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Energy–Efficient Sleep Scheduling For Critical Event Monitoring To Improve Performanceof Wireless Sensor Network

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Abstract
A sensor networked applications can be formed for critical applications where it could send the detected information to the user or to the other sink node. This message is often called as alarm message where it is indicating the current operational state of the system. An alarm needs to be broadcast to the other nodes as soon as possible,when a critical event (e.g., gas leak or fire) occurs in the monitoring area and is detected by a sensor node, then, sensor nodes can inform users nearby to take some response to the event. The life of sensor nodes for event monitoring are expected to work for a long time without recharging their batteries, sleep scheduling method is always preferred during the monitoring process. Sleep scheduling could cause transmission delay because sender nodes should wait until receiver nodes are active and ready to receive the message. The delay could be important as the network scale increases. Hence, a delay-efficient sleep scheduling method needs to be designed to ensure low broadcasting delay from any node in the WSN.Only a small number of packets need to be transmitted during most of the time in the critical event monitoring,. When a critical event is detected, the alarm packet should broadcast to the entire network as soon as possible. Hence, broadcasting delay is an important issue for the application of the critical event monitoring. It is needed to minimize the time wasted for waiting during the broadcasting to minimize the broadcasting delay. The ideal scenario is the destination nodes wake up immediately when the source nodes obtain the broadcasting packets. Hence, the broadcasting delay is definitely reduced. The objective of the project is to reduce the delay of the packet transmitted from the source to destination by a scheduling mechanism. This method is also increasing the lifetime of a node in the network.
Index Terms—Broadcasting Delay, Critical event monitoring, Lifetime of nodes, sleep scheduling, Wireless Sensor Network (WSN),

I. INTRODUCTION

The wireless sensor network (WSN) consists of spatially distributed Autonomous sensors to monitor physical or environmental conditions to cooperatively pass their data through the network to a main location. The target area is covered by large no of nodes. Nodes in wireless sensor network communicate with each other for a given task. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as machine health monitoring, industrial control and process monitoring, etc.

A projecting feature of WSN is that its wireless sensor nodes (devices) are powered by batteries. Sensor nodes are expected to work for a long time without recharging their batteries. Hence energy saving is most fundamental important issue.

In mission –critical application, such as battlefield reconnaissance, fire detection in forest, gas monitoring in coal mines, wireless sensor network is arranged in wide ranges of areas, with a large number of sensor nodes detecting and reporting some information of urgencies to the end users As there maybe be no communication infrastructure, users are usually prepared with communicating devices to communicate with sensor nodes as soon as possible. Then sensor nodes for event monitoring are expected to work for a long time without recharging their batteries.

Sleep scheduling methods are always used for event monitoring as WSN are expected to operate for a long time without recharging their batteries. Sleep scheduling could cause transmission delay because node should wait until receiver nodes are active and ready to receive the message. The delay goes on increases with network scale hence delay efficient sleep scheduling methods needs to be design to ensure low broadcasting delay from any node in network.A sensor networks makes the best possible use of their initial energy resources. There are some protocols that focus on reducing energy at data link/MAC layer

Sleep scheduling: One of the most common methods to reduce the energy consumption of nodes is to put them to sleep when their workload is not heavy. Putting nodes to sleep may be done in various layers and unit of the sensor nodes and have different effects on how the network operates. Positioning the transmitter unit can save a lot of energy but may have longer delay or increase the data loss. Turning off the sensing unit would also save a great deal of energy but may cause lower coverage,higher response time, lower accuracy. Since usually sensor networks are supposed to work many times more than a sensor nodes life in active mode there is no choice but to put sensor nodes into sleep. In such cases we have to find methods to reduce the problems that arise due to this fact. These methods try to improve the way network operates in different layers. Maximum energy saving is possible through putting transmitter unit to sleep. MAC protocol manages the operation of this unit. Several MAC protocols have been designed specifically for WSNs. SMAC (Synchronous MAC) is one of well-known MAC protocols specifically designed for WSNs. In this MAC nodes use Sleep/Active periods to save energy. This approach increases the data transmission delay in network and makes it unusable for delay sensitive applications. Several routing protocols have been proposed for multi hop sensor networks that try to reduce the energy consumption if the node saves the ability to control the sensing unit's operation separately by scheduling its activity energy savings is achieved.

