Paper ID: E&TC14

OPTIMIZED MEDIUM ACCESS CONTROL FOR WIRELESS SENSOR NETWORK & ITS PERFORMANCE ANALYSIS

Dinesh oblesh Shirsath
Dept. of Electronics & Telecommunication Engg
P.V.P.I.T.Budhgaon,
Sangli, India

Prof.Dr.(Mrs) Swati V.Sankpal
Dept. of Electronics Engg.
D.Y.Patil College of Engg.& Tech.K.Bawda
Kolhapur, India

Abstract— Most of medium access control (MAC) protocols proposed for wireless sensor networks (WSN) are targeted only for single main objective, the energy efficiency. critical parameters such as bandwidth utilization, low-latency,, scalability, and fairness, are treated as secondary objectives. In this paper, it is focused on the Medium Access Control (MAC) layer in WSNs & an Optimized MAC scheme, for WSNs is proposed that extends lifetime of the network. This MAC protocol will solve energy inefficiency considering nodes latency based on network traffic and increases Packet delivery ratio. It will achieve high energy efficiency for large range of traffic loads and is able to adopt itself for improving the delay performance when network traffic load is high. Simulation experiments have been performed to demonstrate usefulness of proposed scheme.

Keywords— Wireless sensor Network, Medium access control, Energy efficiency, Packet delivery ratio

INTRODUCTION

Wireless sensor networks (WSNs) [1, 2] are designed to play a huge role to our future ubiquitous world. The demands on such type of networks are increasing exponentially with the increase in their sizes. However, these networks are different from existing networks and create several challenges, such as harsh resources, low communication ranges, error conditions, temporary deployment, unattended operation, and dynamic environment conditions. Low range communication confirm the dense deployment of sensors and only an efficient medium access control (MAC) protocol can handle number of medium-sharing nodes in a better way and form an efficient infrastructure to establish communication links between nodes. Wireless sensor network have become very popular in current decade due to their wide range of applications in different fields such as Military and civilian use. Wireless sensor networks can be used for different purposes such as
Target tracking, intrusion detection, wild life habitat monitoring, and climate control and disaster management. A typical node in Wireless Sensor Network consists of a sensor, embedded processor, memory and transmitter receiver circuit. These sensor nodes are normally battery powered and they coordinate among themselves to perform a common task. Unlike standard wireless network, these wireless sensor network have severe resource constraints and energy conservation is very essential. Major sources of energy waste in wireless sensor network are idle listening, collision, control packet overheads and overhearing. Most of the greedy part of energy is in transmitter and receiver, hence to minimize such wastage of energy research is going on to schedule the sleep wake up pattern of transmitter and receiver. Medium access control is an important technique that enables the successful operation of the network and is very active research area for the researchers. The classical IEEE 802.11 MAC protocol for wireless local area network wastes a lot of energy because of idle listening and also the sensor nodes are battery powered and recharging is expensive and also not possible. In order to design a suitable MAC protocol for WSN it is important to consider energy efficiency along with fairness, latency, delivery ratio. So based upon these parameters Optimized MAC protocol is devised. This MAC protocol solves the energy inefficiency taking nodes latency considerations based on network traffic, achieve high energy efficiency under large range of data loads and is able to adopt it to improve Packet delivery ratio performance when network traffic load is high.

II. RELATED WORK

In wireless sensor networks, energy efficiency is the major issue and during communication different nodes send data at the same to the sink or base station so collision may occur and these packets can be corrupted and for retransmission energy is consumed. A properly designed MAC protocol allows the node to access the channel in a way to save energy and can support quality of service[4].

A. Sensor S-MAC

Sensor S-MAC a contention based MAC protocol is modification of IEEE 802.11 protocol which is specially designed for the wireless sensor network . In this medium access control protocol sensor node periodically goes to listen/sleep cycle in fixed way. A frame period in S-MAC is divided into two parts: one for a listen session and the other for a sleep session. In a listen period, sensor nodes are able to communicate with other nodes and send control packets such as SYNC, RTS (Request to send), CTS (Clear to Send)and ACK (Acknowledgement). By a SYNC packet all the neighboring nodes may synchronize together and using RTS/CTS exchange the two nodes can communicate with each other. More amount of energy is still wasted in this protocol during listen period as the sensor will be awake even when there is no transmission and reception.

B.Timeout T-MAC

Timeout T-MAC is the protocol based on the SMAC protocol in which the Active period is pre-empted and the sensor nodes goes to the sleep period if no activation event has occurred for a time Ta. The event can be data reception, start of listen or sleep frame time etc. The time Ta is the minimal amount of idle listening per frame. The energy consumption in T-MAC is less as compared to S-MAC. However the latency of T-MAC is more as compared to S-MAC.

B. DSMAC

DSMAC is able to dynamically change the sleeping interval with fixed listen interval length and therefore the duty cycle of
sensors is adjusted to adapt to the current traffic condition. Therefore, DSMAC alleviates the high latency problem presented in SMAC when the load traffic is high, by still keeping the energy efficiency when the traffic load is low. Moreover, DSMAC only introduces insignificant overhead than SMAC.

