

Self Configurable Re-link Establishment using Continuous Neighbor Discovery in Asynchronous Sensor Networks

¹Rushikesh B. Shreshtha, ²Rajeswari Goudar

¹Computer Department, MAEER'S MAE,
University of Pune 411015, Maharashtra, India

²Computer Department, MAEER'S MAE,
University of Pune 411015, Maharashtra, India

Abstract

A Sensor network generally has a large number of sensor nodes that are deployed at some audited site. In most sensor networks the nodes are static. Nevertheless, node connectivity is subject to changes because of disruptions in wireless communication, transmission power changes, or loss of synchronization between neighbouring nodes, so there is a need to maintain synchronization between the neighbouring nodes in order to have efficient communication. Hence even after a sensor is aware of its immediate neighbours, it must continuously maintain its view a process we call continuous neighbour discovery. In this proposed work we are maintaining synchronization between neighbouring nodes so that the sensor network will be always active.

Keywords: *Sensor, Hidden link, Hidden Nodes Segments, Neighbour Discovery.*

1. Introduction

A sensor network may contain a huge number of simple sensor nodes that are deployed at some inspected site. In large areas, such a network usually has a mesh structure. In this case, some of the sensor nodes act as routers, forwarding messages from one of their neighbours to another. The nodes are configured to turn their communication hardware on and off to minimize energy consumption. Therefore, in order for two neighbouring sensors to communicate, both must be in active mode. In the sensor network model considered in this paper, the nodes are placed randomly over the area of interest and their first step is to detect their immediate neighbours the nodes with which they have a direct wireless communication and to establish routes to the gateway. In networks with continuously heavy traffic, the sensors need not invoke any special neighbour discovery protocol during normal operation. This is because any new node, or a node that has lost connectivity to its neighbours, can hear its neighbours simply by listening to the channel for a short

time. However, for sensor networks with low and irregular traffic, a special neighbour discovery scheme should be used. Despite the static nature of the sensors in many sensor networks, connectivity is still subject to changes even after the network has been established. The sensors must continuously look for new neighbours in order to accommodate the following situations:

- 1) Loss of local synchronization due to accumulated clock drifts.
- 2) Disruption of wireless connectivity between adjacent nodes by a temporary event, such as a passing car or animal, a dust storm, rain or fog. When these events are over, the hidden nodes must be rediscovered.
- 3) The ongoing addition of new nodes, in some networks to compensate for nodes which have ceased to function because their energy has been exhausted.
- 4) The increase in transmission power of some nodes, in response to certain events, such as detection of emergent situations.

For these reasons, detecting new links and nodes in sensor networks must be considered as an ongoing process. We distinguished between detection of new links and nodes during initialization, i.e. when the node is in Init state, and their detection during normal operation. The former will be referred to as initial neighbour discovery whereas the latter will be referred to as continuous neighbour discovery. While previous works [1], [2], [3], [13], [15] address initial neighbour discovery and continuous neighbour discovery as similar tasks, to be performed by the same scheme, we claim that different schemes are required, for the following reasons: Initial neighbour discovery is usually performed when the sensor has no clue about the structure of its immediate surroundings. In such a case, the sensor cannot communicate with the gateway and is therefore very limited in performing its tasks. The immediate surroundings should be detected as soon as possible in

order to establish a path to the gateway and contribute to the operation of the network. Hence in this state, more extensive energy use is justified [9],[12],[14]. In contrast, continuous neighbour discovery is performed when the sensor is already operational. This is a long term process, whose optimization is crucial for increasing network lifetime. When the sensor performs continuous neighbour discovery, it is already aware of most of its immediate neighbours and can therefore perform it together with these neighbours in order to consume less energy. In contrast, initial neighbour discovery must be executed by each sensor separately. Figure 1 shows a typical neighbour discovery protocol. In this protocol, a node becomes active according to its duty cycle. Let this duty cycle be in Init state and in Normal state. When a node becomes active, it transmits and can invoke another procedure to finalize the setup of their joint wireless link. To summarize, in the Init state, a node has no information about its surroundings and therefore must remain active for a relatively long time in order to detect new neighbours. In contrast, in the normal state the node must use a more efficient scheme. Such a scheme is the subject of our study. When node 'u' is in the Init state, it performs initial neighbour discovery. After a certain time period, during which the node is expected, with high probability to most of its neighbours, the node moves to the Normal state, where continuous neighbour discovery is performed as shown in figure 2. A node in the Init state is also referred to in this paper as a hidden node and a node in the Normal state is referred to as a segment node.