II. LITERATURE SURVEY

The S-MAC medium access protocol [1] introduces synchronized periodic duty cycling of sensor nodes as a mechanism to reduce the ideal listening energy cost. In S-MAC each node follows a periodic active/sleep schedule, synchronized with its neighboring nodes. During sleep periods the radios are completely turn off, and during active period, they are turn back on to transmit and receive messages. Although the synchronized low duty cycle operation of a sensor network is energy efficient, it has one major deficiency it introduces sleep latency. At a source node, a sampling reading may occur during the sleep period and has to be queued until the active period Anintermediate node may have to wait until receiver wake up before it can forward a packet received from its previous hop this is called as sleep latency.

In Adaptive Listening energy-efficient duty cycling may be maintained while reducing sleep latency where nodes that lie one or more step ahesd in the path of transmission can be kept awake for additional length of time to the basic S-MAC. This approach provides some reduction in sleep latency but its energy expense becomes greater due to extended activation and overhearing hence it is not sufficient for long paths. [2] .this paper addresses the important problem sleep latency each sensor has to awake for 1/k fraction of time slots on an average where each sensor has to wake one of the k slots. This paper derives and analyzes optimal solution for tree topologies and ring topologies. This paper suggests that distributed heuristics may perform poorly because of the global nature of the constraints involved. Algorithm of this paper offers a desirable bound of d+o(k) on the delay for tree and greed topology and weaker guarantee od o((d+k)log n) for arbitary graphs. Where d is the shortest path between 2 nodes in the underlying topology and n is the total number of nodes. Idle listening, frame collisions, protocol overhead, and message overhearing these are the main sources of energy loss in WSNs

Most existing contention-based WSN MAC protocols reduce idle listening, but they fail to avoid the nodes from actively monitoring channel contention periods and reservation protocol (RTS-CTS) packets before transitioning to sleep [1][4][5]. Sensor MAC (S-MAC) [1]and Timeout MAC (T-MAC) [6] are contention-based protocols focused on reducing idle radio listening by concentrating the network's data transmissions into a smaller active period and then transitioning to sleep for the remainder of the cycle. SMAC establishes a fixed active cycle (i.e. 10% active), and T-MAC allows the traffic to adjust the duration of the active period dynamically by transitioning nodes to sleep only after listening to an idle channel for a timeout period equivalent to a transmitting node's worst-case contention back off. Concentrating the transmissions into a smaller active period reduces idle listening, but it also increases the probability of collisions, thus wasting precious bandwidth and energy. Berkeley-MAC (B-MAC) [5] is another contention-based protocol that saves energy by having radios periodically wake up to sample the medium. Transmitting nodes extend the duration of message preambles to cover the entire range of the wakeup period to ensure all nodes receive the preamble and remain awake to accept the message. Time division multiple access (TDMA) reservation based protocols create fixed time periods for nodes to communicate to eliminate the channel contention and idle listening energy costs [7] [8]. G-MAC similarly gathers traffic demands during a contention period, but saves additional energy since only transmitting nodes wake up to send their traffic requirements for consolidation by a centralized gateway.

Current wakeup methods can be divided into two main categories:

1) Scheduled wakeups: In this class, the nodes follow deterministic (or possibly random) wakeup patterns. Time synchronization among the nodes in the network is generally assumed however, asynchronous wakeup mechanisms. Which do not require synchronization among the different nodes is also categorized in this class. Although asynchronous methods are simpler to implement, they are not as efficient as synchronous

schemes, and in the worst case their guaranteed delay can be very long.

2) Wakeup on-demand (out-of-band wakeup): It is assumed that the nodes can be signaled and awakened at any point of time and then a message is sent to the node. This is usually implemented by employing two wireless interfaces. The first radio is used for data communication and is triggered by the second ultra-low-power (or possibly passive) radio which is used only for paging and signaling. [9], and passive radio triggered solutions [10] are examples of this class of wakeup methods. Although these methods can be optimal in terms of both delay and energy, they are not yet practical. The cost issues, currently limited available hardware options which results in limited range and poor reliability, and stringent system requirements prohibit the widespread use and design of such wakeup techniques. Consequently, there is a need for efficient scheduled wakeup schemes which are reliable and cost-effective and can also guarantee the delay and lifetime constraints. [11] Paper proposes a new Sleep schedule (Q-MAC) for Query based sensor networks that provide minimum end-to-end latency with energy efficient data transmission. The radios of the nodes sleep more whenever there is no query using a static schedule. The sleep schedule is changed dynamicallywhenever a query is initiated. Based on the destination's location and packet transmission time, we calculate the data arrival time and hold theradio of a particular node, which has forwarded the query packet, in the active state till the data packets are forwarded.

