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A MODEL OF RETRANSMISSION MECHANISM IN WIRELESS AD HOC NETWORKS

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Abstract

In mobile Adhoc Networks (MANETs), due to high mobility of nodes there exist link breakages which lead to frequent path failures and route discoveries. The overhead of a route discovery cannot be neglected. In a route discovery, broadcasting is a fundamental and effective data dissemination mechanism, where a mobile node blindly rebroadcasts the first received route request packets unless it has a route to the destination, and thus it causes the broadcast storm problem. In this project, a neighbor coverage based probabilistic rebroadcast protocol is used for reducing routing overhead in MANETs. In order to exploit the neighbor coverage knowledge, a novel rebroadcast delay is used to determine the rebroadcast order, and obtain the more accurate additional coverage ratio by sensing neighbor coverage knowledge. And also a connectivity factor is defined to provide the node density adaptation. By combining the additional coverage ratio and connectivity factor, we set a reasonable rebroadcast probability. In proposed system to reduce the routing overhead in mobile adhoc networks' adaptive hybrid routing protocol is used. By implementing this methodology, we can increase the group packet delivery ratio and also reduce the latency of the nodes in adhoc network nodes.

Keywords:

Mobile Adhoc Network, Network Connectivity, Routing Overhead

1. INTRODUCTION

A wireless ad hoc network is a decentralized type of wireless network. The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed wireless networks. Instead, each node. An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network devices in link range. Very often, ad hoc network refers to a mode of operation of IEEE 802.11 networks. It also refers to a network device's ability to maintain link status information for any number of devices in a 1 link (aka hop) range, and thus this is most often a Layer 2 activity. Because this is only a Layer 2 activity, ad hoc networks alone may not support a routable IP network environment without additional Layer 2 or Layer 3 capabilities [1].

The earliest wireless ad hoc networks were the packet radio networks (PRNETs) from the 1970s, sponsored by DARPA after the ALOHA net project. MANETs consist of a collection of mobile nodes which can move freely. These nodes can be dynamically self-organized into arbitrary topology networks without a fixed infrastructure [3].

1.1 APPLICATION OF WIRELESS AD HOC NETWORK

Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations like natural disasters or military conflicts. The presence of dynamic and adaptive routing protocols enables ad hoc networks to be formed quickly. Wireless adhoc network can be further classified by their application [4].

1.2 REQUIREMENTS OF NETWORK

An adhoc network is made up of multiple nodes connected by links. Links are influenced by the node resources (e.g. transmitter power, computing power and memory) and by behavioral properties (e.g. reliability), as well as by link properties (e.g. length-of-link and signal loss, interference and noise) [5].

Since links can be connected or disconnected at any time, a functioning network must be able to cope with this active restructuring, preferably in a way that is timely, efficient, reliable, robust and scalable. The network must allow any two nodes to communicate, by relaying the information via other nodes. A path is a series of links that connects two nodes. Various routing methods use one or two paths between any two nodes; flooding methods use all or most of the available paths. In mobile ad-hoc networks, with the unique characteristic of being totally independent from any authority and infrastructure, there is a great potential for the users. Two or more users can become a mobile ad-hoc network to meet the constraints, without any external intervention [7].

In most wireless ad-hoc networks, the nodes compete for access to shared wireless medium, often resulting in collisions (interference). Using cooperative wireless communications improves immunity to interference by having the destination node combine self-interference and other-node interference to improve decoding of the desired signal. In this project concentrate only on the mobile ad hoc networks (MANETs) [10].

1.3 TYPES OF PROTOCOLS

Williams and Camp categorized broadcasting protocols into four classes. They are

- Simple flooding
- Probability based methods
- Area based methods
- Neighbor knowledge method

1.4 MANETS

One of the fundamental challenges of MANETs is the design of dynamic routing protocols with good performance and less overhead. Many routing protocols, such as Ad hoc On-demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) have been proposed for MANETs. The above two protocols are on-demand routing protocols, and they could improve the scalability of MANETs by limiting the routing overhead when a new route is requested [12].

