Neighbor Discovery in Wireless Networks

(Note : the paper title and the name of the proposed algorithm will be altered later.)

***Abstract*—The abstract goes here.**

I. Introduction

Main components in this section:

1.The significance of this research and the background:

2.The weakness of the existing methods and the challenges:

The existing methods can be divided into two categories : deterministic or probabilistic.

The deterministic approaches assume there are no collision or are only suitable for two nodes. Some assume all the nodes are the neighbor of each other.

The probabilistic approaches have a poor performance and can not guarantee a worst case bound.

Challenge of my work: We consider the most demanding problem model in this work, which is also closest to the practical situation.

3.The main contribution and the key idea of my work:

Consider the partially-connected network, which is the most demanding problem model.

Combine the advantages of both two category approaches.

The Proposed algorithm guarantees achieving neighbor discovery within $O(nf(\theta))$, which holds a better performance than the state-of-the-art works.

The core is to propose a deterministic approach to align the sensors' wake-up time and then achieve neighbor discovery with a probabilistic approach.

II. Related Work

Introduce the representative existing algorithms.

1. Birthday Alg.
2. BlindDate Alg.
3. Disco Alg.
4. Hello Alg.
5. Searchlight Alg.
6. Talk More Listen Less Alg.
7. Todis&Hedis Alg.
8. U-Connect Alg.
9. ALOHA-like Alg.

(Note : Introduction and Related Work are expected to be 2 pages)

III. Preliminaries

In this section, we first give some notion definitions and introduce the collision detection mechanism. Then we formulate the Neighbor Discovery problem formally.

A. Sensor Node Model

The wireless sensor network consists of a number of sensors distributed separately in a target area. The deployed sensor nodes keep their most time in sleep pattern to avoid quick energy consumption and wake up timely to work on duty.

In our model the total number of sensors N is not necessary to be known. We assume that each node has a unique identifier ID_i. Time is divided into slots of equal length t_0, which is sufficient to finish communications. In each time slot, a node transform its pattern according to a pre-defined duty schedule.

Definition 1: **Duty schedule** is a pre-defined sequence $S = \{s^t\}_{0\le t<T}$ of period T and

$$s^t = \begin{cases} 0 & sleep \\ 1 & wake \end{cases}$$

Each node construct its own duty schedule according to a specific strategy and repeats it until finding all the neighbors. Since the waking-up duration has a significant affect on the battery's lifetime, duty circle is defined to restrict the energy consumption.

Definition 2: **Duty circle** represents the fraction of one period T where a node turns its radio on. It can be formulated as:

$$\theta = \frac{|\{0 \le t < T : s^t = 1\}}{T}.$$

When a sensor wake up on a time slot, it can turn to either the transmitting state or listening state.

- **Transmitting state**. A node turn to transmitting state will broadcast messages containing its own identify information to all neighbors.
- **Listening state**. A node turn to listening state will monitor the frequency channel to collect its neighbors' information. However collision will occur when two or more neighbor nodes transmit concurrently and thus no valid information will be gathered

Transiting between the states only costs little time, compared to one complete time slot.

B. Collision Detection Mechanism

When a node wakes up and turns to the listening state, there are two possible

A collision detection mechanism allows the node to distinguish these two case, in turn is

A node turns to listening state when it wakes up

C. Problem Definition

We consider a partially-connected sensor network, where two nodes are neighbors if they locate within the radio range of each other. the total number of sensors n A symmetric matrix is used to record the neighboring relations as:

$$M_{i,j} = \begin{cases} 1 & Neighbor \\ 0 & Else \end{cases}$$

Each sensor follows its duty schedule to achieve neighbor discovery. In a synchronous scenario, sensors start their neighbor discovery process at the same time, while in a asynchronous scenario all nodes start at different time slots.

Notice that the neighbor discovery process is not bidirectional, which means any pair of neighbors need to find each other separately. The time slots within which a sensor node u_i find one of its neighbors u_j can be formulated as $L(i,j)$. Then we define the discovery latency that node u_i discovers all neighbors as:

Definition 3: **Discovery latency** of node u_i is the time to discover all neighbors:

$$L(i) = \max_{M_{(i,j)=1}} L(i,j).$$

Thus the neighbor discovery problem can be formulated as:

Problem 1: Given a duty circle θ, design a duty schedule and transiting strategy which optimizes $L(i)$ to the most extent.

IV. A

In this section, we describe ST, a deterministic approach to construct duty schedule. Then we give the performance analysis. The intuitive idea of constructing

V. B

VI. Evaluation

(Note : Evaluation is expected to be less than 2 pages)

VII. Conclusion

The conclusion goes here.

(Note : Conclusion and Reference are expected to be less than 1 page)