Packet delivery ratio
  The packet delivery ratio is the ratio of the data packets received by the destinations to those generated by the CBR sources.

• Path break times
  The path break times is the total path break times of all the paths during the simulation period. The smaller the path break times, the more stable the path selected by the routing protocol.

II) Experimental Results

Considering this paper[11] authors described the performances of AODV & NCR-AODV routing protocol in three different CBR traffic scenario. In the first scenario, there is only one CBR flow between 2 static nodes. In the second scenario, there are three CBR flows between six static nodes. The third scenario has five CBR flows between 10 static nodes. Out of three CBR traffic scenario, first scenario gives us best performance results according to Packet delivery ratio, end-to-end delay & the path break times. The average path break times per CBR flow of the three traffic scenarios are very close to each other. All these phenomena show that node’s mobility is the main factor for causing path breaks and the packet transmission failure of the MAC layer due to the increasing traffic load is a subordinate factor for causing path breaks.

In this paper[6] author described about the comparative study of performance of the Enhanced AODV that is PWAODV according to the simulation metrics as route cost and end-to-end delay. They observes the simulation results taken a value of K=4, & with taken variety values of weighted coefficients (λ). Our PWAODV protocol is compared with AODV and NCR-AODV. We have 0.25 ≤ λ ≤ 1 When K=4. Three appropriate values of λ {0.4, 0.7, 1.0} are selected to analyze the performance of protocols with different maxspeeds & different pause times.
These metrics are used to reflect the influence of the route scheme on network performance. Here NCR-AODV performs better than AODV in the mobile scenarios.

VIII. CONCLUSION

In this paper we provide descriptions of different techniques proposed for improving the performance of AODV ad hoc on-demand distance vector routing protocol in MANET’s. We also discuss about the performance of AODV routing protocol using two techniques one by one for observing enhancement according to their routing strategy. Here We have studied the behavior of enhanced AODV is characterized with CBR traffic. It is more beneficial at higher mobility scenario with slightly higher control overheads.

This paper provides review of piggyback technique and weighted neighbor stability algorithm to achieve better route cost and smaller end-to-end delay respectively. Every protocol has definite advantages and disadvantages, and is well suited for certain situations. The field of ad hoc mobile networks is rapidly growing and changing, and while there are still many challenges that need to be met.

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