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 .Thus, reducing the routing overhead in route discovery is an essential problem. The conventional on-demand routing protocols use flooding to discover a route. So broadcast a Route REQuest (RREQ) packet to the networks, and the broadcasting induces excessive redundant retransmissions of RREQ packet and causes the broadcast storm problem which leads to a considerable number of packet collisions, especially in dense networks Therefore, it is indispensable to optimize this broadcasting mechanism. Some methods have been proposed to optimize the broadcast problem in MANETs in the past few years.

For the above four classes of broadcasting protocols, it showed that an increase in the number of nodes in a static network will degrade the performance of the probability based and area based methods .Kim et al indicated that the performance of neighbor knowledge methods is better that of area based ones, and the performance of area based methods is better than that of probability based ones. Since limiting the number of rebroadcasts can effectively optimize the broadcasting and the neighbor knowledge methods perform better than the area based ones and the probability based ones based probabilistic rebroadcast protocol.

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 [9]. Kim et al. [8] studied the broadcast protocol experimentally and analytically observed that there exist a frequent link breakage which leads to frequent path failures and route discoveries. Broadcasting is a fundamental and effective data dissemination mechanism, where a mobile node blindly rebroadcasts the first received route request packets unless it has a route to the destination, and thus it causes the broadcast storm problem. So a neighbor coverage based probabilistic rebroadcast protocol is used for reducing routing overhead in MANETs. It combines the advantages of the neighbor coverage knowledge and the probabilistic mechanism, which can significantly decrease the number of retransmissions so as to reduce the routing overhead, and can also improve the routing performance.

The main contribution of this paper is to calculate rebroadcast delay, rebroadcast probability, connectivity factor and additional coverage ratio. This protocol generates less rebroadcast traffic than the flooding and some other optimized scheme in literatures. Because of less redundant rebroadcast, the proposed protocol mitigates the network collision and contention, so as to increase the packet delivery ratio and decrease the average end-to-end delay

The probabilistic method on-demand route discovery is used to reduce the overhead involved in the dissemination of RREQs. Peng and Lu [11] proposed a DP Algorithm which is used to avoid broadcast storm problem. It does not eliminate all redundant transmissions based on 2-hop neighborhood information. Two algorithms, Total Dominant Pruning (TDP) and partial Dominant Pruning (PDP), are proposed to eliminate redundant retransmission. Both algorithms utilize neighborhood information more effectively. Simulation results of applying these two algorithms show performance improvements compared with the original dominant pruning. From this paper we got some basic Knowledge about TDP and PDP. We studied the broadcast process in ad hoc wireless networks with an objective of minimizing the number of forward nodes.

Johnson et al. [2] proposed a Dynamic Source Routing (DSR) protocol utilizes source routing and maintains active routes. It has two phases route discovery and route maintenance. It does not use periodic routing message. It will generate an error message if there is any link failure. It also comes under Reactive protocol. The operation of both Route discovery and Route Maintenance in DSR are designed to allow unidirectional links and asymmetric routes to be supported.

The advantages of DSR are,

- Routes only for communicating nodes
- Route caching reduces route discovery overhead
- A single route discovery may find multiple routes
- Packet header size grows with route length.
- Flooding adds complexity.
- Collisions may occur.
- RREP storm problem may be possible.
- Cache inconsistency or invalidation.

Perkins studied that Adhoc on Demand Distance Vector routing protocol is a reactive routing protocol which establish a route when a node requires sending data packets. It has the ability of unicast and multicast routing. It uses a destination sequence number(*DestSeqNum*) which makes it different from other on demand routing protocols. It maintains routing tables, one entry per destination and an entry is discarded if it is not used recently. It establishes route by using RREQ and RREP cycle. If any link failure occurs, it sends report and another RREQ is made. The advantages of AODV are,

- Smaller message size than DSR since full route is not transmitted to source
- Lower connection setup time than DSR

The drawback of AODV are

- If source sequence number is low and intermediate nodes have higher numbers but old routes, state routes can be used
- Still have possible latency before data transmission can begin link break detection adds overhead.

