Dynamic Neighbor Discovery in Wireless Sensor Networks

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Abstract: The process of synchronizing between neighbor nodes with maintenance of transmission power and other events generated in asynchronous wireless sensor networks. Traditionally more number of techniques was introduced to constructing neighbor discovery process efficiently. In that each sensor employs a simple protocol in a coordinate effort to reduce power consumption without increasing the time required to detect hidden sensors. If the nodes in a connected segment work together on this task, hidden nodes are guaranteed to be detected within a certain probability P and a certain time period T, with reduced expended on the detection. In this paper, we design and analyze several algorithms for neighbor discovery in wireless networks. Starting with the setting of a single-hop wireless network of n nodes, we propose a O(n ln n) ALOHA like neighbor discovery algorithm when nodes cannot detect collisions, and an order-optimal _(n) receiver feedback-based algorithm when nodes can detect collisions. Our result thus implies that when |E| = (n), the ALOHA-like algorithm is at most a factor min(Δ, ln n) worse than the optimal.

Index Terms: ALOHA-like algorithm, Neighbor Discovery, Randomized Neighbor Discovery, wireless sensor networks.

I. INTRODUCTION

Sensor networks considered with more number of sensor nodes that process in single primary station. Recent technologies can be developed for doing this type process in wireless sensor networks. Sensor node take signal from different other nodes present in wireless sensor networks. Each sensor node is capable of only a limited amount of processing. But when coordinated with the information from a large number of other nodes, they have the ability to measure a given physical environment in great detail. Thus, a sensor network can be described as a collection of sensor nodes which co-ordinate to perform some specific action. Unlike traditional networks, sensor networks depend on dense deployment and co-ordination to carry out their tasks.

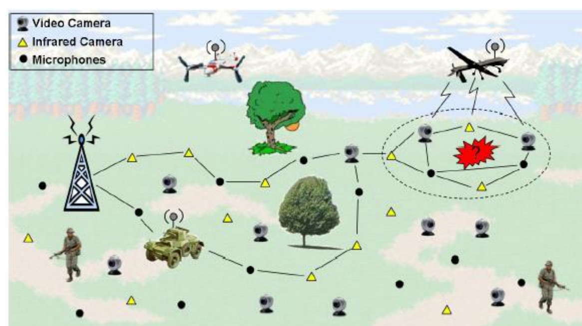

Figure 1: Wireless Multimedia Sensor Networks

These networks have the potential to enable a large class of applications ranging from assisting elderly in public spaces to border protection that benefit from the use of numerous sensor nodes that deliver multimedia content. In the sensor network model considered in this work, 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 operation. 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 special neighbor discovery scheme should be used.

In wireless sensor networks every node consists some active node termination and other node permissions are processed in every node activation in recent generation of accessing services from other nodes. During some parts of our analysis, we also assume that the network is a unit disk graph; namely, any pair of nodes that are within transmission range are neighboring nodes. Two nodes are said to be *directly connected* if they have discovered each other and are aware of each other's wake-up times. Two nodes are said to be connected if there is a path of directly connected nodes between them. A set of connected nodes is referred to as a segment. Consider a pair of neighboring nodes that belong to the same segment but are not aware that they have direct wireless connectivity. The main idea behind the continuous neighbor discovery scheme traditionally propose is that the task of finding a new node u is divided among all the nodes that can help v to detect u.

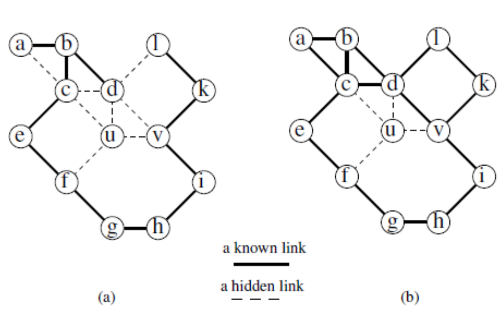

Figure 2: Segments with hidden nodes and links

These nodes are characterized as follows: (a) they are also neighbors 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 degs (u) be the number of these nodes. In this paper we propose to develop efficient process generation at each time slot, a sensor either transmits HELLO messages in a random direction, or listens for HELLO messages from other nodes. The goal is to determine the optimal rate of transmission and reception slots, and the pattern of transmission directions.

