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AN EFFICIENT SLEEP SCHEDULING STRATEGY FOR WIRELESS SENSOR NETWORK

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ABSTRACT:

The sensor nodes are grouped into clusters and cluster head may be chosen according to some predefined algorithm. Clustering architecture provides a convenient framework for resource management, such as channel access for cluster member, data aggregation, power control, routing, code separation, and local decision making. The aim of our proposed work is to dynamically balancing energy consumption and to enhance the functional lifetime of the network by dynamically scheduling nodes to go for a sleep in each round. Functional life time of the network normally refer to the duration when a percentage of sensors exceeding a threshold (e.g. 80%) have depleted their energy.

Medium Access Control (MAC) protocol play an important role in the successful operation of WSNs. The Sensor Medium Access Control (SMAC) is one such protocol that identifies a few source of energy wastage and proposes an adaptive sleep-and-listen scheme to minimize energy wastage. In this we proposes a modified SMAC that attempts to increase energy savings by introducing changes to the existing SMAC protocol. The modified SMAC introduce a clustering mechanism, in which the node form clusters and elect a cluster head. The energy saving achieved with the modified SMAC protocol are primarily due to the increased sleep-time fraction for cluster nodes. The clustering mechanism also reduces control overhead, which is prevalent in the SMAC protocol due to the periodic control packet exchanges. In our work, energy consumption is analyzed with respect to time for a reactive protocol and a proactive protocol such as AODV and DSDV and concluded that our proposed modified-SMAC consumed less energy in both the cases.

KEYWORDS*—MAC,SMAC,WSN,AODV,DSDV.*

I. INTRODUCTION

A wireless sensor network consists of a number of sensors spread across a geographical area. These sensors are distributed either randomly or in a pattern. Wireless sensor networks have been a subject of interest due to their wide variety of potential applications. Initially, these networks were primarily researched for their military applications, and now, the networks have a wide industrial and consumer applicability through their remote interaction with the physical world. In many applications, wireless sensor networks face some drawbacks, such as limited power, limited communication capabilities, limited computation capabilities, huge deployment area, and the node count in a network. Because of all these drawbacks with wireless sensor networks, there are many challenging problems.

Among all, a very important issue regarding the design of sensor networks is power consumption. Efficiency of energy consumption is an important objective for these wireless sensor networks. All the sensor nodes have limited battery supplies and limited sensing capabilities. Network lifetime has a strong dependence on the sensor's battery power. Because these sensor networks have a large number of nodes, allowing some nodes to sleep for particular time intervals can result in an increased network lifetime. The goal for this paper is to develop a sleep scheduling algorithm to maximize the coverage and the lifetime of the wireless sensor networks. This algorithm schedules a sensor's sleep probability based on the area of overlapped coverage by its neighboring sensors.

II. RELATED WORK

A significant amount of research has been done in the area of energy conservation both at the routing layer Existing MAC and physical layer research on energy conservation in 802.11 networks can be categorized in to three broad areas. Protocols in the first area deal with transmission power control for reducing the transmission energy by choosing optimal transmission power level on a per-transmission basis. Deng et al. [1] studied the node sleep scheduling problem in the context of cluster-based sensor networks. In this paper, the traditional sleep scheduling scheme, randomized sleep scheduling (RS) scheme, is described and used to solve the node sleeping problem. In the RS scheme, all the nodes are assigned with a random probability to sleep in each cycle. Then the author proposed the linear distance based scheduling (DS) scheme to put the sensor nodes to sleep in each cycle. The DS scheme selects sensor nodes to sleep with a higher probability if they are farther away from the cluster head. In contrast, the overall performance of the DS scheme is better than that of the RS scheme. Although the DS scheme offers a longer lifetime than the RS scheme, its coverage is not high. The CS algorithm works under the following assumptions. First, the cluster maintains a static structure, i.e., each sensor node will stay in the same cluster for the duration of its lifetime. Second, a cluster head knows the location and sensing range of each node in its cluster In general, the higher density of test points in a cluster, the more accuracy to estimate the degree of overlap for the sensing area of a node. The coverage problem was formulated in [2] as a decision problem, whose goal was to determine whether every point in the service area of the sensor network was covered by at least k sensors, where k is a given parameter. Ahmed et al. [3] proposed a distributed probabilistic coverage algorithm to evaluate the degree of confidence in detection probability provided by a randomly deployed sensor network, using a uniform circular disc for sensing coverage in the binary detection model. These methods addressed the coverage problems in different scenarios,but few consider the network lifetime. In high density wireless sensor networks, Deng et al.[4] studied the node sleep scheduling problem in the context of cluster-based sensor networks. The authors proposed a linear distance based scheduling (DS) scheme that selects sensors to sleep with a higher probability if they are farther away from the cluster head to compensate the higher energy they use in communication. DS offers longer network lifetime, but its coverage is lower. Another weakness of DS is that it is a centralized algorithm. Heavy scheduling and communication tasks make the cluster head a bottleneck.

