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Design & Implementation of Data Forwarding Mechanism with Sleep Scheduling in WSN

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Abstract: Energy is a scarce resource in wireless sensor networks (WSN) and conservation of energy has been the subject of extensive research. This paper proposes an optimal routing mechanism under sleep scheduling in wireless sensor networks. Duty cycling is a technique that increases energy efficiency by allowing a node to turn off part or all of its systems for periods of time. These sensor networks have certain characteristics such as limited power and battery driven. In this work, an on demand routing under asynchronous sleep scheduling is proposed for each sensor. The aim of this work is to minimize the energy consumption by nodes so that lifetime will improve. The proposed mechanism is implemented with MATLAB.

Keywords: Sleep Awake Cycle, shortest path in Networks, wireless sensor networks, sleep scheduling.

I. INTRODUCTION

Energy is a scarce resource in wireless sensor networks (WSN) and conservation of energy has been the subject of extensive research. While a variety of solutions have been proposed, duty cycling and network coding have proven to be two of the most successful techniques in this field. Network coding is a technique that increases energy efficiency and reduces network congestion by combining packets destined for distinct users. Since many applications have incorporated this idea. Network coding is particularly well-suited for WSN due to the broadcast nature of their communications. Overhearing is effortless, propagation is usually symmetric, and energy efficiency is a priority. Network coding can be found in applications including multicast, content distribution, delay tolerant networks (DTN), underwater sensing suites, code dissemination, storage, and security. As diverse as these applications are, they all share a common assumption: nodes in the network are always awake.

A wireless sensor network (WSN) consists of a large number of tiny and inexpensive devices, mostly sensors, which send their data wireless within a network. In general the tasks that these devices perform are the following: on board data processing, communication between sensors, sensing capabilities and actuation applicability but these are not all mandatory present within a WSN. These devices communicate with each other to share their data obtained from measurements taken by the device or to redirect their data to a central collection point. The advantages of these kinds of networks are that the communication between the devices is performed wireless and there is no need for any additional network infrastructure. Hence these kinds of networks are very flexible which makes them interesting to use in certain scenarios.

Wireless Sensor Networks may consist of many different types of sensors such as seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar. They are able to monitor a wide variety of ambient conditions that include temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, and the current characteristics such as speed, direction and size of an object.

One of the most important issues regarding the design of sensor networks is power consumption since these networks consist of a large number of nodes and are usually deployed in hazardous and remote areas where the replacement of batteries is impossible. The second is overhearing, which occurs when a node receives and decodes packets that are not destined to it. The third, over-emitting, occurs when the transmitter node transmits a packet while the receiver node is not ready to receive it.

There are several major sources of energy wastage in the MAC layer of WSNs which should be minimised to achieve greater energy efficiency. The first is idle listening, which occurs when the radio transceiver is active while there is no data to transmit or receive. It has been studied that sending and receiving packets of various sizes indicate that the power consumed when the interface is active or idle is virtually identical. Duty cycling is a technique that increases energy efficiency by allowing a node to turn off part or all of its systems for periods of time.

To improve a sensor network's reliability and extend its longevity, sensor networks are deployed with high densities. However, if all sensor nodes in such a dense deployment scenario operate at the same time, energy will be consumed excessively. Also, packet collisions will increase as a result of the large number of packets being forwarded in the network. In addition, most of the data forwarded in the network will be redundant since when node density is high, sensing regions of the nodes will overlap and the data of adjacent sensor nodes will be highly correlated.

The paper is ordered as follows.

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In Section II, It defines sleep scheduling in WSN. In section III, it describes the proposed work related to sleep awake cycling in WSN. In section IV, it provides the proposed results of system. Finally, conclusion is explained in Section IV.

