A novel approach for detecting and monitoring a critical event in wsn using sleep scheduling

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Abstract - In wireless sensor networks during critical event monitoring only a small number of packets have to be transmitted. The alarm packet should be broadcast to the entire network as earlier, if any critical event is detected. Therefore, broadcasting delay is an important problem for the application of the critical event monitoring. To prolong the network lifetime some of the sleep scheduling methods are always employed in WSNs it results in a significant broadcasting delay. A novel sleep scheduling method to be proposed it is based on the level-by-level offset schedule to achieve a low broadcasting delay in wireless sensor networks (WSNs). There are two phases to set the alarm broadcasting first one is, if a node detects a critical event, it create an alarm message and quickly transmits it to a center node along a pre-determined path with a node-by-node offset way. Then the center node broadcasts the alarm message to the other nodes along another predetermined path without collision. An on demand distance vector routing protocol is established in one of the traffic direction for alarm transmission. The proposed system is used in military and forest fire application.

Key words—Wireless Sensor Network (WSN), critical event monitoring, sleep scheduling, broadcasting delay.

1. INTRODUCTION

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions such as temperature, sound, pressure ,intruders etc., and to cooperatively pass the data through the network to exact location. The modern networks are bi-directional and it also enabling control for sensor activity. Monitoring is a common application for WSNs. The WSN is deployed over a region where some phenomenon is to be monitored. This can be applied in the field of military where they use sensors to detect intruders. When the sensors detect the event being monitored, the event is reported to one of the base station then it takes appropriate action.

As sensor nodes for event monitoring are expected to work for a long time without recharging the batteries, sleep scheduling method is always used during the monitoring process. Recently, many sleep schedules for event monitoring have been designed. However, most of the techniques focus on minimizing the energy consumption. In the critical event monitoring, only a small number of packets need to be transmitted. If any event is detected the alarm packet should be broadcast to the entire network. Therefore, broadcasting delay is an important problem for the application of the critical event monitoring. Here, unauthorized user enter into the network (or) misbehavior nodes in network that node is a critical node these event are detected by the any sensor node in WSN.

In view of wake-up patterns, most sleep scheduling schemes can be categorized into two kinds:
(1) Synchronous wake-up pattern.
(2) Asynchronous wake-up pattern.

Sleep scheduling is a usual way for power management to save energy. Lots of works have studied it in WSNs, which can be classified into two main categories: 1) determined transmission pattern; 2) dynamic transmission pattern. In the first category, nodes periodically wake up and transmit at the determined time in each duty cycle, and time synchronization is always assumed. While, in the second category, nodes wake up and transmit at variation time in each duty cycle according to current traffic and time synchronization may not be needed. Among these works, most of them try to keep nodes sleeping as long as possible, while seldom study when nodes need to wake up to reduce the transmission delays.

In other word, power saving is the main concern instead of transmission delay.

To minimize the broadcasting delay, it is needed to reduce the waiting time during the broadcasting. The best scenario is the destination nodes wake up immediately when the source nodes obtain the broadcasting packets. Based on this idea, a level-by-level offset schedule is proposed. Hence, it is possible to achieve low transmission delay with node-by-node offset schedule in multi-hop WSNs. It is still a challenge for us to apply the level-by-level offset to alarm broadcasting in the critical event monitoring. First the order of nodes wake-up should conformed by using the traffic direction. If the traffic flow is in the opposite direction the delay in each hop will be as large as the length of the whole duty cycle. Second the level-by-level offset employed by the packet broadcasting could cause a serious collision.

Through designing a special wake-up pattern the two possible traffic paths could be carried by a node. To eliminate the collision in broadcasting, a colored connected dominant set (CCDS) in the WSN via the *IMC* algorithm is established.

2. RELATED WORK

A centralized gateway node collects all transmission requirements during a contention period and then schedules the distributions according to the reservation path. An energy-adaptive MAC protocol, Gateway MAC (G-MAC) implements a new cluster-centric paradigm to effectively distribute cluster energy resources and extend network lifetime. Concentrating the transmissions into a smaller active period reduces idle listening, but it also increases the probability of collisions. Receiving and discarding messages intended for other nodes, or message overhearing, is commonly employed in non-energy constrained networks to increase throughput and high delay [5].

Continuous monitoring applications are an important class of wireless sensor application. These application require periodic refreshed data information at the sink nodes. The need of the sensor node was to transmit continuously in periodic fashion to the sink nodes it leads to excessive energy consumption. [9]

DMAC protocol specifically design for the wireless sensor network, where the communication pattern is restricted to an established unidirectional data gathering tree. Here, all nodes having a periodic receive–transmit sleep cycle with level-by-level offset schedule ,which means that all nodes wake up when the source node have just gotten a data packets, and go to the sleep as soon as they transmit packets to the destination nodes. The level-by-level offset schedule in DMAC can achieve much lower transmission delay in one traffic direction. it is not efficient in bidirectional delay guarantee [2].