The types of queries can be categorized as follows based on the applications:

• Continuous queries • Aggregate queries, versus Non-aggregate Queries • Complex queries, versus Simple queries• Queries for unique data and Queries for replicated data

This paper [12] refers to this technique as the CM based on an Event- Driven Reporting (CM-EDR) philosophy. In particular, our proposed CM-EDR mechanism can be viewed as a particular type of EDD applications, where an event is defined as an important change in the supervised phenomenon compared to the last reading sent to the sink node. However, the main difference with typical EDD applications is that with CM-EDR, the user would have a continuous reading of the phenomenon of interest, which is not the case with EDD applications.This paperemphasizes the difference in terms of goals and produced traffic between CM-EDR applications and classical event detection- driven (EDD) applications

A novel time synchronization protocol-Physical layer integrated synchronization protocol (PLISP). [13] This protocol accepts a method of adding timestamp in physical layer to reduce uncertainty of message exchange process. Results proved that 1μs require for single hop time synchronization but its consumption is higher than TPSN (Timing sync protocol for sensor networks) mechanism

A voltage and sleep effective scheduling algorithm [14] in terms of Dynamic frequency/voltage scaling and Dynamic energy management, namely, DV/FS RM and DV/FS2-EDF algorithm which can expands the lifetime of WSN. [15] Presented a new scheduling method for WSN called VBS (Virtual Backbone Scheduling) .VBS combine sleep scheduling and virtual backbone. This paper defines the MLBS (maximum lifetime backbone scheduling) problem for WSNs to find the optimal schedule for VBS. To solve the problem two approximation solutions based on STG (schedule transition graph) and VSG (virtual scheduling graph) are proposed. Self-learning scheduling approach (SSG) [16] this approach mixes sleep scheduling together with packet transmission scheduling to reduce energy consumption. It enable nodes to learn continuous transmission parameters is achieved by Q- learning method and the transmission parameter is used to calculate sleep parameter.[17] In this paper proposed protocol is compared with LEACH (low energy adaptive clustering hierarchy) . In the node scheduling scheme (sleep and active mode) energy efficiency is increased near to 50 % than LEACH protocol also lifetime increased. Boundary energy scheduling method [18] with proper distribution of active nodes and rapid convergence towards activating optimum number of nodes also improves BES by Virtual Clustering based Boundary Energy Scheduling (VCBES)

III. WORK UNDERTAKEN

Alarm could be originated by any node which detects a critical event in wireless sensor network. To reduce broadcasting delay the scheduling methods includes two phases:

UPLINK: Initially, when a node detects a critical event, it originates an alarm message and quickly transmits it to acenter node along a pre- determined path with a level-by-leveloffset way.

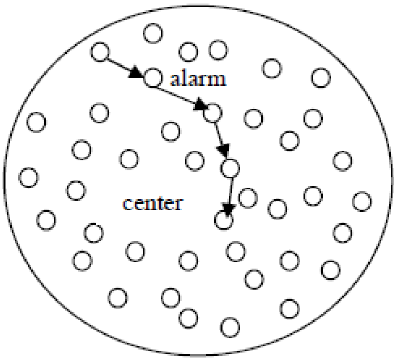

Fig 1: Send the Alarm to center node

DOWNLINK: Then, the center node broadcasts the alarm message to the other nodes along another path also with a level-by- level offset way.

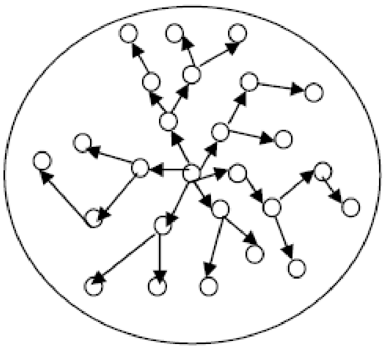

Fig 2: Center node broadcast the alarm to all

IV. METHODOLOGY

It is known that the alarm could be originated by any node which detects a critical event in the WSN to essentially reduce the broadcasting delay.