II. SLEEP SCHEDULING IN WSN

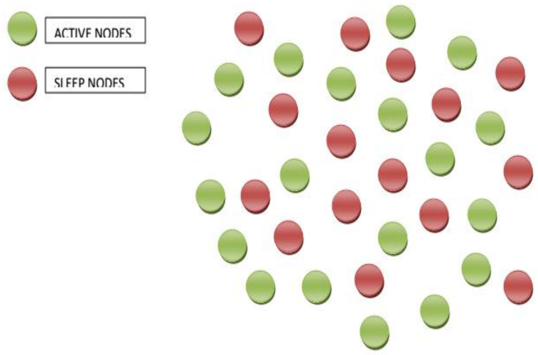

Figure 1: Sleep Scheduled Nodes in Network

The purpose of sleep scheduling techniques is to save energy and prolong network lifetime. Several protocols have been proposed to reduce the energy consumption using sleep scheduling methods. The major design objective for wireless sensor network applications is to minimize the energy consumption in order to maximize network lifetime. Among various approaches for efficient use of energy including clustering [4] and data aggregation, sleep scheduling is the most commonly used one.

A. *Asynchronous sleep Techniques*

Asynchronous sleep techniques aim to keep the radio in default sleep mode and wake-up briefly to check for traffic or send/receive messages. The various asynchronous sleeping techniques are discussed: The secondary wake-up radio concept uses a hardware solution to enable nodes to sleep by default and only awake when needed [4]. In the design, each sensor node is equipped with two radio transceivers. The primary (data) radio remains asleep by default. The secondary radio is a low-power wake-up radio that remains on at all times. When the secondary radio receives a wake-up signal from another node, it instructs the primary radio to wake up for data transmission. This method assumes that an extremely low power radio can be used as a secondary radio. This method does not scale well for densely deployed WSN topologies; all nodes within the broadcasting range will suffer from overhearing, waking up for uni-cast packets which might not be destined to them.

B. *Sleep Scheduled Techniques*

Sleep scheduling techniques aim to reduce energy consumption by synchronizing sleep schedules and enable lower duty cycles. S-MAC, T-MAC, and D-MAC are the most well-known WSN sleep scheduling techniques. Sensor MAC (S-MAC) provides a tunable, non-adaptive, periodic active/sleep cycle for sensor nodes (see Figure 1.8). During sleep periods nodes turn off their radios to conserve energy. During active periods nodes turn on their radios to exchange data. During the initialization phase nodes remain awake and listen for sleep schedules from neighbors. If they do not receive a sleep schedule, they create their own schedule and start broadcasting it. A problem with S-MAC is that a single node can follow multiple schedules, which can severely impact the average duty cycle.

III. PROPOSED WORK

A sensor node consumes battery power in the following four operations: sensing data, receiving data, sending data, and processing data. Generally, the most energy consuming component is the RF module that provides wireless communications. Consequently, out of all the sensor node operations, sending/receiving data consumes more energy than any other operations. Sensor nodes in a WSN have a limited amount of energy and if all the sensor nodes would be active all the time the whole network may collapse in a short time. This is due to the high energy consumption of the sensor nodes. However it is not necessary for all the sensor nodes to be active all the time, they only need to become active when there is a need to transmit and /or receive data. Therefore, sleep scheduling can prolong the lifetime of a WSN significantly. Sleep scheduling works by activation sensor nodes when there is a need to transmit/receive data the remainder of the time the sensor node sleeps. Sleep scheduling belongs to the category of power management protocols which is one of the main energy conservation techniques used for WSNs.

First of the power management protocol that is introduced is the on-demand protocol. This protocol is based on the idea that a sensor node should be in the sleep mode or off when there is no data packet to transmit and/or receive. As soon as there is a data packet that needs to be transmitted and/or received the sensor node shall become active. In this way sensor nodes alternate between active and sleep periods depending on network activity. The consequence is that the energy consumption is minimized since sensor do not waste energy by unnecessary transmissions and unnecessary sensing. But the main disadvantage of this protocol is that it is difficult to inform the sleeping sensor nodes if another sensor node wants to communicate with them.

The second power management protocol is called scheduled protocol which belongs to the synchronous protocols since it requires all neighbouring sensor nodes to wake up at the same time. In Figure, the sleep scheduling of sensor nodes using a scheduled rendezvous protocol is shown. In this approach sensor nodes wake up according to a wakeup schedule and remain active for a short time interval to communicate with their neighbours. After the transmission of the data the senor nodes will go to sleep until the next rendezvous time.