III. PROPOSED MAC PROTOCOL

In the proposed MAC protocol, the duty cycle sensor is altered based on the network load. If the load is high then the duty cycle will be more and for low load traffic the duty cycle will be less. load on network is identified based on the messages in the queue remaining at a particular sensor. Thecontrol packet overhead is made less by reducing the size and number of the control packets as compared to those used in the S-MAC protocol. This protocol is called as optimized MAC protocol.

A .Modified Data and Control Packets:

The control and data packets in the wireless sensor networks are broadcasted. Apart from the frame control,duration, cyclic redundancy check these packets contains the source & destination address which have been removed as every node is the recipient. Removing source and destination address minimizes the overhead of control packet in the sensor network communication. some of the control packets such as RTS and SYNC have combined in to one control packet SYNCrts generated by combining SYNC packet and RTS packet. Due to such combination, reduces the packets overhead and finally contributes to reduction in energy consumption and latency.

B. Adaptive Duty Cycle

In the Optimized-MAC protocol each sensor maintains track of the load traffic based on the number of data messages in its queue.When message is received, the counter is increased and the counter is decreased when it is transmitted. If the message counter is more than the threshold COUNT then the duty cycle is increased and this change in duty cycle is reported to the neighboring sensor in the SYNCrts packet. When the neighboring sensor receives SYNCrts packet then it checks its queue if it contains message more than COUNTthres, it increases its duty cycle. If it is not, then it will simply update the synchronization table and proceeds with its original duty cycle. When the data traffic is less and when message counter is less than COUNTthres , then sensors duty cycle is decreased.The sensor node reports the change in duty cycle to its neighboring nodes. In this Optimized-MAC method , it is not necessary that all the sensor nodes to have the same duty cycle,as the new duty cycle is multiple of the original duty cycle, as shown in fig. 1and fig.2. the original duty cycle is still valid.

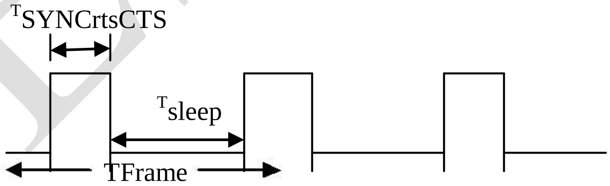

Fig.1 Optimized MAC original duty cycle

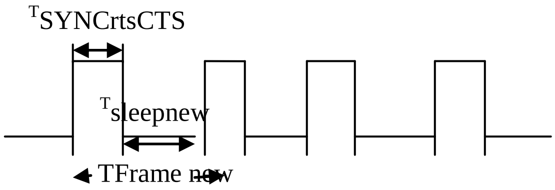

Fig.2 Optimized MAC new duty cycle

As compared to the S-MAC protocol, each Optimized-MAC based sensor also needs to maintain its own message counter and the $SYNC_{rts}$ packet contains an extra duty cycle field. However, these processing and storage overheads introduced in the Optimized-MAC protocol can be negligible, and these are well compensated by the decreased latency.

.IV. PERFORMANCE PARAMETERS OF OPTIMIZED

Paper ID: E&TC14

MAC PROTOCOL

A) Energy Consumption per bit
B) Packet delivery ratio

A) Energy Consumption per bit.

Energy is a key concern in wireless sensor networks, radio is the main energy consumer in a sensor node.Multihop packet transmission, scalable routing algorithms and controlling the duty cycle of sensor nodes can reduce the power consumption(5).

B) Packet delivery ratio.

It is the ratio of number of packets received successfully and the total number of packets sent into the network

.

V.SIMULATION RESULTS.

We have experimented the Optimized-MAC Protocol using Network Simulator ns-2 [9] version 2.34.on Fedora 8 which is Linux operating system. In our experiment we have considered 16 nodes, Dynamic Source Routing (DSR) is used as the primary routing Protocol Two-Ray ground propagation model is considered for the experiment and Omni Antenna is used for the simulation. The performance of the Optimized-MAC protocol is evaluated based upon energy consumption per bit, and Packet delivery ratio.

- Energy Consumption per bit

Energy efficiency of the sensor nodes for the Optimized-MAC, S-MAC, DSMAC, and T-MAC is shown in Figure 3. The energy consumption per bit of the Optimized-MAC protocol is less than both S-MAC and DSMAC because of the reduction in the number and size of the control packets. But the energy consumption per bit of the Optimized-MAC protocol is more than T-MAC protocol in which there is premature termination of active period when no event is expected to occur.

