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RESEARCH ARTICLE

A NEIGHBOUR COVERAGE PROTOCOL FOR REDUCING ROUTING OVERHEAD IN MOBILE AD HOC NETWORKS

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Abstract: Mobile ad hoc network is a wireless network without any infrastructure less network and self-managed networks. The mobile nodes are connected with links and data packets are transferred from node to another node and vice versa. A simple flooding approach is used by the mobile node if the destination is not within the hop region. If the data packet is not transferred within a particular time, rebroadcast of data packet is done and which leads to overhead in Manet. In this paper we propose a neighbor coverage probabilistic rebroadcast protocol for reducing routing overhead in Manet. In order to find the neighbor coverage nodes, we propose a novel rebroadcast delay to determine the common neighbors. We also define a rebroadcast probability which is the combination of additional coverage ratio and connectivity factor. The both approaches are defined to reduce the number of retransmissions so as to reduce the routing overhead, collision rate and improve the packet delivery ratio.

1. Introduction

A mobile ad hoc network consists of multiple mobile nodes that does not have any infrastructure and which moves freely from one place to another place. Mobile nodes are self-organized and infrastructure less networks where mobile nodes forward data packets from one node to another node with the help of a routing protocol. The routing protocols are divided into three types, where a pro-active routing type protocol forwards the data packet by using the distance, routing table, link cost table and retransmission table [1]. DSDV and WRP are the best Pro-active routing protocols. The Re-active routing type protocols [2] forwards the data packet without knowing the destination address and uses a simple flooding concept. A node discovery and route response approach is used to forward the packet to destination. Dynamic Source Routing and AODV are the best Reactive routing protocols. And the last hybrid routing protocols are the combination of both pro-active and reactive approach, where in order to find the destination node it acts as Globally pro-active approach [3] and to forward the packet it uses Locally Reactive approach. Zone Routing protocol and Link Reversal routing is the best Hybrid Routing protocol [4]. Williams and camp [5] categorized broadcasting protocols are categorized into four types: "simple flooding, probability based methods, area based methods and neighbor knowledge methods." Zhag [6] described that performance of neighbor knowledge is better than are based method and area based method is better than probability based method. A neighbor coverage probabilistic rebroadcast protocol (NCPR) is used to exploit the neighbor coverage knowledge [7]. A rebroadcast delay is used to determine the rebroadcast order to obtain more accurate additional coverage and to keep network connectivity, reduce redundant transmissions with a connectivity factor. A combination of the additional coverage ratio and connectivity factor is used to calculate Rebroadcast probability for reducing the number of rebroadcasts of Route Request packet (RREQ) to improve routing performance.

The main Contributions of the paper are:

i. Calculate Rebroadcast Delay to determine the forwarding order. The node which has more common neighbors with previous node has lower delay. If a rebroadcast of same message is done, then a rebroadcast delay enables the information that nodes have transmitted the packet to spread to more neighbors.
ii. A Rebroadcast probability that covers the information about the uncovered neighbor's connectivity metric and local node density to calculate the rebroadcast probability.
    a. Additional Coverage Ratio is the number of nodes that should be covered in a single broadcast message.
    b. Connectivity Factor is the relationship of network connectivity and number of the neighbors for a given node.

2. Neighbor Coverage – Based Probabilistic Rebroadcast Protocol

The paper mainly discusses about the Rebroadcast Delay and rebroadcast probability of the proposed protocol. We generally use the RREQ packet to calculate the Rebroadcast delay, Additional coverage and connectivity factor, which generally needs one hop neighbor nodes information and their distances.

A. Rebroadcast Delay:

The rebroadcast delay is used to determine the order of neighbor coverage knowledge to the nodes which receive the Route Request packet from the corresponding neighbor node. If a corresponding node which has large neighbor nodes will usually have the maximum Rebroadcast Delay. The Rebroadcast Delay is generally used to find the forwarding order.

