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Efficient Neighbor Discovery in Wireless Ad Hoc Networks

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Abstract- Neighbor Discovery (ND) is an important pre-requisite for a typical Wireless Ad-hoc Network for achieving self-organization and multi-hop communications which subsequently affect routing, MAC and topology control protocols. Reliability, Resource Efficiency and Responsiveness could be termed as important performance parameters for a typical Neighbor Discovery protocols. This paper attempts to review the working/ operations of some of the popular ND approaches/techniquesunder various operating scenarios/ assumptions.

Keywords- Wireless Ad Hoc Networks, Neighbor Discovery, Randomized Algorithms

I. INTRODUCTION

Self-Organization and Multi-Hop communication are two major characteristics of a typical Wireless Ad-Hoc network. To achieve Self-Organizing and Multi-Hop communication, it is imperative for a given node to discover its neighbors. In the most of the applications of wireless ad hoc networks, the communication pattern is multi-hop.Multi-hop communication is preferred by the routing protocols because of energy efficiency. However, for achieving multi-hop communications a node is supposed to first identify those nodes around the given node which are exactly one hop away, such nodes are termed to be as neighbors of the given node and the process initiated by the given node to identify such one hop distant surrounding nodes is called as Neighbor Discovery (ND).Knowledge of neighbors is an essential to start proper operations for the MAC protocols and routing protocols. However, it is expected that the ND process should not only be accurate and precise but also resource efficient and quick.

II. NEIGHBOR DISCOVERY

In [1], authors discussed about the Neighbor discovery algorithms. They can be classified into two categories, viz. randomized or deterministic. In a randomized strategy neighbor discovery, starts with randomly chosen times and discovers all its neighbors by a given time. In a deterministic neighbor discovery algorithm, each node transmits according to a pre-determined transmission schedule that allows it to discover all its neighbors by a given time with probability one. Guaranteed neighbor discovery typically comes at the cost of increased running time and often requires unrealistic assumptions such as synchronization between nodes and apriori knowledge of the number of neighbors [8]. Authors, therefore, choose to investigate randomized neighbor discovery algorithms.

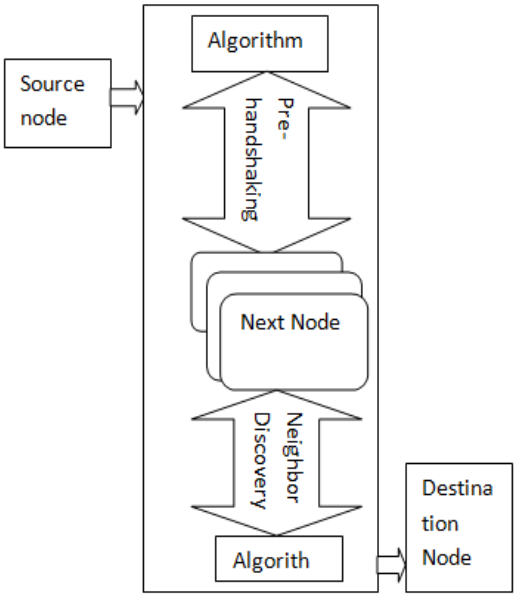

Fig.1 Neighbor Discovery

The performance can be analyzed in terms of time taken for ND, energy consumed by ND process, system resources spent, accuracy or reliability of result. The characteristics of a typical ND process are:

- Nodes have either a prior knowledge of neighbors or not.
- Nodes are either collision aware or not.
- ND process is done either in a synchronous or in an asynchronous manner.
- Nodes are either aware about initialization and termination criteria or not.

Non-trivialness of randomized ND are as follows [1]:

(1) Nodes have no knowledge of the number of neighbors, which makes coping with collisionseven harder.
(2) When nodes do not have access to a global clock, they need to operate asynchronously and still be able to discover their neighbors efficiently.
(3) In asynchronous systems, nodes can potentially start the neighbor discovery process at different time instants and consequently, may miss each other's trans-missions.
(4) Furthermore, when the number of neighbors is un-known, nodes do not know apriori when/how to terminate the neighbor discovery process.

III. NEIGHBOR DISCOVERY ALGORITHM

In [2],M. J. McGlynn and S. A. Borbash, address two problems associated with static ad hoc wireless networks. First is, methods of saving energy during a deployment of the nodes and second is, efficient methods of performing adjacent ND. Birthday protocols use random independent transmission to discover nodes. Authors also discussed that the Birthday protocols are a promising tool for saving energy as well as an efficient and flexible means of having the nodes discover their neighbors.

Many papers have focused on the neighbor discovery problem when nodes have Omni-directional antennas.However, these solutions require either apriori knowledge of the number of neighbors [2, 4, 8], or node synchronization [2, 8]. Neighbor discovery algorithms when nodes have directional antennas have been proposed in [5, 6, 7]. Again, the proposed solutions assume knowledge of the number of neighbors [6], or node synchronization [5]. In [7], the authors propose antenna scanning mechanisms for directionalneighbor discovery.