Fue and Kumar [6] observed that to improve the lower bound on the number of neighbors required for the asymptotic connectivity of a dense ad hoc network. Critical to the proof is the use of the $GPoisson(N)$ model, for which the distributions of nodes in non-overlapping areas are not dependent. The result is then extended from $GPoisson(N)$ to the $G(N)$ model of interest, resulting in an improvement in the lower bound for the latter model to $0.129 \log N$ and also observed that the network connectivity performance as a function of k. As k increases, network connectivity improves. For a network with N nodes, if $k = N-1$, any pair of nodes can communicate directly, which is the best achievable connectivity. However, node power must increase to achieve such connectivity, which leads to more signal interference and lower network capacity. Thus the above reference paper induced to reduce the routing overhead by using NCPR.

3. PROPOSED WORK

In the proposed protocol we set a deterministic rebroadcast delay, but the goal is to make the dissemination of neighbor knowledge much quicker. We use the 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.

3.1 UNCOVERED NEIGHBORS SET AND DELAY

When node n_i receives an RREQ packet from its previous node s, it can use the neighbor list in the RREQ packet to estimate how many its neighbors have not been covered by the RREQ packet from s. If node n_i has more neighbors uncovered by the RREQ packet from s, which means that if node n_i rebroadcasts the RREQ packet, the RREQ packet can reach more additional neighbor nodes.

UnCovered Neighbors (UCN) set $U(n_i)$ of node n_i: The UnCovered Neighbors (UCN) set $U(n_i)$ of node ni as follows:

$$U(n_i) = N(n_i)-[N(n_i)\cap N(s)] - \{s\} \tag{1}$$

where $N(s)$ and $N(n_i)$ are the neighbors sets of node s and n_i, respectively. s is the node which sends an RREQ packet to node n_i. According to Eq.(1), we obtain the initial UCN set. Due to broadcast characteristics of an RREQ packet, node n_i can receive the duplicate RREQ packets from its neighbors. Node n_i could further adjust the $U(n_i)$ with the neighbor knowledge. In order to sufficiently exploit the neighbor knowledge and avoid channel collisions, each node should set a rebroadcast delay.

The choice of a proper delay is the key to success for the proposed protocol because the scheme used to determine the delay time affects the dissemination of neighbor coverage knowledge. When a neighbor receives an RREQ packet, it could calculate the rebroadcast delay according to the neighbor list in the RREQ packet and its own neighbor list.

3.2 REBROADCAST DELAY $T_d(n_i)$ OF NODE n_i

The Rebroadcast delay $T_d(n_i)$ of node n_i is defined as follows:

$$T_p(n_i) = 1\text{-}N(s)\cap N(n_i)/N(s)$$

$$T_d(n_i) = \text{MaxDelay}\times T_p(n_i) \tag{2}$$

where $T_p(n_i)$ is the delay ratio of node n_i, and MaxDelay is a small constant delay. |•| is the number of elements in a set.

The above rebroadcast delay is defined with the following reasons: Firstly, the delay time is used to determine the node transmission order. To sufficiently exploit the neighbor coverage knowledge, it should be disseminated as quickly as possible. When node s sends an RREQ packet, all its neighbors n_i, $i = 1,2,$• $|N(s)|$ receive and process the RREQ packet.

Assume that node n_k has the largest number of common neighbors with node s, according to Eq.(2), node n_k has the lowest delay. Once node n_k rebroadcasts the RREQ packet, there are more nodes to receive it, because node n_k has the largest number of common neighbors. Then there are more nodes which can exploit the neighbor knowledge to adjust their UCN sets. Of course, whether node n_k rebroadcasts the RREQ packet depends on its rebroadcast probability calculated in the next subsection. The objective of this rebroadcast delay is not to rebroadcast the RREQ packet to more nodes, but to disseminate the neighbor coverage knowledge more quickly. After determining the rebroadcast delay, the node can set its own timer.

3.3 NEIGHBOR KNOWLEDGE

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

$$U(n_i) = U(n_i)\text{-}[U(n_i)\cap N(n_j)] \tag{3}$$

3.4 REBROADCAST PROBABILITY

In order to calculate rebroadcast probability the following are the requirements factor. They are additional coverage ratio ($R_a(n_i)$) of node n_i Connectivity Factor. In order to effectively exploit the neighbor coverage knowledge, a novel rebroadcast delay is used to determine the rebroadcast order, and then obtain the more accurate additional coverage ratio by sensing neighbor coverage knowledge. And also a connectivity factor is defined to provide the node density adaptation.