For example consider a wireless network containing various nodes, where X is one of it. We also find the node n_x which has more common neighbor nodes with the previous node.

a. At first we calculates the set of all Uncovered neighbor nodes.
b. We also find the maximum Delay each Uncovered neighbor set.
c. Then a Delay Ratio $T_r(N_x)$ is calculated by node n_x and max Delay of the neighbor set.
d. In order to sufficiently exploit the neighbor knowledge and to avoid channel collisions, each node should set a rebroadcast Delay T_{Delay} by using the Maximum Delay and Delay ratio

   T_{delay} = Max Delay X $T_r(N_{x)}$

B. Neighbor knowledge and Rebroadcast Probability:

The node which has the larger rebroadcast Delay may listen to the RREQ packet from the nodes which has lower one. For example if a node n_x receives a large number of rebroadcasting RREQ packets from a node n_y, then the receiver node n_x finds the number of duplicate RREQ packets sent by the node n_y and also finds the number of nodes that do not cover with the RREQ packets. An additional coverage ratio R_a is used to find the number of nodes additionally covered after rebroadcasting a RREQ packet. Connectivity factor C_f is used to find the number of nodes that need to receive the RREQ packet. By Comparing the connectivity factor C_f and Number of nodes covered by n_x defines weather the node n_x has to rebroadcast the RREQ packet or not. A Rebroadcast probability is used to reduce the overhead and the number of rebroadcasts of RREQ packets. A Rebroadcast Probability is calculated by combing the additional coverage and connectivity factor

a. An Uncovered nodes set will be calculated in order to transfer the RREQ packet to all the corresponding uncovered neighbor nodes.
b. An additional coverage ratio is the ratio of number of nodes that are additionally covered by a rebroadcast to that of total number of nodes.
c. Connectivity factor C_f is the ratio of number of the number of nodes that need to receive the RREQ packet to that of total number of nodes.
d. If number of node is greater than connectivity factor, then the node has to rebroadcast the RREQ packet.
   $N_x > C_{f,}$ then node N_x has to rebroadcast the RREQ packet
e. If number of nodes is equal to connectivity factor, then the node does not require to rebroadcast the RREQ packet.
f. A Rebroadcast probability P_{re} is calculated by combining the additional coverage and connectivity factor.

3. Protocol Implementation

- A base wireless network is created and data packet is forwarded from source to Destination.
- Hello packet is forwarded from one node to another node and RREQ is broadcasted in order to forward the packet from one node to another node. RERR is generally sent from destination point if a packet is dropped.
- Consider a wireless network which contains multiple nodes and a node N_x which checks for the Rebroadcast Delay and Rebroadcast probability, Node N_j which forwards the RREQ packet to node N_x when required. The following steps are to be followed:
  1. First check for an uncovered node set
  2. Calculate and identify Uncovered node first
  3. Calculate Delay Ratio and Maximum Delay of neighbor node set to avoid collision and overhead in the Manet.
  4. Calculate Rebroadcast Delay
  5. Set Rebroadcast Timer according to the Rebroadcast Delay.
  6. If node N_x receives a duplicate RREQ packet from another node N_j before additional coverage expires adjust Uncovered nodes at N_x and discard the RREQ packet from Node $N_{j.}$
  7. If rebroadcast timer expires then compute Rebroadcast probability P_{re}, Additional Coverage and Connectivity factor C_f.
     a. If rebroadcast probability is zero then discard the RREQ packet.
     b. If rebroadcast probability is one then rebroadcast the RREQ packet again.
  8. The node which receive the RREQ packet from node N_x can take their according to the num_neighbors in the received RREQ packet:
     a. If the num_neighbors is positive, node substitutes its neighbor cache of node N_x according to the neighbors list in the RREQ packet
     b. If the num_neighbors is negative, the node updates its neighbor cache of node N_x and deletes the deleated neighbors in the received RREQ packet
     c. If the num_neighbors is Zero, the node does nothing.