The next algorithm that can be used is the asynchronous protocol. The basic idea is that each node is allowed to wake up independently of the others by guaranteeing that neighbouring sensor nodes always have overlapped active periods of time within a specified number of cycles. One of the advantages of this protocol is

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that a sensor node can wake up at anytime when it wants to communicate with its neighbouring sensor nodes. Therefore, in asynchronous protocols there is no need to exchange extra synchronization information unlike in the synchronous protocols so that the energy efficiency is improved. In contrast with the scheduled rendezvous protocol, it is not possible to broadcast a message to all neighbouring sensor nodes in one period of time.

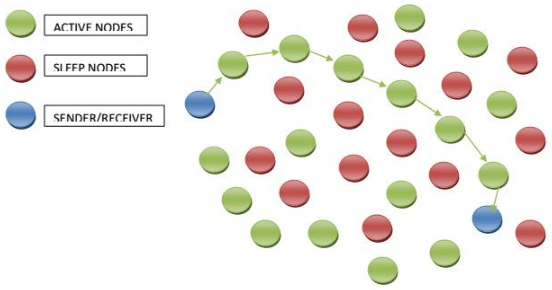

Figure 2: Proposed On Demand Scenario under Sleep Scheduled Network

Proposed Algorithm
Input N: No. of Nodes
Begin
Step 1: Provide N
Step 2: Activate all N.
Step 3: Communication with all N
Step 4: Set wake up time (t)
Step 5:
Case 1: If N is idle then
Put N in sleep state
Case 2: Put half N in sleep and half N active
Provide routing in On state.
Case 3: Initially all N in sleep
Provide On demand Routing in them for energy efficiency.
End

IV. SIMULATION RESULTS

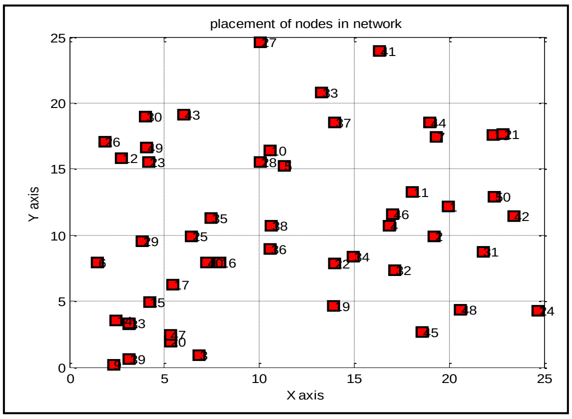

Figure 3: Placement of 50 Nodes in Network

Sleep wake scheduling has been used to save the energy and extend the network lifetime. Energy efficiency has inherent trade-off with delay, thus, generally in such sleep wake scheduling strategies, maximization in network lifetime is achieved at the expense of increase in delay. To achieve this, delay minimization at three levels is analyzed and addressed: the delay occurred because of traffic load at the nodes near the BS, the delay occurred due to traffic load at the connectivity critical node, and delay occurred while dealing with traffic burst when an event occurs.

In minimum-energy routing protocol, nodes in a network act as a router for other nodes. Transmission to the base station from one node occurs through intermediate nodes. The energy dissipation of the receiver is neglected in some of the protocol [7] and only transmitter energy is taken. The selection of midway nodes is completed in such a manner that transmission energy is minimized. It has been discussed whether this routing protocol perhaps consumes more energy than direct routing algorithm. That is, the energy consumed by each neighbour in order to receive and then transmit data could result in the total energy consumption to be higher.

In this work, take the scenario for 50 nodes and following result will show the information about the placement of sensor nodes in an area. The simulation environment is to randomly distribute 50 sensor nodes to an 25m*25m square. The initial energy of each node is provided. In each round, the sensor node will deliver a packet. All sensor nodes are stationary and homogenous. All sensor nodes can adjust their power levels based on distance.