In [3], authors discussed FRIEND protocol to initialize synchronous full duplex wireless ad hoc networks. Many existing protocols like, deterministic [8] and multi-user detection-based [9] protocols, randomized protocols are most commonly used to conduct ND process in wireless networks. In those protocols, each node transmits at different randomly chosen time instants to reduce the possibility of the collision with other nodes.

G. Sun, F. Wu, X. Gao, and G. Chen, pointed out that many existing protocols have high probabilities to generate idle slots.FRIEND protocol decrease the duration of ND in comparison to the classical ALOHA-like protocols [1,2].It is a randomized protocoland expected value of time slots needed is 1.5n and upper bound is 3n for ND process.

IV. PROPOSED ALGORITHM

Algorithm Proposed FRIEND-GR-TR:

If A_f=1 then
    A will keep silent in TR and exit
End if

Node A decides to send M_s by probability, checking the number of nodes having the less or equal probability of sending at the same time

If A sends M_s then
    If A does not receive M_s during GR then
        A will transmit M_d in TR;
    Else
        A will transmit M_d in TR by probability ½
    End if
Else
    If A does not receive M_s during GR then
        A will transmit M_d in TR by probability $1/A_n$;
    Else
        A will keep silent in TR.
    End if
End if
If A plans to send M_d then
    A sends M_d and monitors the channel meanwhile.
    If A does not receive M_d during TR then
        A_f=1.
    Else
        Current iteration is invalid.
    End if
Else
    A keeps listening
    If A does not receive M_d during TR then

Current iteration is invalid.
Else if A receive a single M_d then
Record the ID in M_d.
A_n=An-1.
Else
Current iteration is invalid.
End if
End if

V. EXPERIMENTAL SETUP

Simulation Tool

Matlab R2013a Version: 8.1.0.604 (64-bit) (win 64).

The performance comparison using simulations were implemented using MATLAB. In the simulation nodes may choose their random actions according to the probabilities. The various settings of the sizes of the cliques includes in the simulations. All nodes are within the communication range in a clique. The discovery process of 100 nodes simulate using tool. The usual settings of wireless networks are considered. In the 2D plane nodes are put into the plane according to a uniform distribution. The transmission range is same. The iterations for the Neighbor Discovery process are reduced shown through the simulation. Here we have Compared FRIEND-GR-TR with the Proposed FRIEND-GR-TR.

VI. SIMULATION RESULTS

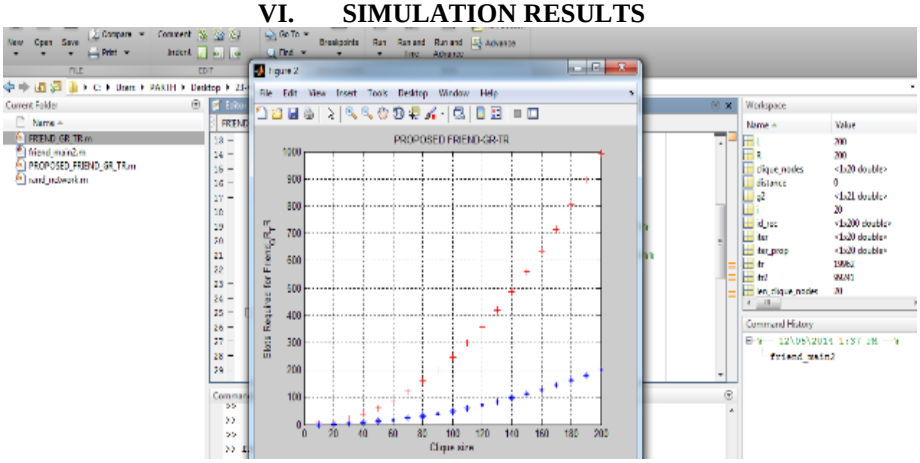

Figure shows plot diagram for the proposed_FRIEND_GR_TR as well as FRIEND_GR_TR. This gives the information saying the the no of iterations requried for the no of the nodes.

Red stars indicate the iterations required proposed in the paper. The blue starts indicates the iterations required by a proposing a new technique.Figure shows the comparison between two algorithms and we can see that proposed algorithm significantly reduces the iterations. Existing algorithm takes about 24000 iterations to complete the neighbor discovery process, whereas proposed algorithm only uses about 4900 iterations to finish the process.

No. of nodes	Transmission Range	Iterations for existing algorithm	Iterations for proposed algorithm
50	200	5987	1203
100	200	24,810	4902
200	200	99,241	19,962

VII. CONCLUSION

The different Neighbor Discovery approaches have been surveyed. The FRIEND protocol significantly reduces the probabilities of generating idle slots and collisions. However, existing protocol has some limitations. The proposed system has decreased the no of iterations based on the some enhancements to achieve the better performance. Simulation proved that proposed algorithm significantly decreases the iterations needed to finish the ND process.

In the future, we would apply this algorithm on multiple pre-handshaking protocol and more realistic environment. Also consider the issue of energy consumption of ND process.

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