4. Simulation Environment

NS2 simulator generates a TCL (Tool Command Language) file. On running a TCL file it results three more files, namely the first one is Terminal File which shows the status of the packet from which node the packet is forwarded and to which node the packet is delivered. The second file is NAM (Network Animator) file which is a visual display showing all the mobile nodes and how packets flow along the network. The third file is the Trace File which shows all the corresponding information regarding the network and data flow.

PARAMETER	SPECIFICATION
Simulation tools used	NS2 Network Simulator NS 2.35
Simulation Time	10s, 20s
Number of nodes	10,20,40,60,100
Transmission Range	250m
Maximum Speed	0-22 m/s
Application Traffic	CBR [constant Bit Rate]
Packet Size	512 bytes
Protocol	AODV, Neighbor cover Protocol
Node Mobility Model	8 Pkts/s

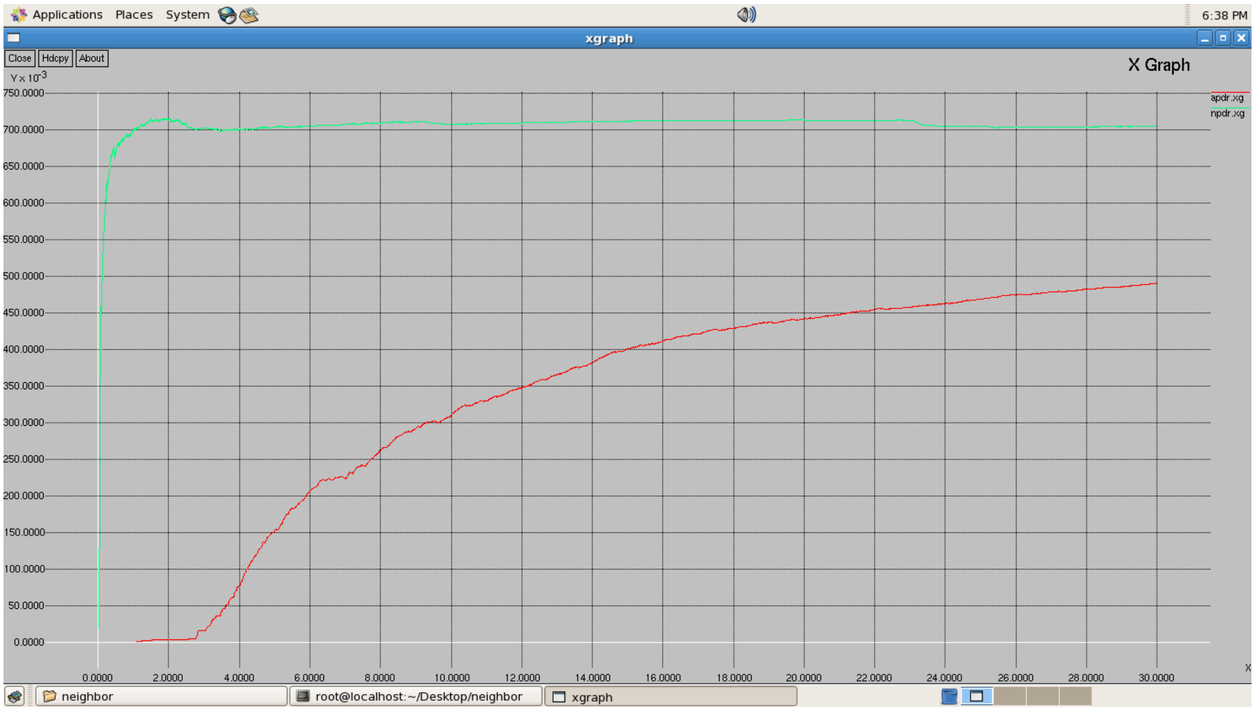
TABLE: SIMULATION PARAMETERS

A wireless ad hoc network is created and a node which has more number of neighbor nodes is chosen. Then a uncovered node set is determined to that particular node. A rebroadcast delay to determine rebroadcast order and connectivity factor to number of nodes that requires RREQ packet to be covered. The Rebroadcast probability is calculated and graphs are plotted for Neighbor packet delivery ratio, neighbor Delay, Neighbor collision rate.