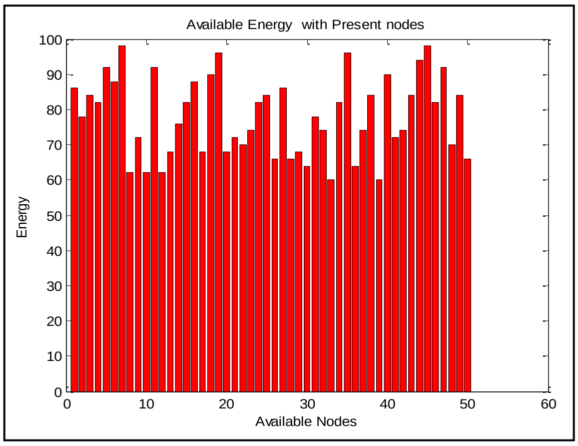

Figure 4: Available Energy of Nodes in Synchronous Mode

Initially all nodes are in OFF State. If nodes want to communicate with each other, all nodes have a wakeup time and they woke up all at a time i.e. they are synchronous in nature. All nodes are ON & OFF synchronously. They provide communication by multi-hop routing technique. When the distance between a sensor node and the base station is large the data transmission from sensor node to base stations consumes more energy than in the case when the distance is small. Hence the distance between sensor nodes among another and the distance from sensor nodes to the base station impacts the lifetime of the WSNs.

In a direct data transmission, each sensor node collects and transmits the data to the base station directly, there do not exist any intermediate nodes for transmission, the path which from sensor node to the BS can also be called single-hop path. The advantage of direct transmissions is that the data rate is higher and the

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implementation is easier. Indirect transmission means that sensor nodes send their collected data to intermediate nodes also called relay nodes that are in the proximity of themselves. This relay node will then forward the aggregated data to the BS, the path from the sensor node to the BS is also called multi-hop path.

