IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 1, Issue 5, Oct-Nov, 2013
ISSN: 2320 - 8791
www.ijreat.org

A Novel Rebroadcasting Algorithm for MANETs

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Abstract

Mobile Adhoc is infrastructure less network. Here all the nodes are moving in different direction independently. Due to high mobility of nodes , there exist frequent link breakages which lead to frequent path failures and route discoveries. In MANET, the route maintenance and route discovery is very important mechanism for maintaining rout life. In a route discovery, normally we are using flooding scheme for sending and receiving the route request and route reply message. Based on the route discovery, the routing methods are categorized into the following1.Proactive2.Reactive

Reactive Routing Protocol is also called On Demand Routing Protocol like AODV (Adhoc On Demand Vector Routing)and DSR(Dynamic Source Routing) and they could improve scalability of MANETs by limiting the routing overhead when a new route is requested. However, due to node mobility in MANETs, frequent link breakages may lead to frequent path failures and route discoveries, which could increase the overhead of routing protocols and reduce the packet delivery ratio and increasing the end-to-end delay

Index Terms—*Mobile ad hoc networks, neighbor coverage, network connectivity, probabilistic rebroadcast, routing overhead*

1. Introduction

1.1 MANETs

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. Such networks may operate by themselves or may be connected to the larger Internet. Routing in MANETs is difficult since mobility causes frequent network topology changes and requires more robust and flexible mechanisms to search for and maintain routes. When the network nodes move, the established paths may break and the routing protocols must dynamically search for other feasible routes. With a changing topology, even maintaining connectivity is very difficult. In addition, keeping the routes loop free is more difficult when the hosts move. Besides handling the topology changes, routing protocols in MANETs must deal with other constraints, such as low bandwidth, limited energy consumption, and high error rates, all of which may be inherent in the wireless environment. Furthermore, the possibility of asymmetric links, caused by different power levels among mobile hosts and other factors such as terrain conditions, make routing protocols more complicated.

1.2 Proactive Routing Protocol

Proactive routing protocols maintain routes to all destinations, regardless of whether or not these routes are needed. In order to maintain correct route information, a node must periodically send control messages. Therefore, proactive routing protocols may waste bandwidth since control messages are sent out unnecessarily when there is no data traffic. The main advantage of this category of protocols is that hosts can quickly obtain route information and quickly establish a session. In this type of routing protocol, each node in a network maintains one or more routing tables which are updated regularly. Each node sends a broadcast message to the entire network if there is a change in the network topology. However, it incurs additional overhead cost due to maintaining up-to-date information and as a result; throughput of the network may be affected but it provides the actual information to the availability of the network. Distance vector (DV) protocol, Destination Sequenced Distance Vector (DSDV) protocol, Wireless Routing protocol Fisheye State Routing (FSR) protocol are the examples of Proactive protocols

1.2.1 Destination Sequenced Distance Vector (DSDV)

Destination sequenced distance vector routing (DSDV) is adapted from the conventional Routing Information Protocol (RIP) to ad hoc networks routing. It adds a new attribute, sequence number, to each route table entry of the conventional RIP. Using the newly added sequence number, the mobile nodes can distinguish stale route information from the new and thus prevent the formation of routing loops.

1.3 Reactive Routing Protocol

In this type of routing protocol, each node in a network discovers or maintains a route based on-demand. It floods a control message by global broadcast during discovering a route and when route is discovered then bandwidth is used for data transmission. The main advantage is that this protocol needs less touting information but the disadvantages are that it produces huge control packets due to route discovery during topology changes which occurs frequently in MANETs and it incurs higher latency. The examples of this type of protocol are Dynamic Source Routing (DSR), Ad-hoc On Demand Routing (AODV) and Associativity Based Routing (ABR) protocols.

1.3.1 DSR-Dynamic Source Routing

The Dynamic Source Routing (DSR) protocol uses the source routing approach (every data packet carries the whole path information in its header) to forward packets. Before a source node sends data packets, it must know the total path to the destination. Otherwise, it will initiate a route discovery phase by flooding a Route Request (RREQ) message. The RREQ message carries the sequence of hops it passed through in the message header. Any nodes that have received the same RREQ message will not broadcast it again. Once an RREQ message reaches the destination node, the destination node will reply with a Route Reply (RREP) packet to the source. The RREP packet will carry the path information obtained from the RREQ packet. When the RREP packet traverses backward to the source, the source and all traversed nodes will know the route to the destination. Each node uses a route cache to record the complete route to desired destinations.