5. Performance of Packet Delivery with AODV and Neighbor Cover Protocol

In the experiment analysis, when two protocols are compared, we use the average method to calculate and compare their performances. We plan to simulate the network with an AODV protocol and Neighbor coverage protocol simulation.

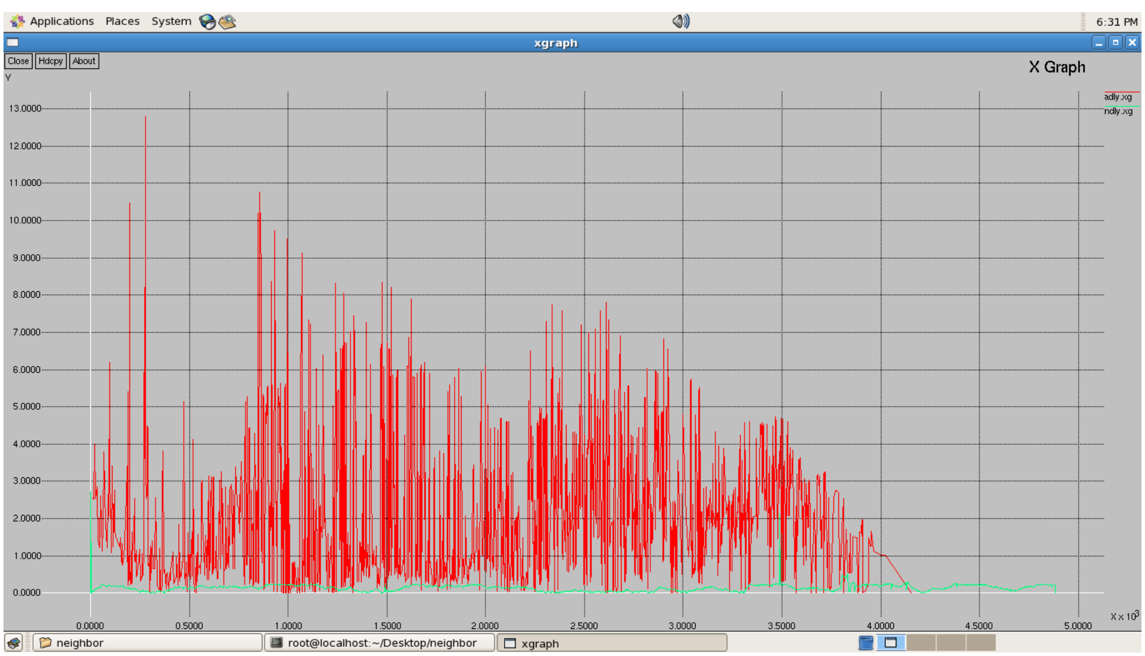
The packet Delivery ratio decreases with Aodv simulation when compared to that of Neighbor protocol simulation packet delivery ratio increases. And the comparison simulation table and Graph is shown in Figure 1:



Graph 1: Comparison of Packet Delivery with AODV and Neighbor cover protocol

Performance of neighbor Delay with AODV and Neighbor cover protocol:

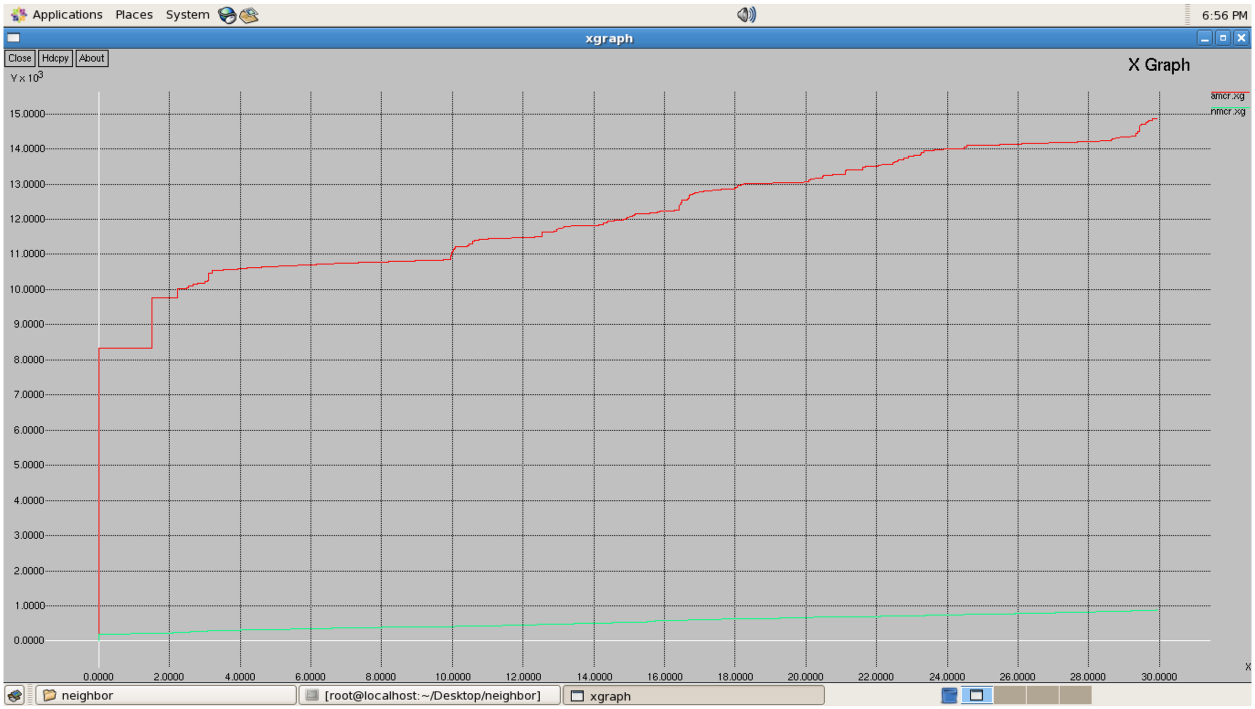
The neighbor delay reduces in AODV when compared to that neighbor cover protocol and the simulation graph is shown in Graph 2.



Graph 2: Performance of Neighbor delay with AODV and Neighbor Cover protocol

Performance of collision rate with AODV and Neighbor collision rate:

The collision rate is more in AODV simulation environment when compared to Neighbor cover protocol it is less. And the comparison graph is shown:



Graph 3: Comparison of Collision rate with AODV and Neighbor cover protocol.

6. Results

The packet delivery ratio, neighbor delay and collision rate with AODV and neighbor cover protocol is calculated where the neighbor cover protocol reduces overhead and collision rate, improves the packet Delivery.

S.no	Parameter	AODV	Neighbor Coverage protocol
1	Packet Delivery ratio	80.58	99.35
2	Neighbor Delay	916.426ms	71.388ms
3	Collision rate	511693.56	29610.74
4	Number of collisions	14872	883

7. Conclusion

We propose a probabilistic rebroadcast protocol based on neighbor coverage to reduce routing overhead. The proposed protocol generates less traffic compared to flooding as it decreases the rebroadcasting of RREQ packet. The proposed protocol decreases the network collision and contention, increases the packet delivery ratio and decreases the end to end delay. We also proposed a scheme to calculate rebroadcast delay weather to rebroadcast the packet or not. The proposed neighbor coverage scheme calculates additional coverage ratio and connectivity factor. The simulation results also show that the proposed protocol has decreased overhead and good results when compared with the standard protocol.

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