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Energy Consumption in Sensor Network using Continuous Neighbor Discovery

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ABSTRACT:- In wireless sensor network to make reliable path connectivity and packet exchange will take more time and also need more power. Two techniques are analysed here to reduce time and maintain power consumption. One of the techniques is *Continuous Neighbor Discovery*, It will find neighbor node and also continuously maintain a immediate neighbour node view. Another one is L*ink Assessment Method*, It allows for probabilistic guarantee of collision-free packet exchange. Each sensor using a simple protocol in a coordinate effort to reduce power consumption without increasing the time required to detect hidden sensors.

I. INTRODUCTION

Sensor network are widely used in both civil and military applications such as security management, surveillance, automation, and environmental monitoring. So far, most commercially deployed system utilizes wire based communication. However in recent years there has been tremendous interest in both industry and academia in self configuring wireless networks. Main motivations are reduce installation cost, gain flexibility, allow for unobtrusive installation, and enable entire new applications such as tracking and wireless interrogation. The recent developments have been fuelled by advances in low cost and low power RF communications, as most envisioned system are battery operated and expected to be successful only if low cost.

The nodes are typically small and battery operated. Hence, energy is a scarce resource. Therefore, energy efficiency is a crucial factor for all tasks performed throughout the lifetime of the system. Energy can be saved by communication over reliable links and by avoiding collision of packets, which eliminates the necessity of re-transmission. During the implementation of a protocol targeting industrial applications of stationary wireless sensor networks, it was found that it is advantageous to acquire accurate information about the availability and quality of the RF communication links prior to the network topology formation. This task is accomplished by the link assessment.

In the sensor network model considered as, the nodes are placed randomly over the area of interest and their first step is to detect their immediate neighbors, 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 neighbor discovery protocol during normal operations. This is because any new node, or a node that has lost connectivity to its neighbors, can hear its neighbors simply by listening to the channel for a short time. However, for sensor networks with low and irregular traffic, a pecial neighbour discovery scheme should be used.

Detecting new links and nodes in sensor networks must be considered as an ongoing process. In the following discussion we distinguish between the detection of new links and nodes during initialization, i.e., when the node is in Init state, and their detection during normal operation, when the node is in Normal state. The former will be referred to as *initial neighbor discovery* whereas the latter will be referred to as *continuous neighbor discovery*. While previous works [2], [3], [4] address initial neighbor discovery and continuous neighbor discovery as similar tasks, to be performed by the same scheme, we claim that different schemes are required, following reasons: Initial neighbor 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. In contrast, continuous neighbor 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 neighbor discovery, it is already aware of most of its immediate neighbors and can therefore perform it together with these neighbors in order to consume less energy. In contrast, initial neighbor discovery must be executed by each sensor separately.

The link assessment process includes discovery of all nodes and the available links between them, and grading the quality of these links. The latter can be achieved by estimating parameters such as packet success rate or signal strength, which may be determined by assessing a sufficient number of packets exchanged between neighboring nodes. This information can then be used to make routing decisions and form a reliable multi-hop network topology.

II. RELATED WORK

Wireless ad hoc and sensor networks are communication systems where the infrastructure is dynamically created and maintained. To enable communications, hosts cooperate together to provide several complex services like self-organization, routing or data gathering. All these high level services usually rely on a neighbor discovery protocol. During the process of neighbor discovery, a node tries to find out which other nodes are within its transmission range. To accomplish this discovery, a node broadcasts periodically a message (a hello packet) to inform the nearby nodes of its presence. This periodic exchange of hello messages is used to create and maintain a local neighborhood table. This table is then used by higher level protocols to communicate with nearby nodes, for example to establish a route between two distant nodes.

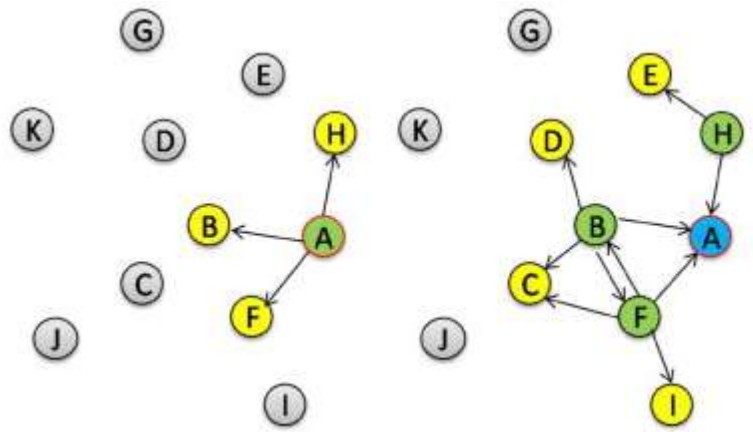
In a WiFi network operating in centralized mode, a special node, called an access point, coordinates access to the shared medium. Messages are transmitted only to or from the access point. Therefore, neighbor discovery is the process of having a new node detected by the base station. Since energy consumption is not a concern for the base station, discovering new nodes is rather easy. The base station periodically broadcasts a special HELLO message1. A regular node that hears this message can initiate a registration process. The regular node can switch frequencies/channels in order to find the best HELLO message for its needs. Which message is the best might depend on the identity of the broadcasting base station, on security considerations, or on PHY layer quality (signal-to-noise ratio). Problems related to possible collisions of registration messages in such a network are addressed in [5]. Other works try to minimize neighbor discovery time by optimizing the broadcast rate of the HELLO messages. The main differences between neighbor discovery in WiFi and in mesh sensor networks are that neighbor discovery in the former are performed only by the central node, for which energy consumption is not a concern. In addition, the hidden nodes are assumed to be able to hear the HELLO messages broadcast by the central node. In contrast, neighbor discovery in sensor networks is performed by every node, and hidden nodes cannot hear the HELLO messages when they sleep.

