International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

Neighbor Discovery in Wireless Ad Hoc Networks using Multi Sender Program

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Accepted 25 May 2014, Available online 01 June2014, **Vol.4, No.3 (June 2014)**

Abstract

Neighbor discovery (ND) is an important pre-requisite for initializing wireless ad hoc networks through the fast and efficient ND protocol for achieving self-organization and multi-hop communications which subsequently affect routing, MAC and topology control protocols. Most important performance parameters such as reliability, resource efficiency and responsiveness are necessary for a typical neighbor discovery protocols. Existing protocol have no multiple packet reception is used that is, a collision occurs when two or more nodes simultaneously transmit packets to it in a slot. FRIEND protocol conducts the neighbor discovery process and it significantly reduces the probability of generating idle slot and collisions. By introducing some enhancement, we further decrease the processing time needed in existing protocol. Analysis proves that proposed algorithm can decrease the duration of ND in comparison to the existing protocol. Simulation results show that new algorithm can significantly decrease the iterations for ND.

Keywords: *Wireless Ad Hoc Networks, Neighbor Discovery, Randomized Algorithms.*

1. Introduction

In wireless ad hoc networks, nodes are deployed without the support of pre-existing infrastructures for communication. Nodes need to configure themselves through their own communication activities to form a reliable infrastructure during the initialization for further operations. Networks deployed without any communication infrastructure, required to configure themselves upon deployment in order to establish an efficient communication infrastructure. Nodes are capable of acting as source, sink as well as routing nodes. Self-organization and multi-hop communication are important features of wireless ad hoc networks. MANETs are a kind of Wireless ad hoc networks.

2. Neighbor Discovery

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 (Parth et al 2014). Reliability, Resource Efficiency and Responsiveness could be termed as important performance parameters for a typical Neighbor Discovery protocols (Parth et al 2014). 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.

2.1 Neighbor Discovery Algorithms

Authors discussed about the Neighbor discovery algorithms. They can be classified into two categories, viz. randomized or deterministic (Vasudevan et al 2009). 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

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Table 1 Algorithm / Protocol: Birthday Protocol (Mcglaynn et al 2001)

ND Scenarios / Assumptions	Remarks / Comments
• Randomized strategy, • Time is slotted, • n is large, • Total number of nodes is known, • Nodes do not coordinate their actions in any way[2] • Nodes are placed randomly in some area,[2] • Nodes are distinguishable by an ID such as a MAC address, • Each node has some internal memory to record local topology	• Optimal probability that a node transmits is 1/n, • Expected time slots needed to finish ND process is neHn, where Hn is the n-th Harmonic number.

Table 2 Algorithm / Protocol: Aloha-like Algorithm (Vasudevan et al 2009)

ND scenarios / Assumptions	Remarks / Comments
• Randomized neighbor discovery algorithms , • Nodes have Omni-directional antennas	• Reduces to the classical coupon collector's problem
• When nodes do not have a collision detection mechanism	• Each node discovers all its n neighbors in an expected time equal to ne (ln n+c), for some constant c, • O(ne ln n)
• When nodes have a collision detection mechanism, • Propose an algorithm based on receiver status feedback, • Nodes can detect collision	• Which yields a ln n improvement over the ALOHA-like algorithm, • O(ne)
• Absence of an estimate of the number of neighbors	• Results in a slowdown of no more than a factor of two, compared to when nodes know n.
• Lack of synchronization among nodes	• Results in at most a factor of two slowdown in the algorithm performance from the case when nodes are synchronized
• Starting execution at different time instants • Multipacket reception situation	• Each node can discover all its neighbors • Expected time needed to discover all nodes is Θ(n ln n/k)

apriori knowledge of the number of neighbors (Ramanathan et al 2005). Authors, therefore, choose to investigate randomized neighbor discovery algorithms.

2.2 Characteristics of Neighbor Discovery Process (Parth et al 2014)

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.

2.3 Non-trivialness of Neighbor Discovery (Vasudevan et al 2009)

Non-trivialness are as follows:

(1) Nodes have no knowledge of the number of neighbors, which makes coping with collisions even harder.

(2) When nodes do not have access to a global clock, they need to operate asynchronously and still be able to discover their neighbor's 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.

Furthermore, when the number of neighbors is un-known, nodes do not know apriori when/how to terminate the neighbor discovery process.

3. Literature Review

A large number of works have focused on the problem of accelerating the process of ND in wireless networks and various protocols have been proposed to adapt to different situations. Compared with existing deterministic and multi-user detection-based 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.