This scheme is invoked when a new node is discovered by one of the segment nodes. The discovering node issues a special SYNC message to all segment members, asking them to wake up and periodically broadcast a bunch of HELLO messages. This SYNC message is distributed over the already known wireless links of the segment. Thus, it is guaranteed to be received by every segment node.

In this paper, we propose and analyze an efficient approach called Filter-based Addressing Protocol (FAP). The proposed protocol maintains a distributed database stored in filters containing the currently allocated addresses in a compact fashion. We consider both the Bloom filter and a proposed filter, called Sequence filter, to design a filter-based protocol that assures both the univocal address configuration of the nodes joining the network and the detection of address collisions after merging partitions. We also propose to use the hash of this filter as a partition identifier, providing an important feature for an easy detection of network partitions. Hence, we introduce the filters to store the allocated addresses without incurring in high storage overhead. The filters are distributed maintained by exchanging the hash of the filters among neighbors. This allows nodes to detect with a small control overhead neighbors using different filters, which could cause address collisions. Hence, our proposal is a robust addressing scheme because it guarantees that all nodes share the same allocated list.

II. RELATED WORK

The lack of servers hinders the use of centralized addressing schemes in ad hoc networks. In simple distributed addressing schemes, however, it is hard to avoid duplicated addresses because a random choice of an address by each node would result in a high collision probability, as demonstrated by the birthday paradox. Nevertheless, if the number of bits in the address suffix is smaller than number of bits in the MAC address, which is always true for IPv4 addresses, this solution must be adapted by hashing the MAC address to fit in the address suffix. Hashing the MAC address, however, is similar to a random address choice and does not guarantee a collision-free address allocation. The first node in the network, called prophet, chooses a seed for a random sequence and assigns addresses to any joining node that contacts it. The joining nodes start to assign addresses to other nodes from different points of the random sequence, constructing an address assignment tree. Prophet does not flood the network and, as a consequence, generates a low control load. The protocol, however, requires an address range much larger than the previous protocols to support the same number of nodes in the network. Moreover, it depends on the quality of the pseudo-random generator to avoid duplicated addresses.

III. EXISTING SYSTEM

In the following discussion, two nodes are said to be neighboring nodes if they have direct wireless connectivity. We assume that all nodes have the same transmission range, which means that connectivity is always bidirectional. During some parts of our analysis, we also assume that the network is a unit disk graph; namely, any pair of nodes that are within transmission range are neighboring nodes. Two nodes are said to be *directly connected* if they have discovered each other and are aware of each other's wake-up times. Two nodes are said to be connected if there is a path of directly connected nodes between them.

A set of connected nodes is referred to as a segment. Consider a pair of neighboring nodes that belong to the same segment but are not aware that they have direct wireless connectivity. See, for example, nodes a and c. These two nodes can learn about their hidden wireless link using the following simple scheme, which uses two message types: (a) SYNC messages for synchronization between all segment nodes, transmitted over known wireless links; (b) HELLO messages for detecting new neighbors.

Simulated a sensor network to analyze our algorithms and showed that when the hidden nodes are uniformly distributed in the area, the simplest estimation algorithm is good enough. When the hidden nodes are concentrated around some dead areas, the third algorithm, which requires every node to take into account not only its own degree, but also the average degree of all the nodes in the segment, was shown to be the best.

IV. PROPOSED PROTOCOL

We consider the ALOHA-like neighbor discovery algorithm We first study this algorithm when all n nodes in the network are arranged in a clique. We further assume that n is known to each node in the clique. Finally, we consider a slotted, synchronous system where time is divided into slots and nodes are synchronized on slot boundaries. In other words, each transmission starts at the beginning of a slot and lasts the entire duration of the slot.

a) Algorithm Description

The ALOHA-like algorithm is a randomized algorithm that operates as follows. In each slot, a node independently transmits a *DISCOVERY* message announcing its ID, with probability pxmit, and listens with probability 1 − pxmit. A discovery is made in a given slot only if exactly one node transmits in that slot

b) Neighbor Discovery As Coupon Collector's Problem.