III. PROBLEM DEFINITION

CONTINUOUS NEIGHBOR DISCOVERY

Initial neighbor discovery: It 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. In contrast, continuous neighbor 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 neighbor discovery, it is already aware of most of its immediate neighbors and can therefore perform it together with these neighbors in order to consume less energy. In contrast, initial neighbor discovery must be executed by each sensor separately.

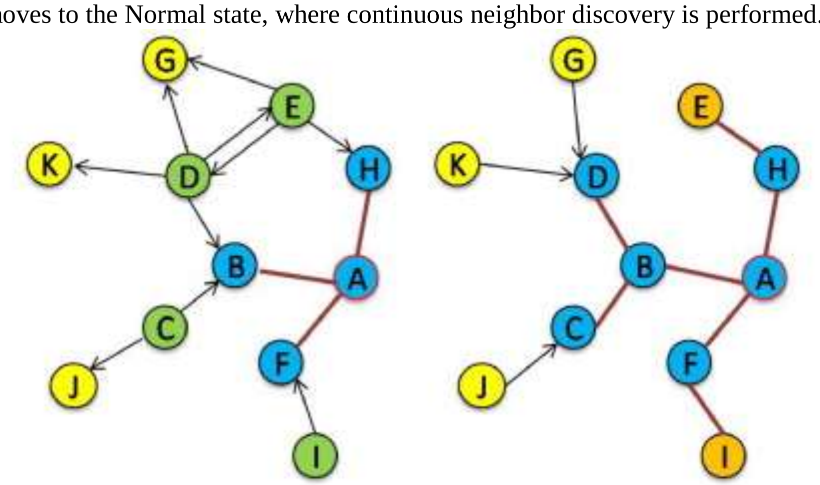
Figure 1 shows a typical neighbor discovery protocol. In this protocol, node A(as Initiator) and other 11 nodes are placed randomly. Node A will becomes active according to its duty cycle. Let this duty cycle be α in Init state and β in Normal state. We want to have $\beta << \alpha$ When a node becomes active, it transmits periodical HELLO messages and listens for similar messages from possible neighbors. A node that receives a HELLO message immediately responds and the two nodes can invoke another procedure to finalize the setup of their joint wireless link.



A – Initiator
H,B,F - Uncovered node which received Hello message
C,D,E,F,G,J - Uncovered node in initial state

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

Figure 2 summarizes this idea. When node u is in the Init state, it performs initial neighbor discovery. After a certain time period, during which the node is expected, with high probability, to find most of its neighbors, the node moves to the Normal state, where continuous neighbor discovery is performed.



A – Node is in active state
E,I – Node which in sleeping mode

Fig 2. Continuous neighbor discovery

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. The main idea behind the continuous neighbor discovery scheme we propose is that the task of finding a new node among all the node.

IV LINK ASSESSMENT METHOD

The main goal of the link assessment process is to discover the connectivity graph of network. Each node Should not only find all its neighbors (the nodes that it can hear from), but it also should assess all the available

Links and measure their qualities. As described above, definition of quality is application dependent. However, no matter what definition is used or which parameters should be estimated, we assume that the following two conditions must be satisfied:

(a) Some fixed number of packets should be transmitted on each link: The required number of packets basically depends on the parameters that should be estimated, and the accuracy needed for these estimates. For example, if we just want to discover the neighbors of a node (with no link grading), the node should correctly receive only one (or two) packet(s) from each of its neighbors, so transmission of only a couple of packets is sufficient. However, for a good estimate of packet success rate or bit error rate, hundreds of packets may be measured.

(b) Inner network interference/collision should be avoided: the number mentioned in part (a) corresponds to the number of *collision-free* packets that are required for the perfect estimation and quality measurement. Collision occurs at a particular node, when two (or more) of its neighbors send a packet simultaneously.