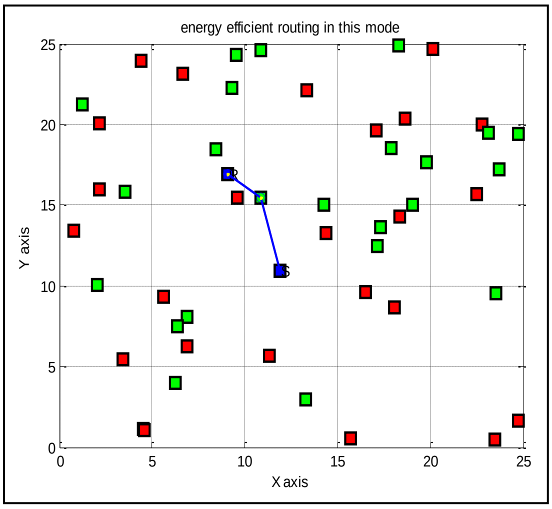

Figure 5: Energy Efficient Routing in Asynchronous Mode

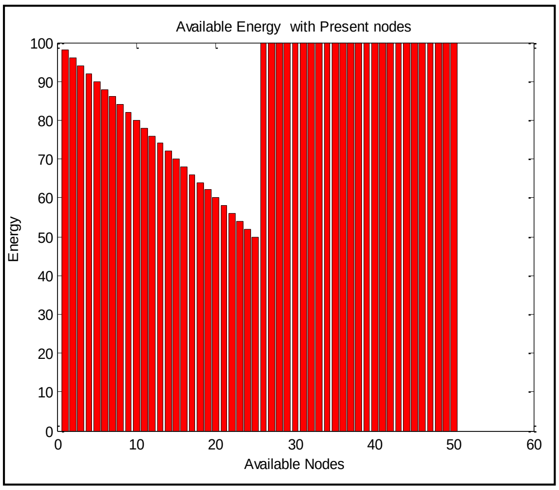

Figure 6: Available Energy in Asynchronous Mode

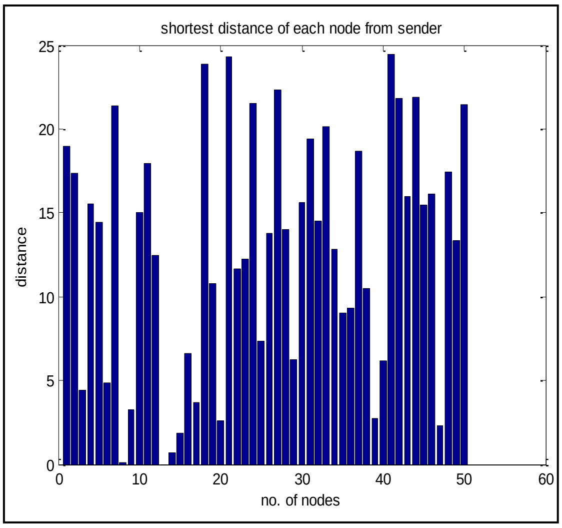

Figure 7: Shortest Distance between Nodes

In the proposed on demand case, all nodes are initially in OFF State. As Sender node is chosen and he wants to send data to a particular node. Then he finds initially all present nodes location in the path and stores it. So, only those nodes which are coming in the path gets wakeup call and they may help the sender to communicate with destination.

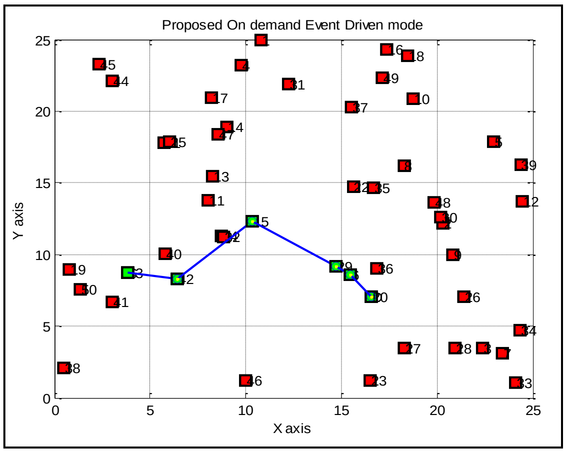

Figure 8: Proposed On Demand Routing

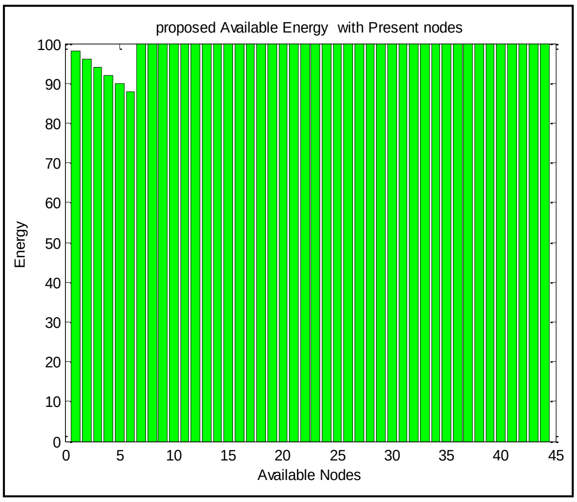

Figure 9: Proposed Available Energy in Nodes

V. CONCLUSION

In this work, we exploited the problem of energy wastage multi-hop broadcasts in low duty-cycled wireless sensor networks, then it presented the sleep scheduling of nodes in WSN. In this, data forwarding is based on shortest distance between nodes which is to be calculated. In this, it covers different scenarios under sleep schedule. The main objective is to provide energy efficiency in network & also reduce delay. In this, it presents a multipath routing protocol for data transmission. All these are useful for reducing the energy consumption and improve the accuracy. We simply shows time synchronization for sleep scheduling in first scenario, which requires all neighbouring nodes to wake up at the same time, nor assume duty-cycled awareness, which makes it difficult to use in low duty-cycled WSNs. So, to overcome this, we showed the on demand scheduled routing. In this routing, it improves 20-30% the energy efficiency as compared to asynchronous routing protocol under sleep scheduling.

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The proposed mechanism consumes only 20% of total energy. Hence provides effectiveness in proposed scheme. Further In future work, this algorithm must implement under collision detection with mobility in nodes.

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