International Journal of communication and computer Technologies, ISSN: 2278-9723

Available at http://www.ijccts.org

A Systematic Study of Various Radio Propagation Models for a Hybrid Mac Protocol in Sensor Networks

1S.Kiruthika*, 2S.Vadivel

1Asst.Professor/ECE, 2Asst.Professor/ECE

1KPR Institute of Engineering and Technology,2KSR College of Engineering

1Coimbatore, 2Erode

1kirthika.srinivasan@gmail.com, 2ecevadivel@gmail.com

Received: 15-01-2015, **Revised:** 06-03-2015, **Accepted:** 18-04-2015, **Published online:** 30-05-2015

Abstract

Wireless sensor networks are expected to find wide applicability and increasing deployment in the near future. It consists of spatially distributed autonomous sensors to monitor physical or environmental conditions and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance, many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. The operation of WSN is normal under ordinary condition. But in case of an emergency situation, like fire break out one of the nodes deployed in the area may get ruined. Under such circumstances the data collected around the vicinity of the node may be lost. Such kind of situations results in severe packet drop and thus decreases the communication throughput in medium access control (MAC) protocols. Hence data aggregation and mobility has been put forward as an essential paradigm. In this paper, we propose an alternative mechanism for node failure and a recovery scheme for the vast packet drop problem. Here reference point group mobility model has been used for replacing the damaged node and the aftermath performances are analyzed for various radio propagation models. The simulation is carried out by means of NS2 (Network Simulator).

Keywords— Autonomous Sensors, Wireless Sensor Networks, Data Aggregation Technique, Emergency, Transmission.

Introduction

Power saving is one of the critical issues in energy-constrained wireless sensor networks. Many schemes can be found but significant contributions in energy conservation. Maximizing the life time of sensor nodes by empirical methods, presented the reduced energy utilization of a sensor network lead to an improved lifetime & However, these schemes do not concentrate on reducing the end-to-end packet delay while at the same time retaining the energy-saving capability.

Normally, it is impossible to recharge or replace the drained batteries for sensor nodes in WSNs, which is the primary objective of maximizing node lifetime. Hence energy efficiency is a critical issue for the wireless sensor networks.

The four important reasons for energy wastage in MAC protocol are collision, control packet overhead, idle listening, overhearing.

Various MAC protocols have been designed to alleviate this problem. Generally two major types of media access exist in WSN: TDMA and CSMA/CA.CSMA is popular in wireless networks because of its simplicity, flexibility and robustness [1]. Contention-based MAC protocols may deal with collision through some contention resolution scheme such as retransmitting the data later or occupying the shared medium before data transmission. It does not require much infrastructure support, any clock synchronization, scalability and global topology information. But it faces certain disadvantages such as, more energy consumption, hidden terminal problem. The main task in TDMA scheduling is to allocate time slots for every node in the network so that the devices do not conflict with each other. Its drawbacks are finding the corresponding time schedule, detecting a centralized node for communication and its need for synchronization [5]. In addition to this, sensor networks may undergo frequent topology changes that lead to battery outage and node failures. Also the various problems that have been predicted in [4] make the TDMA MAC protocol difficult to stand alone and work. Therefore a new hybrid MAC protocol having the advantages of traditional MAC protocol is desperately needed for WSN.

WSNs for emergency applications such as monitoring fire must be traffic and topology adaptive [2]. For such situations there are several factors that should be satisfied by the MAC protocol.

-Traffic load

-Energy efficiency

-Delay tolerant

-Delivery ratio

Our proposed hybrid MAC scheme is designed in such a way that if fulfils the various expectation of the sensor networks. It works so that it links the benefits of both CSMA and TDMA MAC protocol and overcoming their weakness [3]. DA MAC protocol is a hybrid one which makes use of TDMA schedule during ordinary traffic. But whenever an emergency situation is detected it shifts to CSMA/CA access. During normal monitoring a TDMA group will be formed and each node is given a slot. Once the nodes are deployed, during this process the various sub operations that takes place are: neighbour discovery, slot assignment, local frame exchange and global time synchronization. The flooding strategy is followed for the node discovery process. To conserve energy a sender turns off it radio if it has no data to send unlike the usual traffic but during the traumatic conditions the only nodes affected by the fire change their MAC behaviour to CSMA/CA access. The one hop neighbours that receive the messages try to access the channel for sending the messages. Before that the nodes always perform carrier sensing and transmit a packet only when the channel is clear.