By combining the additional coverage ratio and connectivity factor, we set a reasonable rebroadcast probability. After adjusting $U(n_i)$, the RREQ packet received from n_j is discarded. There is no 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 timer. When the timer of the rebroadcast delay of node n_i expires, the node obtains the final UCN set. The nodes belonging to the final UCN 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 UCN set is not changed, which is the initial UCN set.

3.5 ADDITIONAL COVERAGE RATIO ($R_a(n_i)$) OF NODE n_i

The additional coverage ratio ($R_a(n_i)$) of node n_i as:

$$R_a(n_i) = |U(n_i)||N(n_i)| \tag{4}$$

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 n_i.

The nodes that are additionally covered need to receive and process the RREQ packet. As Ra becomes bigger, more nodes will be covered by this rebroadcast, and more nodes need to receive and process the RREQ packet, and, thus, the rebroadcast probability should be set to be higher. Xue and Kumar [9] derived that if each node connects to more than 5.1774log$n$ of its nearest neighbors, then the probability of the network being connected is approaching 1 as n increases, where n is the number of nodes in the network. Then use 5.1774log$n$ as the connectivity metric of the network. Assume the ratio of the number of nodes that need to receive the RREQ packet to the total number of neighbors of node n_i is $F_c(n_i)$. In order to keep the probability of network connectivity approaching 1,

$$|N(n_i)| \cdot F_c(n_i) \geq 5.1774 \log n$$

3.6 CONNECTIVITY FACTOR

The minimum $F_c(n_i)$ as a connectivity factor, which is:

$$F_c(n_i) = N_c/|N(n_i)| \tag{5}$$

where $N_c = 5.1774 \log n$, and n is the number of nodes in the network.

3.7 OBSERVATION FROM CONNECTIVITY FACTOR

The following is the observation made from Eq.(5), when $|N(n_i)|$ is greater than N_c, $F_c(n_i)$ is lesser than 1. That means node n_i is in the dense area of the network, then only part of neighbors of node n_i forwarded the RREQ packet could keep the network connectivity, if $|N(n_i)|$ is less than N_c, $F_c(n_i)$ is greater than 1.

Node n_i is in the sparse area of the network, then node n_i should forward the RREQ packet in order to approach network connectivity.

Combining the additional coverage ratio and connectivity factor, we obtain the rebroadcast probability $Pre(n_i)$ of node n_i:

$$Pre(n_i) = F_c(n_i) \cdot R_a(n_i) \tag{6}$$

where, if the $Pre(n_i)$ is greater than 1, we set the $Pre(n_i)$ to 1. The above rebroadcast probability is defined with the following reason.

Although the parameter R_a reflects how many next-hop nodes should receive and process the RREQ packet, it does not consider the relationship of the local node density and the overall network connectivity. The parameter F_c is inversely proportional to the local node density. That means if the local node density is low, the parameter F_c increases the rebroadcast probability, and then increases the reliability of the NCPR in the sparse area. If the local node density is high, the parameter F_c could further decrease the rebroadcast probability, and then further increases the efficiency of NCPR in the dense area.

The parameter F_c adds density adaptation to the rebroadcast probability. Note that the calculated rebroadcast probability $Pre(n_i)$ may be greater than 1, but it does not impact the behavior of the protocol. It just shows that the local density of the node is so low that the node must forward the RREQ packet. Then, node n_i need to rebroadcast the RREQ packet received from s with probability $Pre(n_i)$.

3.8 PROPOSED WORK

Even though the existing system is a fundamental and effective data mechanism the disadvantages of existing system are:

- Increases the overhead of routing and collision
- Frequent link breakages may lead to frequent path failures and route discoveries
- Complexity of calculation
- It does not support large number of nodes and
- Low channel utilization, and contention

3.8.1 *Algorithm:*

The formal description of the Neighbor Coverage based Probabilistic Rebroadcast (NCPR) for reducing routing overhead in route discovery is shown in Algorithm.