We first describe how the neighbor discovery problem maps into the classical *Coupon Collector's Problem*. The process of neighbor discovery can be then be treated as a coupon collector's problem in the following manner. Consider a coupon collector C drawing coupons with replacement from an urn consisting of n distinct coupons, each coupon corresponding to a distinct node in the clique. In each slot, C draws one of the n coupons (i.e. discovers a given node) with probability p, and draws no coupon (i.e., detects an idle slot or a collision) with probability 1 − np. It is easy to see that when C collects n distinct coupons, this can be interpreted as each node in the clique having discovered all of its n – 1 neighbors.

c) Unknown Number of Neighbors

The key idea here is that nodes geometrically reduce their transmission probabilities until they enter the phase of execution appropriate for the population size n.

Algorithm Collision Detection-Based ND(i,n)

```
b ← 0 //Number of neighbors discovered by node i
flag ← 0 //Has node i been discovered by other nodes?
NbrList ← [ ] //List of neighbors of node i
loop
  p_xmit ← 1/(n − b)
  if ((flag = 0) and (Bernoulli(p_xmit) = 1)) then
    Transmit DISCOVERY(i) in first sub-slot
    if energy detected in second sub-slot then
      flag ← 1 //"Drop out"
    end if
  else
    if successful reception in first sub-slot then
      Transmit bit "1" in second sub-slot
      NbrList[b++] ← DISCOVERY.source
    end if
  end if
end loop
```

Figure 3: Neighbor detection process in wireless sensor networks.

This occurs when nodes enter the ⌈ log n⌉ -th phase. During this phase, each node transmits with probability 1/n for duration of 2ne ln n slots.

V. PERFORMANCE ANALYSIS

In this section we describe the following things for accessing services in wireless sensor networks.

Neighbor Discovery Using Directional Antennas

The analysis of the ALOHA-like algorithm in this paper can also be extended to the case when nodes have directional antennas. It must be noted that in addition to reducing neighbor discovery time, using directional antennas also reduces the overall energy consumption, since nodes require less power to communicate over the same distance as compared to Omni-directional antennas.

RFID Tag Identification

The neighbor discovery algorithms proposed in this paper can easily be adapted to solve the RFID tag identification problem, where a tag reader needs to identify the IDs of the tags in its range. Each time the tag reader discovers a new tag, it announces the ID of the tag allowing it to drop out. Unlike prior work addressing the RFID tag identification problem, our algorithms do not require collision detection and do not require *a priori* estimate of the number of tags.

Feedback-based Algorithms for Multi-Hop Networks

There are two important obstacles that need to be overcome in this regard.

1) In a clique setting, when a node i, hears its ID back, it knows that all other nodes in the clique have discovered i, thus allowing it to drop out. In the multi-hop case, however, the presence of hidden terminals may cause a subset of i's neighbors to not receive i's transmission. Thus, i cannot drop out despite hearing its ID back.

2) In the multi-hop setting, i's dropping out needs to be signaled to its neighbors allowing them to increase their transmission probabilities, which appears non-trivial.

VI. CONCLUSION

Our neighbor discovery algorithms do not require estimates of node density and allow asynchronous operation. Furthermore, our algorithms allow nodes to begin execution at different times and also allow nodes to detect the termination of the neighbor discovery phase. A number of avenues for future work remain open. Our analysis shows a gap between the lower and upper bounds on the running time for neighbor discovery in the network case. Clearly, the quest for an order-optimal neighbor discovery algorithm remains an intriguing prospect. we design and analyze several algorithms for neighbor discovery in wireless networks. Starting with the setting of a single-hop wireless network of n nodes, we propose a O(n ln n) ALOHA like neighbor discovery algorithm when nodes cannot detect collisions, and an order-optimal _(n) receiver feedback-based algorithm when nodes can detect collisions.

VII. REFERENCES

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