Protocol	Message Inter-arrival period(sec)					
	2	4	6	8	10	12
SMAC	287.41	238.40	246.20	227.38	205.90	214.56
TMAC	225.08	228.04	239.89	230.56	217.67	212.12
DSMAC	253.19	227.66	235.29	228.33	213.90	211.36
Optimized-MAC	234.89	218.17	223.29	219.33	193.90	201.56

Table I gives energy consumption values for different protocols in which, at message inter-arrival of 2 sec energy consumption in SMAC is 287.41 mJ/bit while for optimized MAC it is 234.89 thus we can say that energy consumption in optimized MAC is less than SMAC protocol. Hence energy consumption in optimized MAC protocol is less than SMAC , DSMAC and TMAC protocol.

Table I

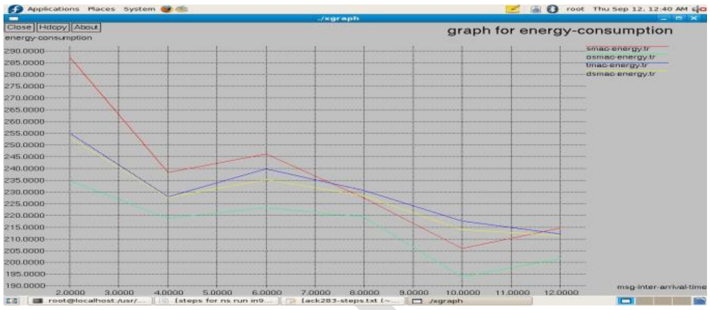

Fig 3: Average energy consumption per bit under different traffic load

- Average Packet delivery ratio

Average packet delivery ratio is the received number of packets to the total number of packets sent over all the sensor nodes. It is clear from the results shown in Figure 4 that the delivery ratio of the Optimized-MAC protocol is more as compared to S-MAC, DSMAC, and T-MAC. This is because the Optimized-MAC adjusts to higher duty cycle under heavy load and so delivers more packets to the sink node. However, the delivery ratio of the Optimized-MAC protocol follows the pattern of S-MAC under low traffic. This is because of the sensor nodes readjustment to its original lower duty cycle as the network traffic decreases. Table II shows values of Packet delivery ratio for different MAC protocols.

From the results shown in Figure 4 It is obseved that the delivery ratio of the Optimized-MAC protocol is more as compared to S-MAC, DSMAC, and T-MAC. This is because the Optimized-MAC adjusts to higher duty cycle under heavy load and so delivers more packets to the sink node. However, the delivery ratio of the Optimized-MAC protocol follows the pattern of S-MAC under low traffic. This is because of the sensor nodes readjustment to its original lower duty cycle as the network traffic decreases. Table shows values of Packet delivery ratio for different MAC protocols

Fig 4: Packet delivery ratio

Paper ID: E&TC14

Table II: Packet delivery ratio

Protocol	Message Inter-arrival period(sec)					
	2	4	6	8	10	12
SMAC	0.29	0.31	0.39	0.48	0.57	0.69
TMAC	0.28	0.32	0.40	0.44	0.61	0.69
DSMAC	0.29	0.39	0.41	0.48	0.62	0.71
Optimized-MAC	0.32	0.38	0.45	0.52	0.66	0.73

CONCLUSION

This paper presents the performance analysis of the Optimized medium access control (MAC) for the wireless sensor network. The Optimized-MAC scheme achieves high energy efficiency under wide range of traffic loads and is able to increase packet delivery ratio.

REFERENCES

[1]. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, ―A Survey on Sensor Networks‖, IEEE Communication Magazine, August 2002, pp. 102-114.

[2] Wei Ye, J.Heidemann and D. Estrin, ―An energy-efficient MAC protocol for wireless sensor networks,‖ IEEE INFOCOM, New York, NY, June 2002, Vol.2, pp. 1567-1576.

[3] Rajesh Yadav, Shirshu Varma and N.Malaviya, ―Optimized medium access control for wireless sensor network‖, IJCSNS International Journal of Computer Science and Network Security, Vol. 8 No.2, February 2008, pp. 334-338Y

[4] Mahmood Ali and Sai Kumar Ravula ―Real-Time support and energy efficiency in Wireless sensor network‖

[5] Binu G.S. ―Energy management in Wireless Sensor Networks:A crosslayer, channel adptive approach toward performance optimization‖

[6] Peng Lin, Chunming Qiao and Xin Wang, ―Medium access control with a dynamic duty cycle for sensor networks‖, IEEE Wireless Communications and Networking Conference (WCNC), March 2004, pp. 1522-1527.

[7] Changsu Suh, Young-Mi Song, Young-Bae Ko, We Duke Cho, ―Energy efficient & delay optimized MAC for wireless sensor networks‖, In Proceedings of the Workshop in the Seventh International Conference on Ubiquitous Computing (UbiComp'05), Sept 2005.

[8] Christopher K. Nguyen and Anup Kumar, ―An energy-aware medium access control protocol with frequent sleeps for wireless sensornetworks‖, In Proceedings of the 10th IEEE Symposium on Computers and Communications(ISCC), June 2005, pp. 386-391.

[9] The Network Simulator ―ns-2, http: //www .isi.edu /nsnams/