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Neighbour Knowledge Based Overhead Reduction in MANET

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Abstract : *Mobile Ad-hoc Networks (MANETs) are multihop wireless networks with mobile nodes that can move freely. One fundamental primitive in a MANET is searching a path from a source node to a destination. In MANETs, the network topology changes frequently and unpredictably due to the arbitrary mobility of nodes. This feature leads to frequent path failures and route reconstructions, which causes an increase in the routing control overhead. The main objective of the work is to reduce the overhead of route discovery in the design of routing protocols of MANETs. Neighbour knowledge based routing protocol is used to reduce the overhead in route discovery by selectively broadcasting RREQ packets to the uncovered neighbour set instead of all neighbours. Thereby the congestion in the network is reduced considerably which leads to increased lifetime of the network.*
Keywords: *Mobile adhoc networks, neighbor coverage, network connectivity, probabilistic rebroadcast, routing overhead.*

I. INTRODUCTION

Wireless technology, which uses electromagnetic waves to communicate information from one point to another, can be applied to computers and other electronic devices. Although wireless technologies have been used in specific applications for decades, wireless networks have recently become much more widespread due to better technology and lower prices.

Once the IEEE first defined wireless standards in the late 1990's, wireless networking became feasible for a wide range of business and personal applications. Wireless networking offers various advantages over wired connections, including mobility, connectivity, adaptability, and ease of use in locations that prohibit wiring. Universities, airports, and major public places are currently taking advantage of wireless technology, and many businesses, health care facilities, and major cities are developing their own wireless networks. Since the cost of wireless networks has dropped dramatically in recent years, they are also becoming more popular in home computing.

Wireless network operates on a specific set of radio frequencies. It operates on a special band of radio frequencies around 2.4 GHz that have been reserved in most parts of the world for unlicensed point-to-point spread spectrum radio services. The wireless network is broadly classified into two types, Infrastructure Networks and Infrastructure less Networks

II. RELATED WORK:

Literature review is carried out by analyzing many papers relevant to 'hello' messages for neighbourhood discovery. The researchcarried out by different authors is surveyed and the analysis done by the researchers are discussed in the following paragraphs.

1. Signal Stability Based Adaptive Routing (Ssa) For Ad-Hoc Mobile Networks,

R. Dube, C. D. Rais, k. Y. Wang, and S. K. Tipathi, [7] proposed Signal Stability Based Adaptive Routing (SSA) each link is classified as a strong one or a weak one, depending on the received signal strength measured when a node receives data packets from the corresponding upstream node. A mobile node only processes a route request (RREQ) that is received from a strong link.

A source initiates a route discovery request when it has data to send to a destination that is not in the routing table. The route search is broadcast to all neighbouring hosts. These hosts propagate the broadcast if it is received over a strong channel and the request has not been propagated previously (to avoid looping). The route search packet stores the address of each intermediate host in the route taken. The destination chooses the route recorded in the first arriving request, since this route is probably shorter and less congested than routes for slower arriving requests. Take destination returns the route reply along the selected route, and each intermediate node includes the new next-hop, destination pairs in its routing table.

2. Age Matters: Efficient Route Discovery In Mobile Ad-Hoc Networks Using Encounter Ages

Dubois-Ferriere et al. [8] proposed a simple algorithm for efficient route discovery in mobile ad-hoc networks. Nodes keep a record of their most recent encounter times with all other nodes. Instead of searching for the destination, the source node searches for any intermediate node that encountered the destination more recently than did the source node itself. The intermediate node then searches for a node that encountered the destination yet more recently, and the procedure iterates until the destination is reached. Therefore, FRESH replaces the single network-wide search of current proposals with a succession of smaller searches, resulting in a cheaper route discovery.

Routes obtained are loop-free a FRESHER Encounter Search (FRESH) scheme that steers a flooding-based search in the general direction of the destination by using encounter ages, and then, it can reduce the number of packet transmissions required to find the destination.

3. The Polarized Gossip Protocol For Path Discover In Manets

Beraldi [3] proposed a new kind of gossip algorithm, dubbed polarized gossip. The polarized gossip algorithm is characterized by a polarizing node, n*, and two gossiping probabilities, pF and pB. The key difference with uniform gossip is that the relaying probability of a node is determined by the node from which the message is being received. More precisely, the algorithm prescribes that if a node i receives a message for the first time and from node j, it forwards the message with probability pF if i is closer than j to the destination and with probability pB otherwise. We explicitly note that to obtain such behaviour it is not necessary that a node knows its real current distance from n*. Rather, nodes can simply estimate their distances with a precision high enough to assure that the message is gossiped with the nominal probabilities. To exemplify, suppose the correct relative position is known with probability q. Then the polarized gossip algorithm with pF = q and pB = 1 _ q is straightforwardly implemented by letting a node to forward the message if it estimates to be closer than the sending node to the destination and discards it otherwise. In other words, the gossiping probability is translated into a margin on the correctness of estimations.

