International Journal of Scientific & Engineering Research, Volume 5, Issue 4, April-2014
ISSN 2229-5518

Energy Efficient Sleep Scheduling for Critical Event Monitoring in Wireless Sensor Networks

Trupti Thakre, Prof. S. M. Choudhary

Abstract—Energy consumption and broadcasting delay is a major issue for critical event monitoring application in WSN. Sleep scheduling technique is always used to employee in WSN to improve the lifespan of wireless sensor networks which leads in significant raise in broadcasting delay. To reduce the broadcasting delay, a sleep scheduling method with level by level offset schedule needs to be used following shortest path. There are two phases to set the alarm broadcasting first one is, if a node detects a critical event, it will immediately transmit an alarm to a centre node through predetermined path with node by node offset way. Then in second phase, this centre node broadcasts the alarm to all other nodes along another preset path without collision.

Keywords— broadcasting delay, critical event monitoring, sleep scheduling, Wireless Sensor Network (WSN.

1 Introduction

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions such as sound, pressure, temperature, intruders etc., and to willingly pass the data through the network to exact location. The recent networks are bi-directional and it also allowing 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 estimated to work for a long time without recharging their batteries, the 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 reducing the energy consumption. A small number of packets need to be transmitted during critical event monitoring. If any event is sensed the alarm packet should be broadcast to the whole network. Therefore, broadcasting delay is main 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 supervision to save energy. Lots of works have calculated it in WSNs, which can be categorized 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. Whereas, 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 broadcast delay. To minimalize the broadcasting delay, it is needed to decrease the waiting time during the broadcasting. The best scenario is the target nodes wake up instantaneously when the source nodes obtain the broadcasting packets. On the Basis of 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.

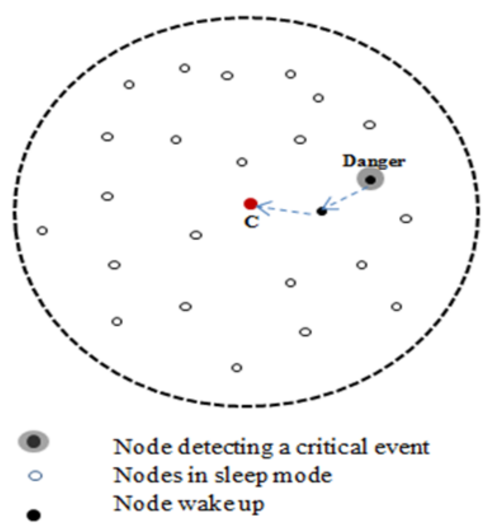

Fig. 1 Critical Event monitoring

- *Author Trupti Thakre is currently pursuing masters degree program in Communication Engineering in G. H. Raisoni Colllege of Engg. Nagpur, India, PH-8007825289. E-mail: truptit2905@gmail.com*
- *Co-Author S. M. Chaudhary is currently working in ETC dept. in G. H. Raisoni College of Engg. Nagpur, India, PH-8007825289. E-mail: swapna2kc@gmail.com*

(This information is optional; change it according to your need.)

ISSN 2229-5518

Initially, the order of nodes wakeup should be established by using the traffic direction. If the traffic stream is in the opposite direction the delay in each hop will be as large as the length of the whole duty cycle. Secondly, the level-by-level offset employed by the packet broadcasting could cause a serious collision. Through scheming a special wake-up pattern the two possible traffic paths could be passed by a node. One is for uplink traffic (i.e. centre node to other node) and other is for downlink traffic (i.e. node to centre node). In this paper, we suggest shortest path algorithm which reduces the broadcasting delay as compared to level by level offset schedule.

2 Problem Description

Primarily, we assume that a center node in the network has obtained the network topology (e.g., sink node). This center node computes the sleep scheduling sequence according to the proposed scheduling scheme and broadcasts the scheduling to all the other nodes. The following terms are plays a vital role in this paper.

• **Event detection:** For the critical event monitoring in a WSN, sensor nodes are equipped with passive event detection capabilities that allow a node to detect an event even when its wireless communication module is in sleep mode. Upon the exposure of an event by the sensors, the radio module of the sensor node is immediately woken up and is ready to send an alarm message.

• **Slot and duty cycle:** Here, the time is divided into time slots. The length of each slot is the smallest time needed by sensor nodes to transmit or receive a packet, which is denoted as τ. The length of each duty cycle is given as T=L*τ, i.e., there are L slots in each duty cycle.