Each node needs to wake up properly for both of the two traffics. Therefore, the focused scheduling scheme should contain two parts

1) Breadth First Search (BFS):

Breadth-first search (**BFS**) is a scheme for searching in a graph when search is limited to basically two operations, in the graph theory:

(a) Visit and check a node of a graph;

(b) Gain access to visit the nodes that neighbour the currently visited node.

First of all, we choose a sensor node as the center node c. Then, we construct the BFS tree which divides all nodes into layers H_1, H_2, H_3; . . .; H_D, where H_n is the node set with minimum hop n to c in the WSN. With the BFS tree, the uplink paths for nodes can be easily obtained.

2) Connected Dominant Set (CDS):

Construct a maximum independent set (MIS) in G.

In graph theory an **independent set** or **stable set** is a set of vertices in a graph, no two of which are adjacent. A maximum independent set is a largest independent set for a given graph *G* and its size is denoted $\alpha(G)$. The problem of finding such a set is called the maximum independent set problem

Select connector nodes to form a connected dominated set (CDS)

A connected dominating set of a graph *G* is a set *D* of vertices with two properties:

i) Any node in *D* can reach any other node in *D* by a path that stays entirely within *D*. That is, *D* induces a connected sub graph of *G*.

ii) Every vertex in *G* either belongs to *D* or is adjacent to a vertex in *D*. That is, *D* is a dominating set of *G*.

3)Energy Scheduling Method (ESM)

This method consists of some periods. In each period, the nodes send its remained energy to their cluster head. Each cluster head has a list of their member nodes. Each cluster head sorts its list descending based on the remaining energy of their nodes. The energy of K^{*TH}node is called *Eb*. After that, it sends this energy value as boundary energy to their nodes. If the receive nodes energy rate is equal to or more than this rate, they will send data at next cycle with probability α.(that is a value near 1), otherwise, send data with probability β. If the nodes don't send until next period, they will become inactive and in the next cycle will decide according to the same probability. The nodes which their remaining energy is less than the boundary energy should be sleep. Regarding to different number of nodes (*N*), the relationship between N and $K^*$is shown in (1).

$$\alpha K^*+\beta(N-K^*) = K^* \qquad (1)$$

Therefore the optimum probability β is calculated as (2)

$$\beta =((1-\alpha) K^*) \;/\; (N-K^*) \qquad (2)$$

V. EXPERIMENTAL RESULTS

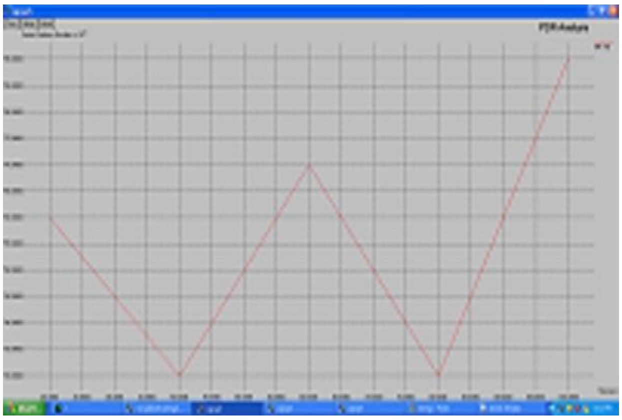

Fig 3: Performance analysis of packet delivery ratio

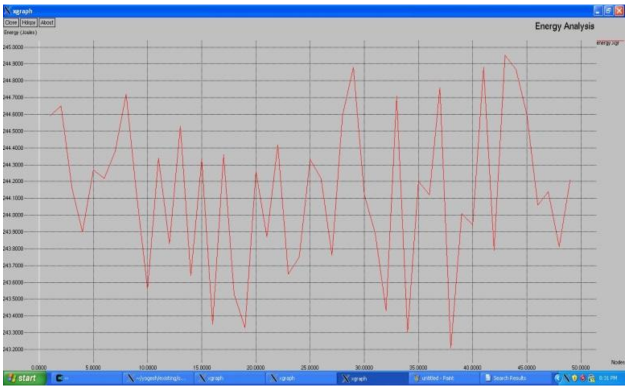

Fig 4: Performance analysis of energy

Fig 5: Performance analysis of end to end delay

VI. CONCLUSION AND FUTURE WORK

This work focus on Critical event monitoring in WSNs with novel sleep scheduling scheme. Collision free environment is achieved by specifically determining two traffic paths .This work get very good result as compare to SMAC. Work is going to improve throughput, end to end delay, and energy consumption to improve Quality of Service of WSN.

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