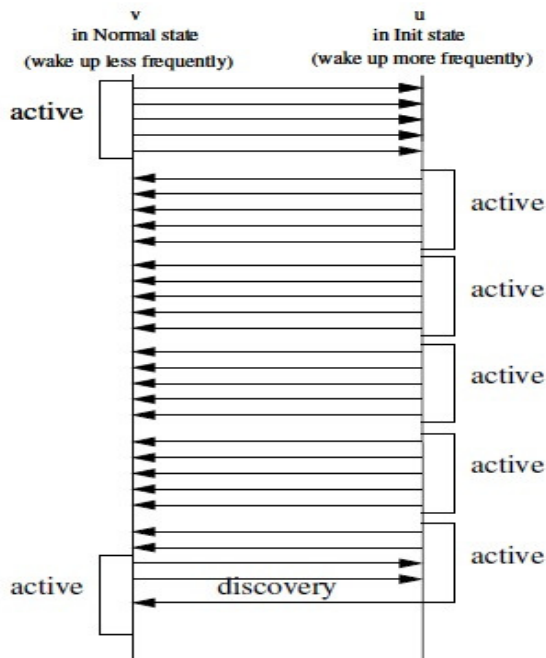


Figure 1. The transmission of HELLO messages in Init and Normal states

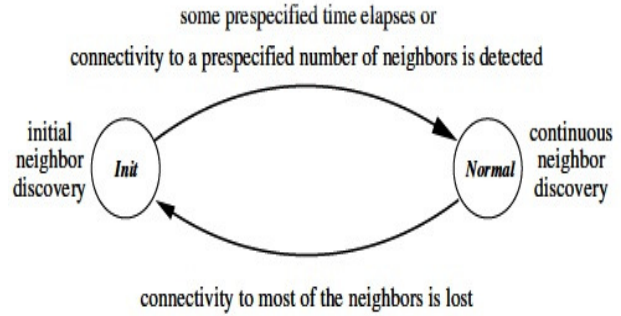


Figure 2. Continuous neighbour discovery vs. initial neighbour discovery in sensor networks

The main idea behind the continuous neighbour discovery scheme we propose is that the task of finding a new node 'u' is divided among all the nodes that can help node 'v' to detect node 'u'. These nodes are characterized as follows: (a) they are also neighbours of 'u' (b) they belong to a connected segment of nodes that have already detected each other; (c) node 'v' also belongs to this segment. Let $deg_S(u)$ be the number of these nodes. This variable indicates the in-segment degree of a hidden neighbour 'u'. In order to take advantage of the proposed discovery scheme, node 'v' must estimate the value of $deg_S(u)$.

2. Related Work

In a special node, called an access point, we are using this point in Wi-Fi network operating in centralized node. The Messages are transmitted only to or from the point. In the process of neighbour discovery, a new node can be detected by the base station. Discovering the new node is easy when compared the energy consumption is not a concern for the base station. The base station broadcasts a special HELLO message1. This message can hear that particular regular node to initiate a registration process. The regular node can switch frequencies/channels in order to handle the best HELLO message for its needs. This is the best message that might be depending on the identity of the broadcasting base station, on security considerations. All these problems related the collisions of messages in such a network are addressed in [4], [10], [11]. So other works trying to minimize the discovery time by optimizing the broadcast rate of the HELLO messages [1], [5], [6], [7], [8].

3. Basic Scheme and Problem

We assume that all nodes are having the same transmission range, it means for every time the connectivity is always bi-directional. In our analysis, the network is a unit disk graph; means: the pair of the nodes that can be within

frequency with which every node enters the HELLO period.

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