• **Network topology:** For understanding purpose, we assume that the network topology is steady and is denoted as a graph G.

• **Synchronization:** In the proposed scheme, time of sensor nodes is assumed to be locally synchronized, which can be implemented and maintained with periodical beacon

3 Proposed Scheme

After nodes are assigned sending channels and receiving channels, wake-up pattern is needed for them to wake up and receive the possible alarm packet to achieve the minimum delay for both uplink traffic and downlink traffic. When a node senses a critical event, as shown in Figure 2, the node will wait until its wake-up time slot for uplink traffic arrives. Then, it transmits an alarm packet to its center node at the center node's wake-up time slot. In this way, the alarm can be transmitted along the uplink traffic path with nodes waking up level-by- level, till to the center node. Then, the center node broadcasts the alarm packet along the downlink traffic paths in CCDS with nodes just waking up level-by-level. The alarm packet is transmitted in channels according to the node's receiving channels. It can be seen that the broadcasting will not cause any collision.

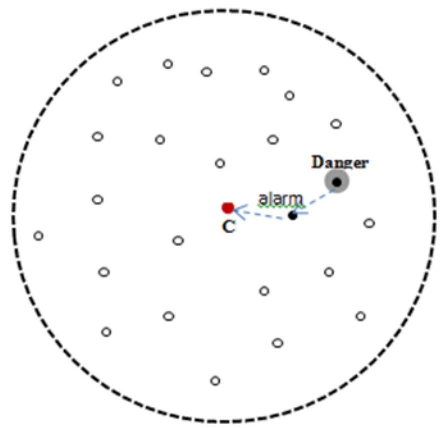

Fig. 2 node transmitting alarm to centre node

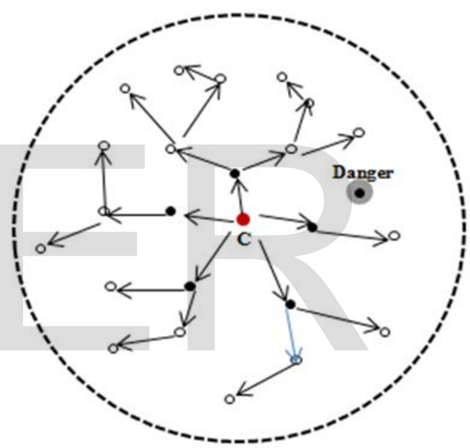

Fig. 3 Center node broadcasting alarm packets to all other nodes

IJSER

4 Performance Evaluation

Here we used the network simulator NS-2 to analyse the performance of combined level-by-level offset schedule in comparison with shortest path algorithm on the basis of certain performance parameter such as energy and delay .We perform the set of experiments for simulation area which is square of 1000m * 1000m using NS-2.nodes are able to communicate with each other using the IEEE 802.11 MAC layer. All the simulation results are taking by varying the number of nodes in the network from 100 nodes for the energy and delay of the network in case of existing scheme and proposed scheme. The simulation parameter settings are given in following table.

In this paper two algorithms have been used for low broadcasting delay one is MIS algorithm and CDS.

Maximum Independent Set- is an independent set such that adding any vertex not in the set breaks the independence property of the set. Thus, any vertex outside of the maximal independent set

ISSN 2229-5518

must be adjacent to some node in the set. The previous independent set *{a; b; f; h}* must have node *d* added to become an MIS. As shown in fig.4

Connected Dominating Set (CDS), C, is a dominating set of *G* which induces a connected sub graph of *G*. One approach to constructing a CDS is to find an MIS, and then add additional vertices as needed to connect the nodes in the MIS. A CDS in Fig. 4 is *{c; d; e; g}*.

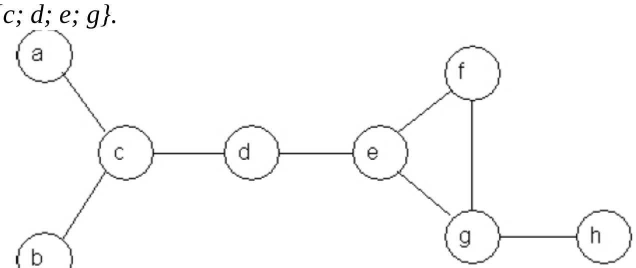

Fig. 4: Representation of a wireless network with eight nodes as a graph.

TABLE 1
SIMULATION PARAMETER SETTINGS

Parameters	**Values**
Simulator	NS-2
Area	1000m*1000m
No. Of Nodes	100
Packet size	1000 bytes
MAC protocol	IEEE 802.11
Transmission Range	1.5 m
Protocol	DSR

.