1.3.2 AODV- Adhoc On Demand Routing

Since DSR includes the entire route information in the data packet header, it may waste bandwidth and degrade performance, especially when the data contents in a packet are small. Ad hoc On-Demand Distance Vector (AODV) Routing tries to improve performance by keeping the routing information in each node. The main difference between AODV and DSR is that DSR uses source routing while AODV uses forwarding tables at each node. In AODV, the route is calculated hop by hop. Therefore, the data packet need not include the total path. The route discovery mechanism in AODV is very similar to that in DSR. In AODV, any node will establish a reverse path pointing toward the source when it receives an RREQ packet. When the desired destination or an intermediate node has a fresh route (based on the destination sequence number) to the destination, the destination/intermediate node responds by sending a route reply (RREP) packet back to the source node using the reverse path established when the RREQ was forwarded. When a node receives the RREP, it establishes a forward path pointing to the destination. The path from the source to the destination is established when the source receives the RREP.

2 Related Work

Broadcasting is an effective mechanism for route discovery, but the routing overhead associated with the broadcasting can be quite large, especially in high dynamic networks [1].Chen et al. [2] proposed an AODV protocol with Directional Forward Routing

(AODV-DFR) which takes the directional forwarding used in geographic routing into AODV protocol. While a route breaks, this protocol can automatically find the next-hop node for packet forwarding. Keshavarz-Haddad et al. [3] proposed two deterministic timer-based broadcast schemes: Dynamic Reflector Broadcast (DRB) and Dynamic Connector-Connector Broadcast(DCCB). They pointed out that their schemes can achieve full reachability over an idealistic lossless MAC layer, and for the situation of node failure and mobility, their schemes are robustness. In our protocol, we also set a deterministic rebroadcast delay, but the goal is to make the dissemination of neighbor knowledge much quicker.

3 Proposed System

3.1 Novel Rebroadcasting Algorithm

Here we calculate the rebroadcast delay and rebroadcast probability of the proposed protocol. We usethe upstream coverage ratio of an RREQ packet received from the previous node to calculate the rebroadcast delay,and use the additional coverage ratio of the RREQ packet and the connectivity factor to calculate the rebroadcast probability in our protocol, which requires that each node needs its 1-hop neighborhood information.

3.2RebroadcastDelay

The rebroadcast delay R_d(neigh) of node neighisdefined as follows:

$$\mathbf{D_r(neigh)=1-[|N(source)\cap N(neigh)|/|N(source)|]}$$

$$\mathbf{R_d(neigh)-MaxDelay.D_r(neigh)(1)}$$

where $D_r(neigh_i)$is the delay ratio of node n_i, andMaxDelay is asmall constant delay. |.| is the number of elements in a set. The above rebroadcast delay is defined with the following reasons: First, the delay time is used todetermine the node transmission order. To sufficientlyexploit the neighbor coverage knowledge, it should bedisseminated as quickly as possible. When node s sends anRREQ packet, all its neighborsneigh$_i$; i = 1, 2, . . . ; N(source) receiveand process the RREQ packet

3.2 RebroadcastProbability

The node which has a larger rebroadcast delay may listen to RREQ packets from the nodes which have lower one. For example, if node $neigh_i$ receives a duplicate RREQ packet from its neighborneigh, it knows that how many its neighbours have been covered by the RREQ packet from neigh. Thus, node $neigh_i$ could further adjust its Uncovered set according to the neighbour list in the RREQ packet from neigh. Then, the $U(neigh_i)$ can be adjusted as follows:

$$\mathbf{U(neigh_i)=U(neigh_i)-[U(neigh_i)\cap N(neigh)] \quad (2)}$$

After adjusting the $U(neigh_i)$, the RREQ packet received from neigh is discarded.We do not need to adjust the rebroadcast delay because the rebroadcast delay is used to determine the order of disseminating neighbor coverage knowledge to the nodes which receive the same RREQ packet from the upstream node. Thus, it is determined by the neighbors of upstream nodes and its own. When the timer of the rebroadcast delay of node neigh $_i$expires, the node obtains the final Uncovered set. The nodes belonging to the final Uncovered set are the nodes that need to receive and process the RREQ packet. Note that, if a node does not sense any duplicate RREQ packets from its neighborhood, its Uncovered set is not changed, which is the initial Uncovered set. Now, we study how to use the final Uncovered set to set the rebroadcast probability. We define the additional coverage ratio ($R(neigh_i)$) of node $neigh_i$,as

$$\mathbf{R(neigh_i)=|U(neigh_i)|/|N(neigh_i)| \quad (3)}$$

This metric indicates the ratio of the number of nodes that are additionally covered by this rebroadcast to the total number of neighbors of node $neigh_i$. As Rbecomes bigger, more nodes will be covered by this rebroadcast, and more nodes need to receive andprocess the RREQ packet, and, thus, the rebroadcast probability should be set to be higher. We assume the ratio of the number of nodes that need to receive the RREQ packet to the total number of neighbors of node $neigh_i$isC_f $(neigh_i)$.
we define the minimum C_f $(neigh_i)$ as a connectivity factor,
which is

$$\mathbf{C_f(neigh_i)=N_{const}/|N(neigh_i)| \quad (4)}$$

whereN_{const}= 5.1774 log n, and n is the number of nodes inthe network.

From (4) if $C_f(neigh_i)$is less than 1 then node $neigh_i$is in thedense area of the network,. and when $C_f(neigh_i)$is greater than 1 means node $neigh_i$ is in the sparse area of the network. Combining the additional coverage ratio and connectivityfactor, we obtain the rebroadcast probability $P(neigh_i)$of node $neigh_i$:

$$P(neigh_i)=C_f(neigh_i).R(neigh_i) \quad \textbf{(5)}$$

where, if the $P(neigh_i)$ is greater than 1, we set the $P(neigh_i)$ to 1.

3.3 Algorithm Description

Algorithm 1. Novel Rebroadcasting

```
if$neigh_i$receives a new RREQs from s then
 {
Compute initial uncovered  set
for RREQs:
}
{
Compute the rebroadcast delay $R_d(neigh_i)$
}
According to equation (1)
Set a Timer according to $R_d(neigh_i)$
end if

while$n_i$ receives a duplicate $RREQ_j$fromneigh before
Timer expires do
 Find neighbor node knowledge
discard(RREQj)
end while
if Timer expires then
{
Compute the rebroadcast probability $P(neigh_i)$:
}
according to equation( 2)
according to equation (3)
$P(neigh_i) = C_f(neigh_i)-R(neigh_i)$
if Random(0,1) <=$P(neigh_i)$ then
broadcast(RREQs)
else
discard(RREQs)
end if
end if
```

4. Simulation Result

In order to evaluate the performance of the proposed Novel Rebroadcasting algorithm, we compare it with some other protocols using theNS-2 simulator. We evaluate the performance of routing protocols using the following performance metrics:

MAC collision rate: the average number of packets (including RREQ, route reply (RREP), RERR, andCBR data packets) dropped resulting from thecollisions at the MAC layer per second**.**

Normalizedrouting overhead: the ratio of the totalpacket size of control packets (include RREQ, RREP,RERR, and Hello) to the total packet size of datapackets delivered to the destinations.

Packet delivery ratio: the ratio of the number of datapackets successfully received by the CBR destinationsto the number of data packets generated by theCBR sources.

Average end-to-end delay: the average delay ofsuccessfully delivered CBR packets from source todestination node. It includes all possible delays fromthe CBR sources to destinations.

Number of nodes. We vary the number of nodes from 50 to 300 in a fixed field to evaluate the impact of different network density. random packet loss.

4.1 Performance with Varied Number of Nodes

Fig. 1 shows the effects of network density on the MAC collision rate. In the IEEE 802.11 protocol, the data and control packets share the same physical channel. In the conventional AODV protocol, the massive redundant rebroadcast incurs many collisions and interference, which leads to excessive packets drop.