III. SMAC- SENSOR MCA

SMAC stands for Sensor MAC. This protocol tries to reduce energy consumption due to overhearing, idle listening and collision. In this protocol also every node has two states, sleep state and active state. Unlike STEM, SMAC does not use two channels. A node can receive and transmit data during its listen-period.

SMAC adopts a periodic wake up scheme. SMAC tries to synchronize the listen periods of neighboring nodes. The listen period of a node is divided into three phases as shown below. The listen period is the time during which a node is awake, rest of the time node is sleeping. The listen and sleep periods intheS-MACarefixedintervals.

IV. SLEEP SCHEDULING ALGORITHM

Before introducing our proposed sleep scheduling algorithm, we assume that the sensors are static, i.e., each sensor stays in the same location during its lifetime; the sensors can communicate with their neighbors to exchange small amount of information; they can detect the sleep status of their neighbors and relay alarm when events are detected. While the Random Scheduling (RS) algorithm schedules a sensor’s sleep probability randomly and the DS algorithm schedules the sleep probability based on the sensor’s distance to the cluster head, We propose a protocol Modified SMAC. Which attempts to increase energy savings by introducing changes to the existing SMAC protocol? The modified SMAC introduce a clustering mechanism, in which the node form clusters and elect a cluster head. The energy saving achieved with the modified SMAC protocol are primarily due to the increased sleep-time fraction for cluster nodes. The clustering mechanism also reduces control overhead, which is prevalent in the SMAC protocol due to the periodic control packet exchanges. In this paper, we also compare the Energy consumption vs Time for a reactive protocol and a proactive protocol such as AODV and DSDV with both SMAC and proposed SMAC and find the later consumed less energy in both the cases.

V. DISTRIBUTED SLEEP-SYNCHRONIZATION PROTOCOL

The aim of this protocol is to reduce energy consumption due to idle listening. This is achieved by making use of a concept of periodic sleep and wake cycles that are synchronized across each neighbor pairs in the network. To explain it further, any pair of neighbor nodes will maintain a synchronized sleep-wake schedule so that their interfaces can sleep during the sleep period and they can execute 802.11 MAC protocol for data transaction during the wake period. Higher duty cycles can handle higher loads at the cost of lower idle energy savings. The proposed distributed algorithm is implemented within a SyncAgent just above the MAC layer as shown in Figure 1 SyncAgent runs in each node and it handles all sleep-synchronization related functions including distributed schedule maintenance and instructing the wireless interface hardware to sleep and wake up according to the converged schedule. The SyncAgent uses standard MAC layer broadcast services and it does not rely on any specific underlying MAC layer protocol.