In such instance the node that is nearer to the base station gains access through the channel and transmits the emergency data by means of data aggregation technique. This usually helps in the fusion of data from multiple sensors at intermediate nodes and transmission of the aggregated data to the base station [11]. This idea helps in enhancing the network lifetime that quantifies the energy efficiency of the network.

RELATED WORK

S-MAC [7] adopts an effective mechanism by employing periodical listening and sleeping. Each node goes to sleep mode for some time, and then wakes up and listens to see if any other node wants to talk to it with the help of a timer. However the S-MAC has some shortcomings such as limitation in period length by delay and cache size. T-MAC [6] makes use of adaptive duty cycle. It makes use of the queue for the new messages and thus reducing the overhead. The defect with is the early sleeping problem, which decreases the efficiency of the protocol. µ-MAC [8] assumes a single time slotted Channel and allots them to each node by means of predictable traffic behaviour. Here the data flow from each and every node to the base station is considered to be superior. But the downside of this protocol is that it introduces large overhead, doesn’t support scalability. Besides it requires the traffic pattern to be known priori. A-MAC [3] purpose is of low power transmissions for long-term surveillance and monitoring applications. It requires being inactive most of the time until some event is detected. As it makes use of advertisement mechanism control packet overhead is large. Moreover, the latency is high due to the transition between CSMA/CA and TDMA protocols. A node has a guaranteed access to its owner slot (TDMA style) and a contention-based access to other slots (CSMA style). Using the TF (Time Frame) rule the nodes are allowed to pick their own time frame sizes based on their two-hop information. Crankshaft [9], a MAC protocol specifically targeted at dense wireless sensor networks. Crankshaft is implemented for the TinyOS operating system. Here the nodes are expected to wake up for reception at different offsets. Broadcast and unicast are the two types of slots. The defect related with the crankshaft protocol is that it cannot provide good broadcast flooding delivery for sporadic traffic. ER-MAC [2] is designed for emergency purpose. During the normal monitoring the nodes make use of TDMA slot assignment. Then in case of any crisis the node working in the TDMA schedule shifts itself to the contention based. Though it has satisfied some basic expectations such as throughput during higher traffic, latency, scalability and energy efficiency, the main challenge counteracted is that the data redundancy. The one hop neighbours of the affected nodes are designed to send the data to the base station along with an emergency flag. Thus by studying the pitfalls of the previous works, we conclude that we need to work on to design a new MAC protocol that should be effective enough to overwhelm all the drawbacks. To achieve that performance level we have introduced data aggregation technique [10] for the hybrid MAC protocol.

DESIGN DETAILS

Neighbour discovery & TDMA slot assignment

Flooding is a simple routing algorithm in which every incoming packet is sent through every outgoing link except the one it arrived on. Flooding is used in bridging and in systems such as Usenet and peer-to-peer file sharing and as part of some routing protocols, including OSPF, DVMRP, and those used in ad-hoc wireless networks. It is initiated by the source node to all other nodes in the network. The source node creating TOPOLOGY_DISCOVERY message, which consists of hop_count, new_parent_id and old_parent_id. Flodding technique for a grid topology is given in fig 1.At this time the node 1 acts as a base station. Since it is a bottom up approach reply for the TOPOLOGY _DISCOVERY is provided by any of the nodes 43,44,45,46,47,39,48 which are considered to be the leaf nodes.For our protocol, we have used a bottom-up tree-based passing approach, in which the slot assignment starts from the leaf node so that each relay node knows the exact number of descendants for each of its children. This is been shown in fig 1. The end of slot assignment scheme is indicated by the reception of SCHEDULE_NOTIFICATION message by the BS.