Advantages

- First ever proposed ND protocol

Table 3 Algorithm / Protocol: FRIEND protocol (G Sun et al 2013)

ND Scenarios / Assumptions	Remarks/ Comments
• Pre-Handshaking Strategy • Full duplex technology • Multi-hop networks • Each node has a unique ID (e.g., the MAC address). • Time is identically slotted • Nodes are synchronized on slot boundaries. • Nodes are in a clique of size n. • n is known to all nodes in the clique. • n can be pre-configured on nodes before deploying • Nodes use omnidirectional antennas, • Nodes have the same transmission range. • No multipacket reception technique is used, • Nodes can listen and transmit on the same channel simultaneously. • Nodes can distinguish between collisions and idle slots.	• Reduce the probabilities of generating idle slots and collisions • To accelerate the ND process • Performs better than the ALOHA-like protocol

Disadvantages

- This applies only for ideal assumptions and systems

In this paper, authors designed and analyzed randomized algorithms for neighbor discovery under various MPR models. They started with a simple Aloha-like algorithm that assumes synchronous node transmissions and a priori knowledge of the number of neighbors. As future work, they are pursuing two interesting directions:

- Extend study to more generalized MPR models,
- Investigate neighbor discovery in multi-hop MPR networks.

Advantage

- Multipacket reception.

Discover time is shortened

4. Existing Protocol

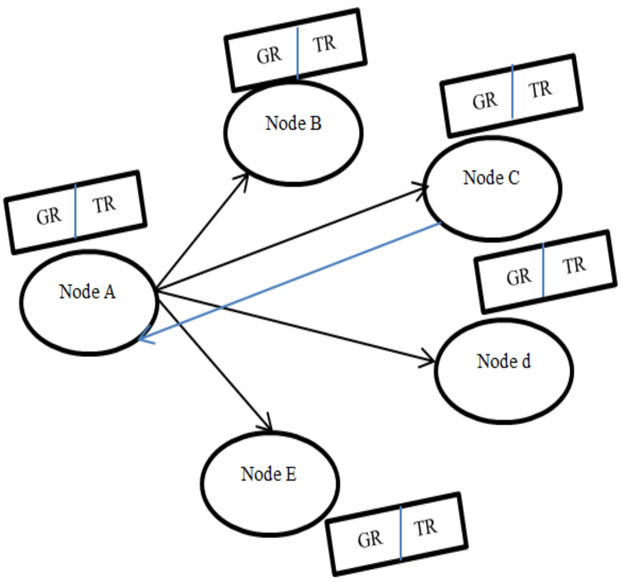

Figure 1: Scenario of nodes

The above figure the messaging would be passed according to fig 1. The working would be same as fig 1 but it considers five Nodes. And also checks for the Ms and Md information from the other nodes.

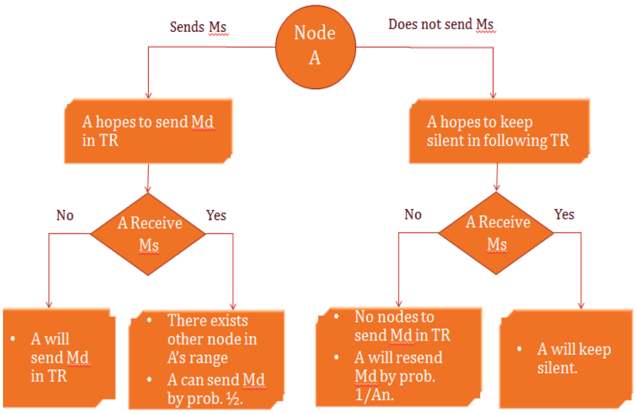

Figure 2: FRIEND-GR

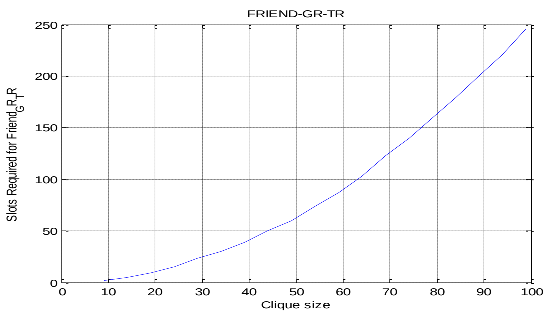

Figure 3 Result

Above figure shows the graph of slots required for the ND versus clique size in terms of number of nodes.

Table 4 Result

Number of nodes	Transmission Range	No of Iterations
50	200	5987
100	200	24,810
200	200	99,241

The above results were recorded while simulating the above algorithm using MATLAB R2013a, Version: 8.1.0.604 (64-bit) (win 64).

5. Proposed System

The technique proposed in the paper is the static probability of the nodes. The new proposed system is the nodes would be having the variable probability which is less than 1/noofNodes.

The proposed system has decreased the no of iterations based on the below enhancements:

- Change the probability of the M_d receive message.
- Handling the Multi sender program, i.e. if 2 or more nodes are sending the M_s signal at the same time, code handling is taken care.

The nodes would be having the variable probability which is less than 1/noOfNodes.

5.1 Proposed Algorithm

Algorithm Proposed FRIEND-GR-TR: (G Sun et al 2013)

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

Conclusions

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 will decrease the no of iterations based on the some enhancements to achieve the better performance. In the future, we would apply this algorithm on multiple pre-handshaking protocol and more realistic environment. Also consider the issue of energy consumption and security of ND process.

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