In this query based sensor network a node cannot voluntary send data packets that they sensed to the sink node, unless the sink node sends them queries, these queries are very complex. Hence the sink node needs to predict the data arrival time for each destination nodes. Collecting information from the environment by keeping all the nodes active and transmitting to the sink is energy expensive. Therefore, the scheme is not suitable to alarm broadcasting in the WSN for critical event detection [4].

A novel asynchronous wake-up schedule is proposed to reduce the end-to-end latency with energy efficient data transmission. Each node has assigned a specific color. The wake-up schedule of a node is fixed according to the color assigned to that particular node. As neighbors of each node are partitioned into several color groups, the average transmission delay within each hop can be reduced to a fraction of the duty cycle. However, the total delay still increases proportionally with the number of hops by a slope of duty cycle length. Furthermore, the performance of the schedule relies on high redundancy of nodes [6].

The authors presented several sleep scheduling patterns that adhere to the bidirectional end-to-end delay constraints, such as shifted even and odd pattern, ladder pattern, two-ladder pattern and crossed-ladders pattern. However, the patterns are not suitable to alarm broadcasting in the WSN, because the traffic discussed, is just a single flow. If the sink node broadcasts packets according to the patterns, there will be serious collision in the network. However, the patterns are not suitable to alarm broadcasting in the WSN, because the traffic discussed in is just a single flow. If the sink node broadcasts packets according to the packets, there will be serious collision [3].

The delay efficient broadcasting in WSN, It is based on the synchronous wakeup .It select separate duration in each duty cycle for sensor nodes to reserve data transmission. Although collision can be avoided during data transmission, sensor nodes still need to contend in the short separate duration. The short length of duration limits the number of hops of data transmission in each duty cycle. The demand wakeup protocol is not efficient for critical event monitoring in WSN, because the nodes are wakeup on demand it increase the delivery latency [7].

ADB is based on asynchronous wake-up. It exploits some information contained in data packets and ACK, so to arrange the transmission among nodes. When sensor nodes take prior knowledge of all the link quality, packet broadcasting in ADB actually follows a determined broadcasting tree in the network. Furthermore, as sensor nodes with ADB wake up asynchronously, collision can almost be avoided. In this technique, to compare the proposed scheduling scheme with ADB [8] and DW-MAC.

3. PROPOSED SYSTEM

3.1 Overview of the proposed system

The alarm could be originated by any node which detects a critical event in the WSN. The proposed scheduling method includes two phases: 1) any node which detects a critical event sends an alarm packet to the center node along a predetermined path according to level-by-level offset schedule 2) the center node broadcasts the alarm packet to the entire network also according to level-by-level offset schedule. To establish a breadth first search (BFS) tree for the uplink traffic and a colored connected dominant set for the downlink traffic. If any link or node failure in downlink path during transmission of packet, an On Demand distance Vector Routing Protocol is proposed to establish the best path and broadcast the alarm message to entire nodes in network.

3.2 Techniques used

i) Breadth First Search Algorithm

The Breadth First Search (BFS) tree is establish in uplink traffic to find the shortest path from sensor node to the center node. In graph theory, breadth-first search (BFS) is a graph search algorithm that begins at the root node and explores it to all the neighboring nodes. Then for each of those nearest node explores their unexplored neighbor nodes and so on until it finds the goal.

The Breadth First Search (BFS) tree is establish in uplink traffic to find the shortest path from sensor node to the center node. Choose sensor nodes as the center node c. Then, to construct the BFS tree which divides all nodes into layers H1, H2, H3, . . .HD, where Hi is the node set with minimum hop i to c in the WSN.

ii) Colored Connected Dominant Set

A Colored Connected Dominant Set (CCDS) is established in downlink traffic for reduce the broadcasting delay. The center node broadcasts the alarm packet to the entire network according to level-by-level offset schedule; these traffic paths are called as downlink traffic path. Connected dominating set are useful in the computation of routing for mobile ad-hoc networks. In this application a small set of connected dominate is used as a backbone for communications.

To establish the CCDS in G with three steps:

1) Construct a maximum independent set (MIS) in G.

2) Select connector nodes to form a Connected Dominated Set (CDS), and partition connector nodes and independent nodes in each layer into four disjoint sets with IMC (Iterative Minimal Covering) algorithm proposed. .

3) Color the CDS to be CCDS with no more than 12 channels.

iii) IMC Algorithm

To eliminate the collision in broadcasting, a Colored Connected Dominant Set (CCDS) in the WSN via the IMC algorithm is established. The idea of the IMC algorithm to select the connector nodes, which partitions independent nodes I ∩ Hi in each layer into four disjoint subsets Ui,j(0 ≤ j ≤3), and selects four disjoint subsets Wi-1,j (0 ≤ j ≤3) among $(Hi-1\ \cup Hi-2)$ ∩ I as connector nodes to cover I ∩ Hi. When nodes in Wi-1,j broadcast simultaneously, they will not cause any collision among nodes in Ui,j. By this way, the CDS is established. The vertex cover problem in which a solution is a vertex cover of a graph, and the target is to find a solution with a minimal number of nodes.

iv) On Demand Distance Vector Routing Protocol

This protocol is mainly used to route the packet and maintain a routes. Routes are selected dynamically when source node need send alarm packet to all other nodes and a node will be wakeup through this path. If any nodes or link failure during data transmission in downlink path an on demand distance vector routing protocol is established to select a path dynamically and it will transmit the data to all nodes in network.