4. Neighbour-Assisted Route Discovery In Wireless Ad Hoc Networks

Gomez et al. [11] proposed a neighbour-assisted route discovery (NARD) protocol. NARD is intended for medium to large ad-hoc networks where traditional flooding is not a practical solution. In NARD, a source node floods a limited portion of the network looking not only for the destination node, but also for information related to other nodes (called neighbours) that were known to be near the destination node recently. Neighbor nodes can be used as anchor points where a second limited flooding takes place in search for the destination node. Because only two limited portions of the network near the source and destination nodes are flooded by control packets, NARD can significantly reduce the signaling overhead of route discovery compared with blind flooding techniques. In NARD, when a source node floods the RREQ packet to a limited region of the network, it looks not only for the destination node but for some neighbours that have been near the destination node recently as well. The second limited flooding that searches for the destination node can use the neighbour nodes as anchor points and then reduces the control overhead of route discovery.

5. Mobility Prediction Based Neighbourhood Discovery In Mobile Ad-Hoc Networks

Xu Li, Nathalie Mitton [21] proposed a novel mobility prediction based hello protocol, named ARH (Autoregressive Hello protocol). Each node predicts its own position by an ever-updated auto regression-based mobility model, and neighbouring nodes predict its position by the same model. The node transmits 'hello' message (for location update) only when the predicted location is too different from the true location (causing topology distortion), triggering mobility model correction on both itself and each of its neighbours.

ARH evolves along with network dynamics, and seamlessly tunes itself to the optimal configuration on the fly using local knowledge only. Through simulation, we demonstrate the effectiveness and efficiency of ARH, in comparison with the only competitive protocol TAP (Turnover based Adaptive hello Protocol). ARH achieves as high neighbourhood discovery performance as the best-known algorithm TAP at dramatically reduced 'hello' rate (about 50% smaller).

III. MOBILE AD-HOC NETWORK

A mobile ad-hoc network (MANET) is a collection of nodes, which have the possibility to connect on a wireless medium and form an arbitrary and dynamic network with wireless links. That means that links between the nodes can change during time, new nodes can join the network, and other nodes can leave it. A MANET is expected to be of larger size than the radio range of the wireless antennas, because of this fact it could be necessary to route the traffic through a multi-hop path to give two nodes the ability to communicate. There are neither fixed routers nor fixed locations for the routers as in cellular networks - also known as infrastructure networks. Cellular networks consist of a wired backbone which connects the base-stations. The mobile nodes can only communicate over a one-hop wireless link to the base-station; multi-hop wireless links are not possible. By contrast, a MANET has no permanent infrastructure at all. All mobile nodes act as mobile routers. A MANET is depicted in Figure 3

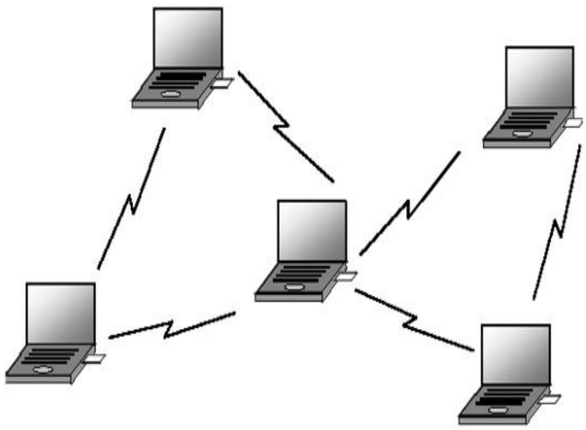

Figure 1 Mobile Ad-Hoc Networks (MANET)

The set of applications for MANET is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANET need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path (based on a given cost function) from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANET. Factors such as variable wireless link quality, propagation path loss, fading, multi-user interference, power expended, and topological changes, become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects.

1 Ad-hoc On-Demand Distance Vector (AODV)

AODV is a very simple, efficient, and effective routing protocol for Mobile Ad-hoc Networks which do not have fixed topology. This algorithm was motivated by the limited bandwidth that is available in the media that are used for wireless communications. It borrows most of the advantageous concepts from DSR and DSDV algorithms. The on demand route discovery and route maintenance from DSR and hop-by-hop routing, usage of node sequence numbers from DSDV make the algorithm cope up with topology and routing information. Obtaining the routes purely on-demand makes AODV a very useful and desired algorithm for MANET.