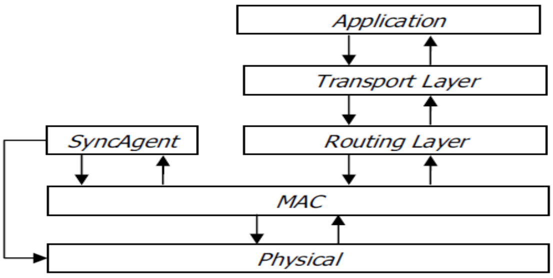

Figure 1: Layered implementation of the proposed synchronization protocol

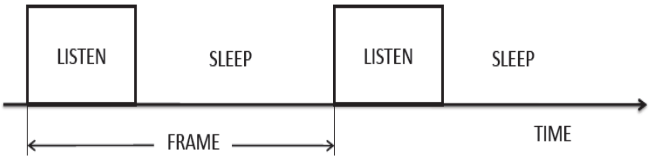

Figure 2: Periodic sleep and listen in SMAC

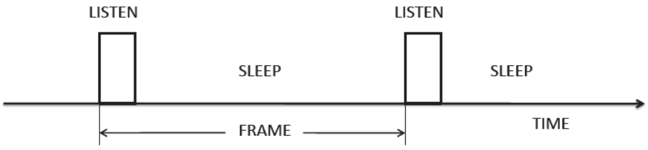

Figure 3: Periodic sleep and listen in proposed SMAC

VI. EXPERIMENTAL SETUP

For implementation we have taken a network of 5 nodes over a rectangular flat space. Simulation time is 10000 seconds. The random waypoint model is selected as a mobility model in a rectangular field (1000 * 1000 m^2). I created the scenario using TCL on the front end of NS2 simulator. I have applied clustering in between the node and choose one cluster head. All other node send its packet to cluster head and not to the node directly also the control packet is send to only Cluster Head which also reduce the energy consumption to a greater extent. All the nodes communicate using half-duplex wireless radios that conform to 802.11-based Wave-LAN wireless radios with a bandwidth of 2Mbps and a nominal reception range of 250m.

1. Finding and Conclusion

Fig 4: Energy consumption of node using AODV in proposed SMAC.

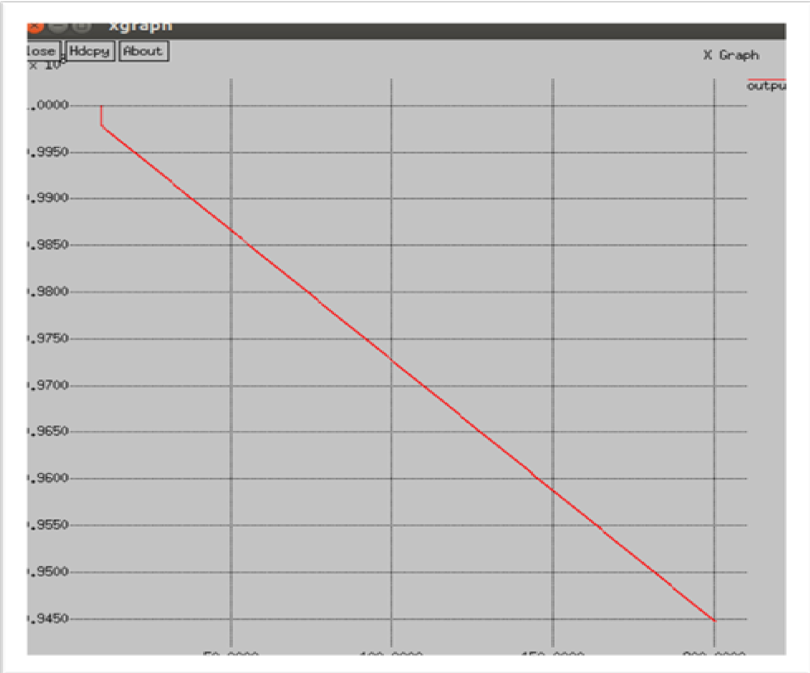

Fig 5: Energy consumption of node using AODV in original SMAC

VII. CONCLUSION

The proposed protocol significantly reduces the energy consumption by significantly reducing synchronization overhead and redefines the communication procedure between nodes. This report presented a modified version of SMAC in which makes use of the concept of clustering. The routing protocols, AODV and DSDV are taken into account in the simulation.

Comparative analyses of the energy consumption vs. time for AODV as well as DSDV for both the modified SMAC and that of SMAC, and found that modified-SMAC consume less energy as compared to its original version.

The key factor that accounts for energy saving are:

- Reduced listen time in cluster nodes,
- Cluster head handling the data forwarding and
- Low control packet overhead

FUTURE WORK

As future research directions, the concept of Gaussian distribution would be applied to the cluster so as to avoid the energy whole problem as well as to minimize the energy consumption per sensor node. Also, the performance of the protocol needs to be evaluated under high network density and heavy traffic scenario.

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