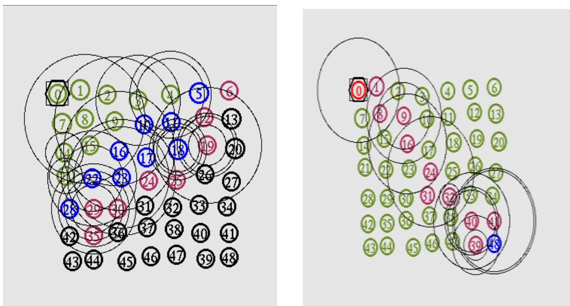

Fig-1: Flooding Technique & TDMA Slot Assignment From the Leaf Node

MAC characteristic during emergency

The characteristic of MAC can be depicted under two situations. 1. Fire 2.No fire. During no fire condition the communication will follow the normal TDMA scheduling. But whenever fire is detected, the nodes affected by the fire changes the MAC behaviour by allowing contention in the TDMA slots. Thus during such instance the behaviour of the MAC changes as follows:

1. The MAC characteristic of the node that is affected by the fire changes but other normal nodes follows TDMA assignment. Hence only if it has a high priority packet to send, it involves in the communication else it allows the contention of the one hop neighbours.
2. The contention of one hop neighbours starts by sending SLOT_REQUEST message during the time interval t_0. If the neighbour is found to be having shortest hop distance from the base station then it receives SLOT_ACKNOWLEDGE message and it gains access over the channel.
3. When no activity is traced in the channel then the node with low priority is allowed to transmit its own data to the sink.

Node Failure & Reference Point Group Mobility Model:

As explained earlier during the emergency situation i.e during the fire break out one of the node may get destroyed and it fails to collect the data around its vicinity thus it also fails to send the SCHEDULE_NOTIFICATION message to the base station. Thus from the figure 2 it is understood that during the time intervals given below one by one the node starts to fail thus missing to send the data around it.

TIME	FAILED SENSOR
4.0	46
5.0	44
20.0	29
25.0	15
27.0	12

Fig-2: Data Aggregation

Once the node 46 starts deteriorate one of the near by mobile node is induced by the base station to start moving and replaces the failure node which is shown in fig 2. Thus in the below fig 3 mobile node 52 after getting intimation from the base station starts moving towards the failure node and according to the reference point group mobility model depending upon the direction of movement of the group head node (node 52) the one hop neighbours rearranges itself.

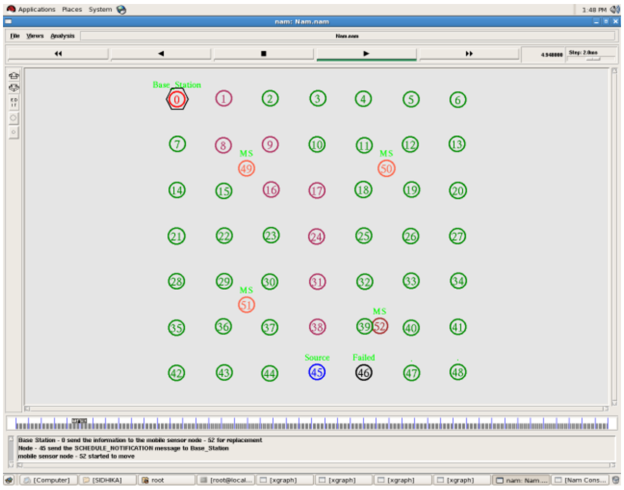

Fig-3: Node Failure

SIMULATION ENVIRONMENT

Analysis of the various propagation models is done by means of NS2.The configuration of the MAC protocol is done according to the table 1 which is shown below. The experiment has been conducted in the lattice (grid) topology consisting of 49 nodes with 200*200 area, with the node 0 taken as the base station and the nodes 49,50,51,52 were taken as mobile nodes.It's noteworthy that our mechanism is independent of any shape and size of the active region.

TABLE-1: SIMULATION PARAMETERS

PARAMETERS	VALUE
TERRAIN	200*200
TOPOLOGY	GRID
ENERGY	100J
AGENT/APPLICATION	UDP/CBR
SIMULATION TIME	46S
PROPOGATION MODEL	TWO RAY/FREE SPACE/SHADOWING

Performance evaluation

Our simulations results are based on the mean value of five different emergency scenarios where the fire breaks out occur for different nodes at different time simultaneously. The comparisons are done for the three radio propagation models.

Throughput: The throughput plotted against the three propagation models show that the two ray ground models outperforms the rest, as shown in fig 7.