The Ad-hoc On-Demand Distance Vector (AODV) protocol enables dynamic, self-starting, multi-hop routing between participating mobile nodes wishing to establish and maintain an ad-hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. The operation of AODV is loop-free, and by avoiding the Bellman-Ford "counting to infinity" problem offers quick convergence when the ad-hoc network topology changes (typically, when a node moves in the network). One distinguishing feature of AODV is its use of a destination sequence number for each route entry. The destination sequence number is created by the destination to be included along with any route information it sends to requesting nodes. Using destination sequence numbers ensures loop freedom and is simple to program.

1.1 Knowledge Based Routing Protocol

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. The broadcasting incurs large routing overhead and causes many problems such as redundant retransmissions, contentions, and collisions. Thus, optimizing the broadcasting in route discovery is an effective solution to improve the routing performance.

1.2 Uncovered Neighbors Set and Rebroadcast 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 neighbours 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. To quantify this, we define the Un-Covered Neighbours set $U(n_i)$ of node n_i as follows:

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

where N(S) and $N(n_i)$ are the neighbours sets of node s and n_i, respectively. S is the node which sends an RREQ packet to node n_i.

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 neighbour knowledge. In order to sufficiently exploit the neighbour 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. The rebroadcast delay $T(n_i)$ of node n_i is defined as follows:

$$T_p(n_i) = 1 - \frac{|N(s) \cap N(n_i)|}{|N(s)|}$$

$$T_d(n_i) = MaxDelay \times T_p(n_i)$$

where $T(n_i)$ is the delay ratio of node n_i, and MaxDelay is a small constant delay. j _ j is the number of elements in a set. The above rebroadcast delay is defined with the following reasons: First, 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. We assume that node nk has the largest number of common neighbors with node s, according to 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 section. 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.

2 Neighbor Knowledge and Rebroadcast Probability

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 nj. Then, the $U(n_i)$ can be adjusted as follows:

$$U(n_i) = U(n_i) - [U(n_i) \cap N(n_j)]$$

After adjusting the $U(n_i)$, the RREQ packet received from n_j 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 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. Now, we study how to use the final UCN set to set the rebroadcast probability. We define the additional coverage ratio ($R_a(n_i)$) of node n_i as

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

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.

IV. SIMULATION SETUP AND RESULTS

The table 4.1 shows the value of each parameter used and the protocol used.

Table 4.1 Simulation setup

Parameter	Value
Channel type	Wireless channel
Propagation model	Two ray ground
Simulation area	1600 x 1000 m^2
Number of mobile nodes	50-200
Transmission range	250m
Node moving speed	15m/ s
Movement model	Random way point
MAC type	IEEE 802.11 DCF
Pause time	0s
P_{max}	1.0
P_{min}	0.3
Training execution time	900 s

4.1 Packet Delivery Ratio

The figure 4.3 shows the Packet Delivery Ratio between sources and destinations in the output Network animator (NAM) window.

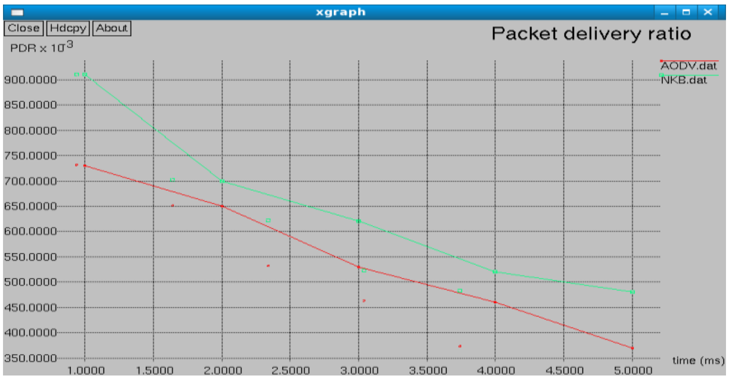

Figure 4.1 Packet Delivery Ratio

The above figure describes packet delivery ratio by comparing AODV protocol with Neighbour knowledge based protocol. It shows that NKB protocol has better packet delivery ratio when compared to AODV.

V. CONCLUSION AND FUTURE WORK

In this Neighbour Knowledge based routing protocol is used to reduce the routing control overhead by restricting the propagation range of RREQ packets. In order to effectively utilize the neighbour knowledge we have to find a node which has more common neighbours than the previous node. Hence the information that the nodes have transmitted the packets would spread to more neighbor,This cloud further reduce the routing overhead.

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