$RREQ_v$: RREQ packet received from node v.

$R_v.id$: the unique identifier (id) of $RREQ_v$.

$N(u)$: Neighbor set of node u.

$U(u,x)$: Uncovered neighbors set of node u for RREQ whose id is x.

$Timer(u,x)$: Timer of node u for RREQ packet whose id is x.

{Note that, in the actual implementation of NCPR protocol, every different RREQ needs a UCN set and a Timer.}

```
if $n_i$ receives a new RREQs from s then
    {Compute initial uncovered neighbors set $U(n_i,R_s.id)$ for RREQs:}
    $U(n_i,R_s.id) = N(n_i)-[N(n_i)\cap N(s)]-\{s\}$
    {Compute the rebroadcast delay $T_d(n_i)$:}
    $T_p(n_i) = 1-|N(s)\cap N(n_i)|/|N(s)|$
    $T_d(n_i) = \text{MaxDelay} \times T_p(n_i)$
    Set a Timer($n_i,R_s.id$) according to $T_d(n_i)$
end if
while $n_i$ receives a duplicate RREQj from $n_j$ before $timer(n_i,R_s.id)$ expires do
    {Adjust $U(n_i,R_s.id)$}
    $U(n_i,R_s.id) = U(n_i,R_s.id) - [U(n_i,R_s.id)\cap N(n_j)]$
    discard(RREQj );
end while
if $Timer(n_i,R_s.id)$ expires then
    {Adjust $U(n_i,R_s.id)$:}
    $U(n_i,R_s.id) = U(n_i,R_s.id) - [U(n_i,R_s.id)\cap N(n_j)]$
    discard($RREQ_j$);
end while
if $Timer(n_i,R_s.id)$ expires then
    {Compute the rebroadcast probability $Pre(n_i)$:}
    $R_a(n_i) = |U(n_i,R_s.id)|/|N(n_i)|$
    $Fc(n_i) = N_c / |N(n_i)|$
    $Pre(n_i) = F_c(n_i) \cdot R_a(n_i)$
    if Random(0,1) $\leq Pre(n_i)$ then
        broadcast(RREQs)
    else
        discard(RREQs)
    end if
end if
```

4. RESULT

MANETs consist of a collection of mobile nodes which can move freely. These nodes can be dynamically self-organized into arbitrary topology networks without a fixed infrastructure. Ad hoc networks are characterized by frequent change. Many of the diverse application areas for ad hoc networks, including emergency relief operations, battle field applications and environmental data collection, exhibit a high degree of temporal and spatial variation. Nodes may join the network at any time, get disconnected as they run out of power, or alter the physical network topology by moving to a new location. Link characteristics, such as bit error rates and bandwidth, change frequently due to external factors like interference and radio propagation fading. Patterns in the network can shift drastically as applications modify their behavior and redistribute load within the network. Consequently, a primary challenge in ad hoc networks is the design of routing protocols that can adapt their behavior to rapid and frequent changes at the network level. Adhoc routing protocols proposed to date fall between two extremes based on their mode of operation.

4.1 THEORETICAL ANALYSIS

4.1.1 Protocol Implementation:

We modify the source code of AODV in NS-2 (v2.30) to implement our proposed protocol. Note that the proposed NCPR protocol needs Hello packets to obtain the neighbour information, and also needs to carry the neighbor list in the RREQ packet.

The nodes which receive the RREQ packet from node n_i can take their actions according to the value of *num* neighbors in the received RREQ packet:

i. If the *num* neighbors is a positive integer, the node substitutes its neighbor cache of node n_i according to the neighbor list in the received RREQ packet;

ii. If the *num* neighbors is a negative integer, the node updates its neighbor cache of node n_i and deletes the deleted neighbors in the received RREQ packet;

iii. If the *num* neighbors is 0, the node does nothing. Because of the two cases 2) and 3), this technique can reduce the overhead of neighbour list listed in the RREQ packet.