Combining the above two conditions implies that to perform a successful link assessment, one needs a protocol which guarantees that between any two neighboring nodes in the network at least some fixed number of collision-free packets are exchanged, and this process should be done while the network is being discovered and the neighbors are being found. The three key constraints in design of such method are (1) the amount of energy consumed by the link assessment protocol, (2) the total time spent, and (3) the complexity of its implementation and the amount of memory it requires. We need to design a method which not only is energy efficient, but it should also take reasonable time and be fairly simple such that it can be implemented in each sensor node which typically has very low computational power.

The links assessment process combines two goals. Neighbor discovery is one part of it, and link grading, *i.e.*, measurement of quality of each link, is the other part. Information about the quality of the links leads to a more reliable and energy-efficient topology or a much better routing method Some recent works suggest schemes to acquire the link quality data during the operation of the network [6], [7]. While these approaches generally justify the use of link quality as a basis for topology formation, they inherently assume that the nodes have a relatively high duty cycle. However, many sensor networks use extremely low duty cycles, *i.e.*, below 0.1%. Reliable link grading during network operation is therefore not feasible. Moreover, in such systems, nodes can be in receive mode only during active communication periods, so promiscuous listening cannot be used. Hence, link grading prior to the topology formation must be employed.

In each mode the node will consume a definite amount of energy. Typically, the amount of energy used in sleep mode is very small in comparison with the amount consumed in the other two states. Hence, we neglect this power consumption in the our analysis. Let E_{TX} (E_{RX}) denote the energy consumed by a node which is in transmit (or receive) state for one time slot. To simplify the energy expressions, the ratio of these two terms is defined to be

$$\beta = E_{TX} / E_{RX}$$

Although it seems that the a node should consume significantly more energy while transmitting than when it is receiving, for low-power (or short range) transceivers the value of β typically is between 1 to 3. This shows that transmission and reception approximately bear the same cost in terms of power consumption. This is a key difference between low-power sensor networks and other ad hoc networks.

V SIMULATION ENVIRONMENT

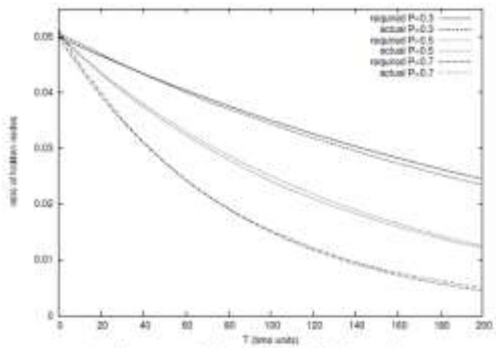
In this section we present a simulation study for the schemes presented in the paper. We simulate a large sensor network, with nodes distributed randomly and uniformly over the area of interest. We assume that the nodes have an equal and constant transmission range. Communication is always bi-directional.

Our simulation model consists of 2,000 sensor nodes, randomly placed over a 10,000 x 10,000 grid. The transmission range is set to r units. Any two nodes whose Euclidean distance is not greater than r are considered to have wireless connectivity. A portion of the nodes are randomly selected to be hidden. These nodes are uniformly distributed in the considered area. We set the algorithm parameters such that every hidden node will be detected with probability P within a predetermined period of time T. For the study reported in this section, r is chosen to be 300 (0.03 of the graph), the detection probability ranges between 0.3 and 0.7, and the target detection time is 100 time units.

The hidden nodes are assumed to be in the initial neighbor discovery state, where they are supposed to wake up randomly, every TI time units on the average, and to exchange HELLO messages with other nodes during a period of H time units. A non-hidden node v is assumed to be in the continuous neighbor discovery state, where it wakes up randomly, every TN(v) time units on the average for a period of H time units, in order to discover hidden nodes. For the study reported in what follows, TI = 20, H = 1 and δ = 0:5 are used. When a node is detected, it joins the segment and learns about its in-segment neighbors. A hidden node that detects another hidden node remains in the initial neighbor discovery state.

Our simulations reveal that when the hidden nodes are uniformly distributed. The reason for this similarity is that the degree estimation errors of the neighbors of every node cancel each other, and the mean estimation bias approaches 0

Figure 3 shows the ratios of hidden nodes to the total number of nodes as a function of time. The initial ratio is 0.05. We can see that after 100 time units, this ratio decreases to 0.035 for P = 0:3, to 0.025 for P = 0:5, and to 0:015 for P = 0:7. After 200 time units, the ratios of the hidden nodes are 0:025, 0:012 and 0:005 respectively. It is evident that these results are very close to the required ratios.



(a) Decrease in the ratio of hidden nodes

Fig 3 Decrease in the ratio of hidden nodes

VI CONCLUSION

In this paper we proposed two different techniques like Continuous Neighbor Discovery and Link Assessment method. These two methods are mainly focused on reducing power usage of sensor network

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