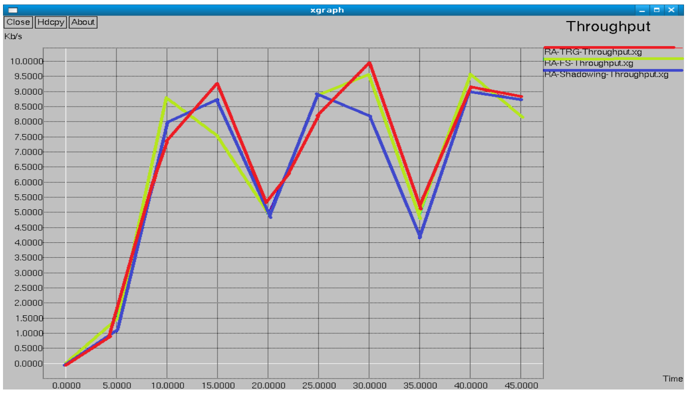

Fig-7: Throughput Comparison

Packet delivery ratio: The comparison between the three models in terms of packet delivery ration is shown in fig 8. Initially the packet delivery ratio is linearly increasing for all the models during the normal monitoring mode and after a mobile node replaces the ruined node the packet delivery ratio maintained in a maximum level except the shadowing model.

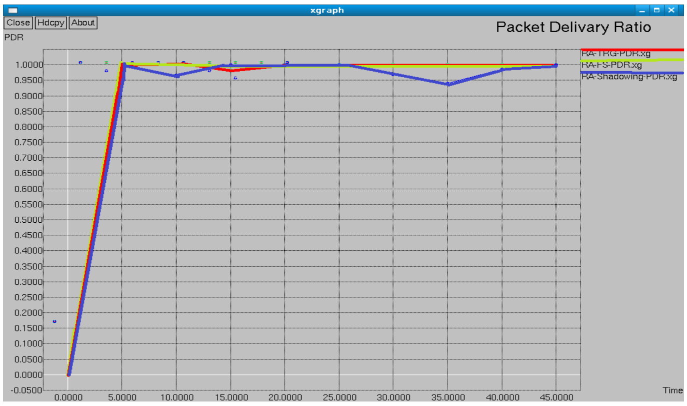

Figure 8. Packet Delivery Ratio Comparison

Packet drop: The maximum packet drop is maximum for the shadowing model which is shown in fig 9.The maximum packet drop is during the emergency situation which remains the same for certain period in shadowing model. Rather in two ray ground model, the drop of the packet is decreased once the mobile node replaces the damaged node and starts collecting the data from its one hop neighbours and redirects to the BS without losing them. Other than the two there isn't any packet drop in shadowing model

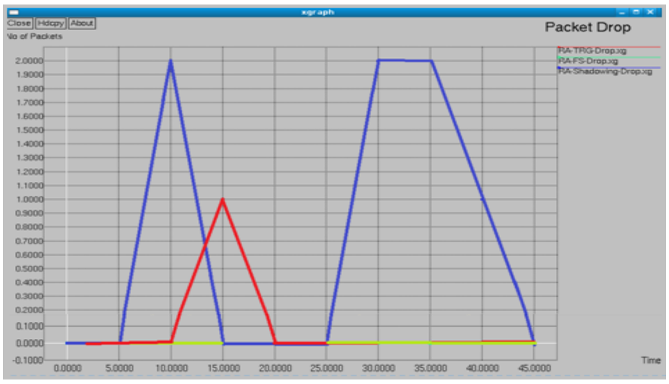

Fig-9: Packet Drop Comparison

Energy consumption: The energy consumption is an important parameter for any sensor network. Only by means of this parameter the efficiency of the MAC protocol is determined, which is plotted in fig 10. Initially the energy of any node is set as 100J.But as the communication between the nodes starts the energy starts decreasing in its own way. Here the energy is plotted against the time. So the efficiency can be measured how long a node can be able to with hold its energy for a certain period. Thus from the figure nodes exposed to the shadowing model ambience consumes less energy when compared to the other two.