4.1.2 Simulation:

In order to evaluate the performance of the proposed NCPR protocol, we compare it with some other protocols using the NS-2 simulator. Broadcasting is a fundamental and effective data dissemination mechanism for many applications in MANETs. Simulation parameters are as follows: The Distributed Coordination Function (DCF) of the IEEE 802.11 protocol is used as the MAC layer protocol. The radio channel model follows a Lucent's WaveLAN with a bit rate of 2Mbps, and the transmission range is 250 meters. We consider constant bit rate (CBR) data traffic and randomly choose different source-destination connections. Every source sends 4 CBR packets whose size is 512 bytes per second. The mobility model is based on the random waypoint model in a field of 1000m×1000m. In this mobility model, each node moves to a random selected destination with a random speed from a uniform distribution [1, max-speed]. After the node reaches its destination, it stops for a pause-time interval and chooses a new destination and speed. In order to reflect the network mobility, we set the max-speed to 5m/s and set the pause time to 0.

The MaxDelay used to determine the rebroadcast delay is set to 0.01s, which is equal to the upper limit of the random jitter time of sending broadcast packets in the default implementation of AODV in NS-2. Thus, it could not induce extra delay in the route discovery. The simulation time for each simulation scenario is set to 300 seconds. In the results, each data point represents the average of 30 trials of experiments. The confidence level is 95%, and the confidence interval is shown as a vertical bar in the figure. The detailed simulation parameters are shown in Table.1.

Table.1. Simulation Parameters

Simulation Parameters	Value
Simulator	NS-2 (v2.30)
Topology Size	1000m ×1000m
Number of Nodes	300
Transmission Range	250m
Bandwidth	2Mbps
Interface Queue Length	50
Traffic Type	CBR
Number of CBR Connections	10,12,...,15,...,18,20
Packet Size	512 bytes
Packet Rate	4 packets/sec
Pause Time	0s
Min Speed	1m/s
Max Speed	5m/s

4.1.3 Performance Metrics:

- **MAC collision rate**: the average number of packets (including RREQ, route reply (RREP), RERR and CBR data packets) dropped resulting from the collisions at the MAC layer per second.
- **Normalized routing overhead**: the ratio of the total packet size of control packets (include RREQ, RREP, RERR and Hello) to the total packet size of data packets delivered to the destinations. For the control packets sent over multiple hops, each single hop is counted as one transmission.
- **Packet delivery ratio**: The ratio of the number of data packets successfully received by the CBR destinations to the number of data packets generated by the CBR sources
- **Average end-to-end delay**: The average delay of successfully delivered CBR packets from source to destination.

4.2 EXPERIMENTAL ANALYSIS

- **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. In this part, we set the number of nodes to 300.
- **Number of CBR connections**: We vary the number of randomly chosen CBR connections from 10 to 20 with a fixed packet rate to evaluate the impact of different traffic load.

In this part, we set the number of nodes to 150, and also do not introduce extra packet loss.

- **Random packet loss rate**: We use the Error Model provided in the NS-2 simulator to introduce packet loss to evaluate the impact of random packet loss. The packet loss rate is uniformly distributed, whose range is from 0 to 0.1. In the experiments analysis, when two protocols are compared, we use the following method to calculate the average - we assume that the varied parameter is (x_1, x_2,..., x_n), the performance metric of protocol 1 is (y_1, y_2,..., y_n) and the performance metric of protocol 2 is (z_1, z_2,..., z_n). When protocol 1 compares to protocol 2, the average is defined as:

$$[(y_1-z_1)/z_1+(y_2-z_2)/z_2+\ldots+(y_n-z_n)/z_n]/n \times 100\% \qquad (7)$$

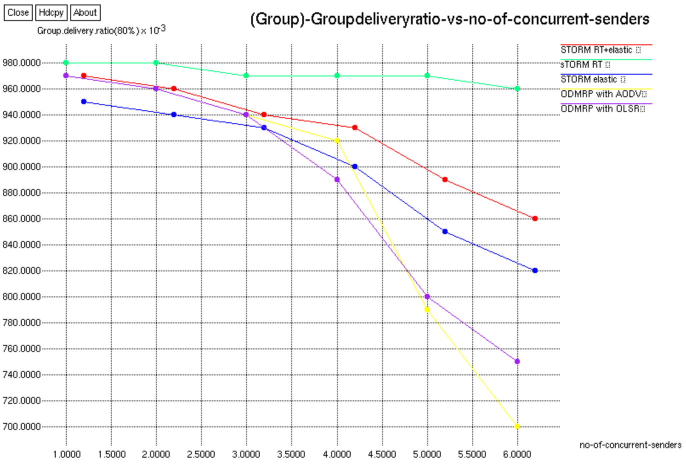


Fig.1. Output for group delivery ratio vs. number of senders

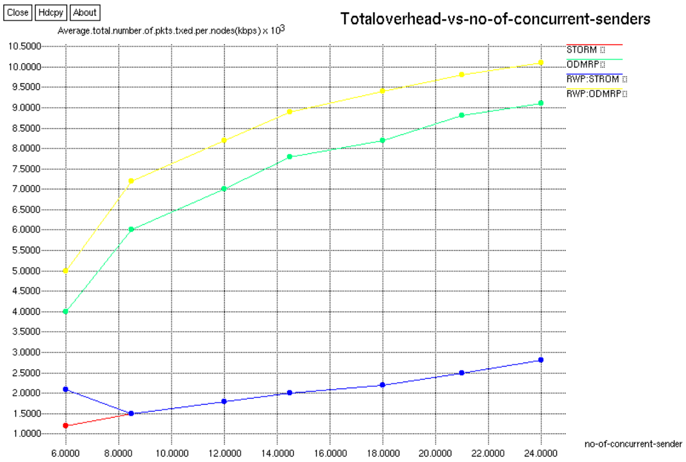


Fig.2. Output for total overhead vs. number of senders

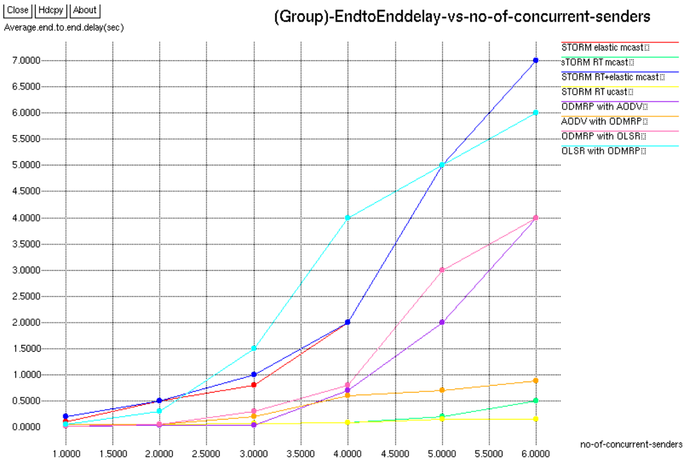
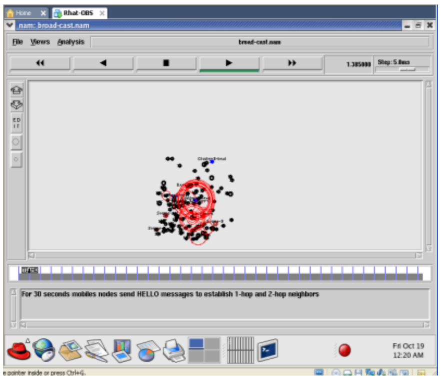


Fig.3. Output for End to End vs. number of senders



For 30 seconds mobiles nodes send HELLO messages to establish 1-hop and 2-hop neighbors

Fig.4. Output for sending Hello messages in NAM window

5. CONCLUSION

In this paper, a probabilistic rebroadcast protocol based on neighbor coverage is used to reduce the routing overhead in MANETs. This neighbor coverage knowledge includes additional coverage ratio and connectivity factor. And also proposed a new scheme to dynamically calculate the rebroadcast delay, which is used to determine the forwarding order and more effectively exploit the neighbor coverage knowledge. Simulation results show that the proposed protocol generates less rebroadcast traffic than the flooding and some other optimized scheme in literatures. Because of less redundant rebroadcast, the proposed protocol mitigates the network collision and contention, so as to increase the packet delivery ratio and decrease the average end-to-end delay. The simulation results also show that the proposed protocol has good performance when the network is in high-density or the traffic is in heavy load.

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