5 RESULT

Fig. 4 shows the simulation environment having 100 nodes in which node 99 shows a center node. There are 4 cluster heads shown by orange colour, green colour nodes are the nodes in sleep mode, yello colour nodes are active nodes, and the nodes detecting critical event are shown by red colour.

Fig 5 and fig. 6 showing the graph which gives comparison of energy consumption and broadcast delay in existing scheme and proposed scheme.

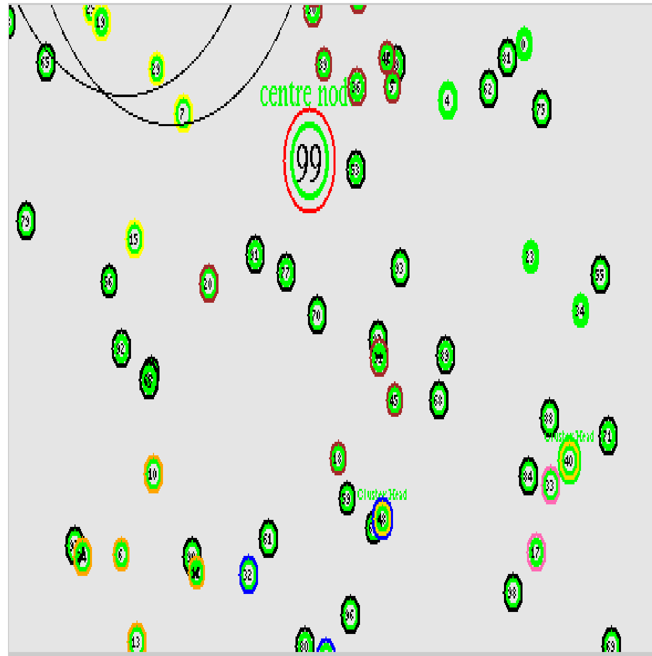

Fig.5 Output if NS2

IJSER

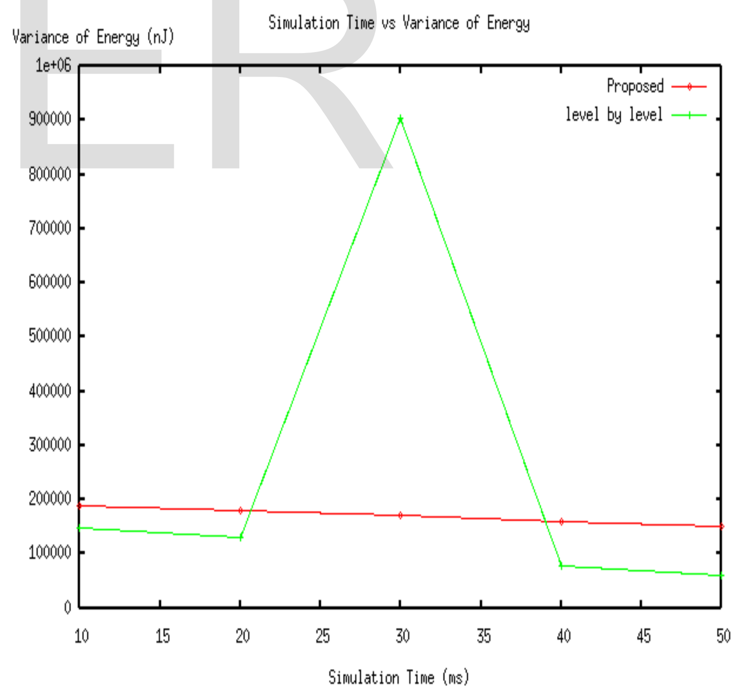

Fig. 6. Comparison of energy consumption in proposed scheme and level by level offset schedule