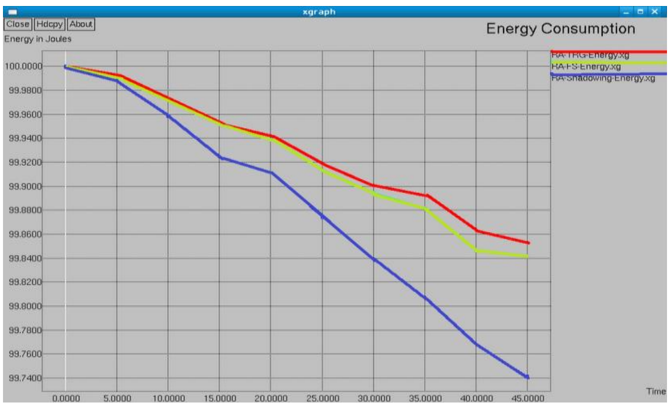

Fig-10: Energy Comparison

CONCLUSION AND FUTURE WORK

Existing solution for the emergency situation in WSN mostly relies on the hybrid MAC protocols. In this paper a new MAC protocol is proposed for an emergency event which takes the advantage of both contention and TDMA along with the data aggregation approach. We have compared the DA-MAC with the Z-MAC and the results show that prior excels the later in all aspects.

For future work N number of mobile nodes can be implemented in case of any complete destruction for the affected node. Along with this a routing algorithm can be applied to the aggregated node in order to make higher priority data move faster and reach the BS as soon as possible.

REFERENCES

[1]. Jian Shen; Faliu Yi, Sangman Moh and Ilyong Chung"*A contention-based MAC for wireless sensor networks including a mobile node*",*Proceedings of IEEE International Joint Conference on Neural Networks*,pp.490-496,June 2008

[2]. Ibrahim Khider Eltahir," *The Impact of Different Radio Propagation Models for Mobile Ad hoc Networks (MANET) in Urban Area Environment", Proceedings of 2nd International Conference on Wireless Broadband and Ultra Wideband Communications (Aus Wireless 2007)*,pp.30-34,2007

[3]. Injong.R, Warrier.A, Aia.M, Jeongki and Sichitiu.M.L, "*Z-MAC: A Hybrid MAC protocol for Wireless Sensor Networks", IEEE/ACM Transaction on Networking,* Vol. 16, NO. 3, pp.511-524, June 2008.

[2]. Lanny Sitanayah, Cormac J, Sreenan and Kenneth N.Brown," *ER-MAC: A Hybrid MAC Protocol for Emergency Response Wireless Sensor Networks", Proceedings of fourth International Conference on Sensor Technologies and Applications*, pp.244- 249, 2010.

[3]. Jian Shen, Faliu Yi, Sangman Moh and Ilyong Chung," *Energy Efficiency of MAC Protocols in Wireless Sensor Networks", Proceedings of International Conference on Information Science and Applications (ICISA)*, pp. 1-10, May 2011.

[4]. W. Ye, J. Heidemann, and D. Estrin, "*An Energy-Efficient MAC Protocol for Wireless Sensor Networks," in Proceedings of 21st Ann. Joint Conf. IEEE Computer and Communications Societies (INFOCOM'02)*, vol. 3, 2002, pp. 1567–1576.

[5]. F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, "*Wireless Sensor Networks: A Survey," Elsevier Journal of Computer Networks*, Vol. 38, No. 4, pp. 393-422, 2011.

[6]. T. Van Dam and K. Langendoen,"*An Adaptive Energy- Efficient MAC Protocol for Wireless Sensor Networks", Proceedings of 1st International Conference on Embedded Networked Sensor Systems (SenSys'03),* pp. 171–180,2003.

[7]. W. Ye, J. Heidemann, and D. Estrin, "*Medium access control with Coordinated Adaptive Sleeping for Wireless Sensor Networks," IEEE/ACM*

Transaction on Networking, vol. 12, No. 3, pp. 493–506, 2004.

[8]. A. Barroso, U. Roedig, and C. Sreenan, "*µ-MAC: An Energy Efficient Medium Access Control for Wireless Sensor Networks."Proceedings of Second European Workshop on Wireless Sensor Networks*, pp. 70 – 80, 2005.

[9]. G. Halkes and K. Langendoen, "*Crankshaft: An EnergyEfficient MAC-Protocol for Dense Wireless Sensor Networks," in Proceedings of 4th European Conf. Wireless Sensor Networks (EWSN)*, pp. 228–244, 2007

[10]. Krishnamachari, L, Estrin and Wicker.S"*The impact of data aggregation in wireless sensor networks", Proceedings of 22nd International conference on Distributed Computing Systems Workshops*, pp. 575 - 578, 2002.

[11].R. Rajagopalan and P.K Varshney,"*Data-aggregation techniques in Sensor Networks: A Survey," IEEE Communications Society*, vol.8, No. 4, pp. 48-63, 2004.