A distance-vector routing protocol requires that a router informs its neighbors of topology changes periodically. Compared to link-state protocols, which require a router to inform all the nodes in a network of topology changes, distance-vector routing protocols have less computational complexity and message overhead. The term distance vector refers to the fact that the protocol manipulates vectors (arrays) of distances to other nodes in the network.

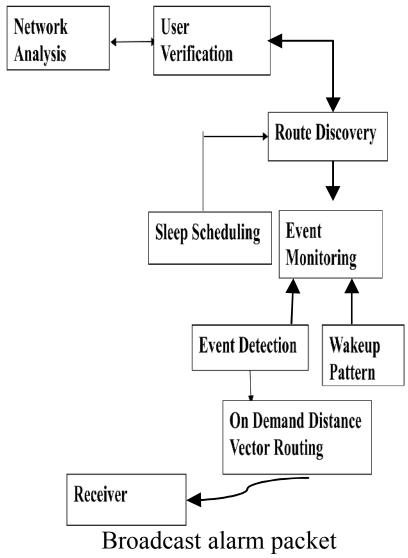

Figure1.Architecture diagram of the proposed system

4. RESULT AND EXPERIMENTAL EVALUATION

To validate the proposed scheduling scheme in real wireless communication environment, we implement it on 64 Micaz nodes.

4.1 Deploy sensor nodes

To deploy 64 Micaz sensor nodes on a grid with the grid size $0.8m$. A prior test about the communication range of Micaz nodes has been made. The test results show that the transmission range of Micaz nodes is dynamic and heterogeneous, and transmission between two Micaz nodes will strictly fail at the distance $1.3m$ in any direction when putting them on the ground and setting the transmission power of nodes to be $30\mu W$. It can be seen that each Micaz node in the experiments has no more than 8 neighbors.

4.2 Keep time synchronous

After broadcasting the assignment, the center node begins to send beacon in its *sending* time slot and sleeps according to its sleep scheduling. Each neighbor receiving the beacon actually gets a reference of time, and it relays the beacon in its *sending* time slot assigned. In this way, all nodes will begin to work in a duty cycle way. Every 10 minutes, the center node transmits a beacon in its *sending* time slot, and its neighbors receiving the beacon will adjust their timers according to the beacon if there is an error of synchronization due to clock drift in this way, local time synchronization in the network is maintained.

4.3 Record the broadcasting delay

To obtain the result of broadcasting delay in the network, a mobile Micaz node carried by a person is used for results collection. Each node records the time when it receives the alarm and sends its record to the mobile node when the mobile node inquires it. The alarm is originated by an arbitrary node selected in the network. It made 10 experiments and recorded the maximum broadcasting delay in the network. The duty cycle is set to be $1s$.

Figure 2 shows the experiment results. The red line stands for results when time slot is $5ms$, and the blue line stands for results when time slot is $10ms$. It can be seen, the proposed scheme achieves very low broad-casting delay ($0.06s$) in most of the experiments when time slot is $5ms$, except for experiment 6 and 7. In experiment 6, the case that packet cannot be successfully transmitted within $5ms$ took place once in the alarm broadcasting, resulting in an extra delay of two duty cycles, i.e., $2s$. In experiment 7, the case took place twice. When we increased the size of time slot to be $10ms$, the performance of the proposed scheme becomes better, as shown in Figure 2.

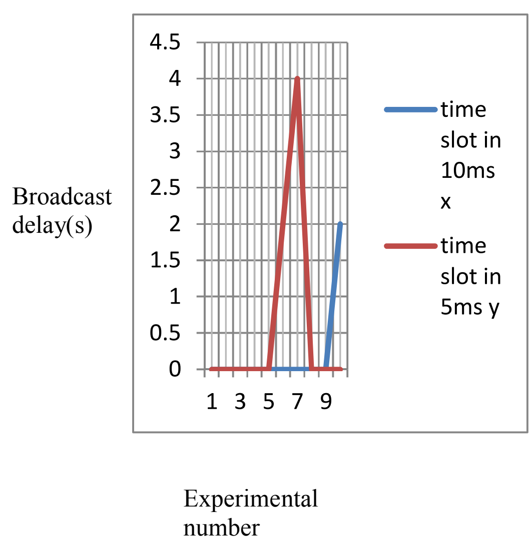

Figure 2 the result of the experiments

5. CONCLUSION AND FUTURE WORK

The sleep scheduling technique is used to detect and monitor the critical event that occurs in wireless sensor network. This can be done by predetermining the route and synchronous wakeup pattern. The upper bound of the delay is 3D + 2L, which is just a linear combination of hops and duty cycle. Moreover, the alarm broadcasting delay is independent of the density of nodes in WSN. The broadcasting delay and the energy consumption of the proposed scheme are much lower than that of existing methods.

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