ISSN 2229-5518

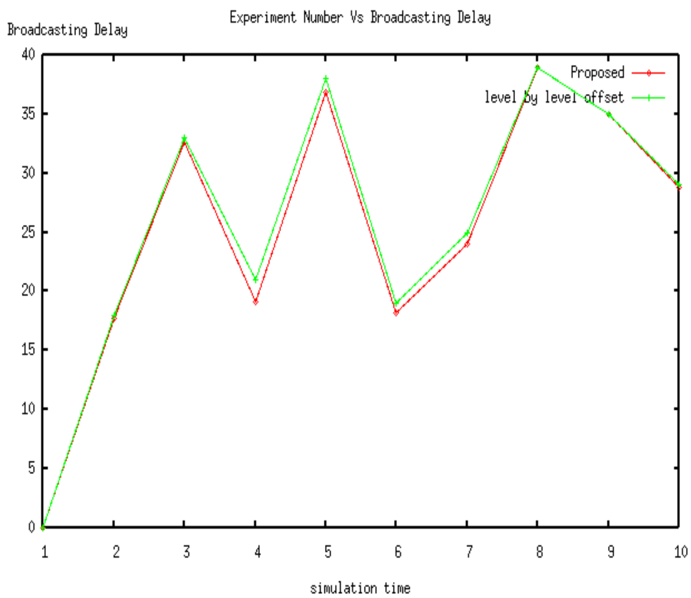

Fig. 7. Comparison of Broadcast delay in proposed scheme and level by level offset schedule

4 Conclusion

With the help of proposed scheme the energy consumption and delay is getting reduced as compared to existing scheme. The alarm broadcasting delay is independent of the density of nodes in WSN. Theoretical analysis and conducted simulations showed that the notification delay and the energy consumption of the proposed scheme are much lower than that of existing methods.

IJSER

Acknowledgment

This work was supported in part by the ETC Department of G. H. Raisoni College of Engg. The authors wish to thank Prof. S. M. Choudhary for her guidance.

References

[1] N. Bouabdallah, M.E. Rivero-Angeles, and B. Sericola, “Continuous Monitoring Using Event-Driven Reporting for Cluster-Based Wireless Sensor Networks,” IEEE Trans. Vehicular Technology, vol. 58, no. 7, pp. 3460-3479, Sept. 2009.
[2] M.I. Brownfield, K. Mehrjoo, A.S. Fayez, and N.J. Davis IV., “Wireless Sensor Network Energy-Adaptive Mac Protocol,” Proc. Third IEEE Consumer Comm. and Networking Conf., pp. 778 782, Jan. 2006.
[3] T. Zheng, S. Radhakrishnan, and V. Sarangan, “PMAC: An Adaptive Energy-Efficient MAC Protocol for Wireless Sensor Networks,” Proc. 19th IEEE Int’l Parallel and Distributed Processing Symp., pp. 224-231, Apr. 2005.
[4] S.C. Ergen and P. Varaiya, “TDMA Scheduling Algorithms for Wireless Sensor Networks,” Wireless Networks, vol. 16, no. 4, pp. 985-997, 2010.
[5] A. Keshavarzian, H. Lee, and L. Venkatraman, “Wakeup Scheduling in Wireless Sensor Networks,” Proc. Seventh ACM Int’l Conf. Mobile Ad Hoc Networking and Computing, pp. 322-333, May 2006.
[6] G. Lu, N. Sadagopan, B. Krishnamachari, and A. Goel, “Delay Efficient Sleep Scheduling in Wireless Sensor Networks,” Proc. 24th IEEE Int’l Conf. Computer Comm., pp. 2470-2481, Mar. 2005.
[7] N.A. Vasanthi and S.A., “Energy Efficient Sleep Schedule for Achieving Minimum Latency in Query Based Sensor Networks,” Proc. IEEE Int’l Conf. Sensor Networks, Ubiquitous, and Trustworthy Computing, pp. 214-219, June 2006.
[8] N.A. Vasanthi and S. Annadurai, “AWS: Asynchronous Wakeup Schedule to Minimize Latency in Wireless Sensor Networks,” Proc. IEEE Int’l Conf. Sensor Networks, Ubiquitous, and Trustworthy Computing, pp. 144-151, June 2006.
[9] Y. Sun, O. Gurewitz, S. Du, L. Tang, and D.B. Johnson, “ADB: An Efficient Multihop Broadcast Protocol Based on Asynchronous Duty-Cycling in Wireless Sensor Networks,” Proc. Seventh ACM Conf. Embedded Networked Sensor Systems, pp. 43-56, Nov. 2009.
[10] Y. Sun, S. Du, O. Gurewitz, and D.B. Johnson, “DW-MAC: A Low Latency, Energy Efficient Demand-Wakeup MAC Protocol for Wireless Sensor Networks,” Proc. Ninth ACM Int’l Conf. Mobile Ad Hoc Networking and Computing, pp. 53-62, 2008.
[11] A. Keshavarzian, H. Lee, and L. Venkatraman, “Wakeup Scheduling in Wireless Sensor Networks,” Proc. Seventh ACM Int’l Conf. Mobile Ad Hoc Networking and Computing, pp. 322-333,May 2006.