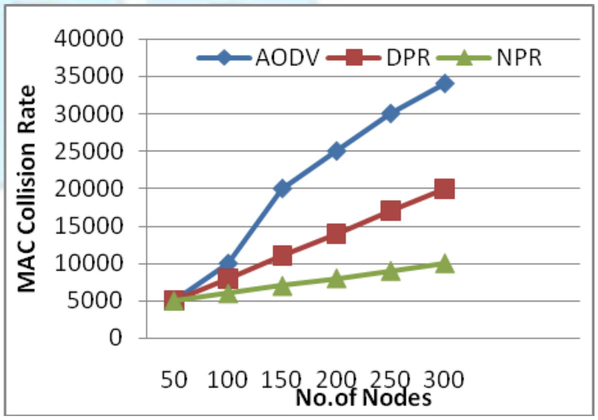

Fig. 1 Effects of network density on the MAC collision rate

Compared with the conventional AODV protocol, the Novel Rebroadcasting algorithm reduces the MAC collision rate by about 92.8 percent on the average. Under the same network conditions, the MAC collision rate is reduced by about 61.6 percent when the Novel Rebroadcasting algorithm is compared with the DPR protocol. This is the main reason that the Novel Rebroadcasting algorithm could improve the routing performance. Fig. 2 shows the normalized routing overhead with different network density

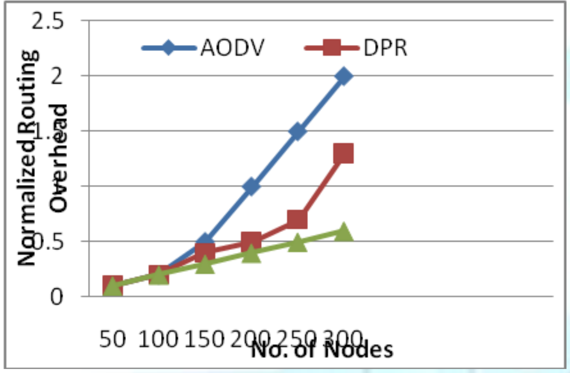

Fig. 2 Normalized routing overhead with different network density.

The Novel Rebroadcasting Algorithm can significantly reduce the routing overhead incurred during the route discovery, especially in dense network.On average, the overhead is reduced by about 45.9 percent in the Novel Rebroadcasting Algorithm compared with the conventional AODV protocol.Under the same network conditions, the overhead is reduced by about 30.8 percent when the NCPR protocol is compared with the DPR protocol. When network is dense, the novel rebroadcasting algorithm reduces overhead by about 74.9 and49.1 percent when compared with the AODV and DPR protocols, respectively.

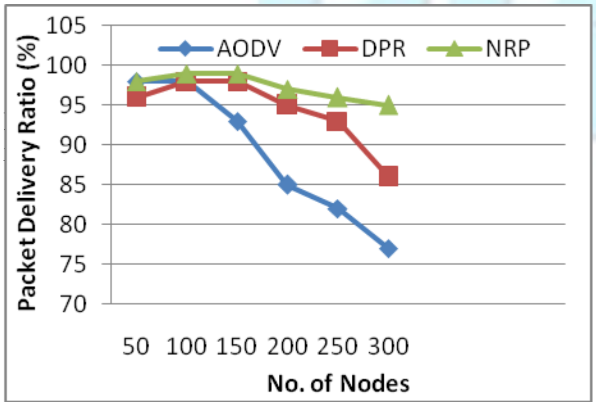

Fig. 3 Packet delivery ratio with increasing network density

The Novel Rebroadcasting algorithm can increase thepacket delivery ratio because it significantly reduces thenumber of collisions.

5. Conclusion

Here, we proposed a Novel rebroadcast Algorithm based on neighbor coverage to reduce the routing overhead in MANETs.We proposed a new scheme to dynamically calculate the rebroadcast delay, which is used to determine the forwarding order and more effectively exploit the neighbour coverage knowledge. Simulation results show that the proposed protocol generates less rebroadcast traffic than the flooding and some other optimized scheme in literatures.

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