IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-5, Issue-11 E-ISSN: 2347-2693

Performance Analysis of S-MAC Protocol in Wireless Sensor Network

Deepika Bishnoi[1], Dr. Sunil Kumar Nandal[2]

[1*]Department of Computer Science and Engineering, GJUST, Hisar, India
[2]Department of Computer Science and Engineering, GJUST, Hisar, India

[*]*Corresponding Author: bishnoideepika72@gmail.com*

Available online at: www.ijcseonline.org

Received: 26/Sept/2017, Revised: 12/Oct/2017, Accepted: 09/Nov/2017, Published: 30/Nov/2017

***Abstract*:** Wireless sensor network has become a leading area of research because of its various applications such as environmental monitoring, target detection and tracking, health monitoring, industrial process monitoring, energy efficiency, disaster management and military security system. In a Wireless sensor network, the capacity of a battery of small size sensors is restricted and once the sensor nodes work, it consumes extra energy which is depending on the batteries. Sensor node performs the operation of computation and communication through which consumption of energy get exhausted at the faster rate. Energy efficiency is an important requirement in a wireless sensor network. Most of the energy is consumed in the communication part of the sensor node. Medium access control protocol plays an important role in energy consumption for wireless sensor network. MAC protocols have the capability to maintain real time functionality and achieve energy efficiency. The S-MAC protocol is used for increasing sleep duration, overhearing and decreasing idle listening, the collision of packets or eliminating hidden terminal problem which is a help to increase energy efficiency. The aim of this paper is to study S-MAC protocol in wireless sensor network. The objective of this work is to find the best-suited performance of S-MAC protocol in the term of energy efficiency, throughput, latency, etc. in wireless sensor network.

Keyword: Wireless Sensor Network, S-MAC Protocol, Energy Efficiency.

I. INTRODUCTION

A. Wireless Sensor Network

Wireless sensor network (WSN) is a network of a sensor, microcontroller, and an RF transceiver and user interface device for communications infrastructure for monitoring and recording the physical conditions of the environmental and organizing the collected data at a central location. WSNs measure ecological conditions like temperature, sound, pollution levels, humidity, wind speed and direction, pressure, etc. WSN is a collection of sensing nodes. Each node has a small energy and processing power which monitor the environment & collect the information. Each node has limited power, energy saving is a very important task in the wireless sensor network. Each node transfer information to another node & make a communication network [12]. The goal of wireless sensor network is to collect data at regular intervals and then transform data into an electrical signal. Finally, send the signals to the sink or the base node. The main features of WSN are too self – organization, energy efficiency, self-healing, low complexity, the low size of nodes and low cost [14] [1].

WSN created a growing concern from industrial and research perspectives. It can be generally defined a network of nodes that supportively sense and may control the environment enabling interaction between persons or computer and surrounding environment [15].WSNs consist hundreds or thousands of nodes, each node has minor computers capable of computing physical characteristics of surrounding environment and communicating the information to cover the aim. Nodes in WSN communicate with each other to give a common job [2]. The nodes can be static or move. They can be attentive of their location or not. They can be regular or not. For general consequence, single sink WSN consists a large number of nodes through it the amount of data collected by the sink rises and once the capacity is extended, the network size cannot be increased. That's why it suffers from the privation of scalability [16].

This paper transaction not only with the application and the features of WSNs but put together all the phases means the consideration on energy efficient protocol in WSN. Generally, when the node is in communicate mode then the transceiver channel much additional current from the battery than the microprocessor in the dynamic state or the sensors and the memory chip [10]. The ratio between the energy needed for communicating and for processing a bit of data is usually expected to be much superior to one. For this reason, the communication protocol needs to be designed according to prototypes of energy efficiency, while this limitation is less obstructive for processing tasks. Then the design of

energy efficient communication protocols is a very creepy matter of WSNs. In all shared-medium networks, MAC is an important technique. This technique enables the successful operation of the network [9].

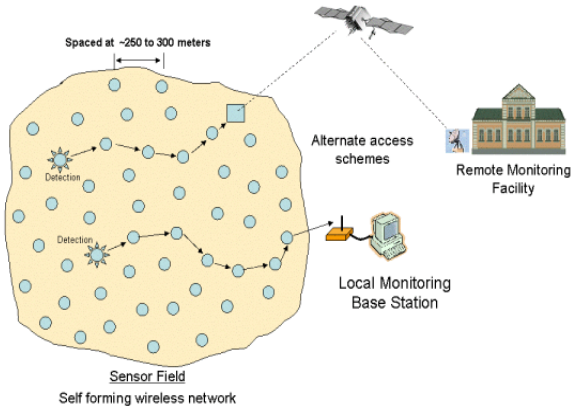


Figure 1.1: Wireless sensor network [17]

B. MAC Protocol

MAC stands for Media Access Control. A MAC layer protocol is the protocol that controls access to the physical transmission medium on a LAN. The role of medium access control (MAC) is to controls, when and how each node can transmit in the wireless channel. It tries to ensure that no two nodes are interfering with each other's transmissions and deals with the situation [6]. The MAC protocol choice has a significant effect on the performance of WSN. The MAC protocol considers all the feature of the network. MAC protocol is used for reduced and prevent energy consumption. It must take into the account of the energy management and the mechanism to minimize the energy consumption in the system. When the device is dynamic then the required task can be executed [8]. The battery is used as the basis authority of the device. The aim of the Mac protocol is to discover the energy efficient progression and transfer the data from a sensor to the destination so that it can prolong the life of network [5]. A MAC protocol is design for wireless sensor network for the following features, the first and the important feature is energy efficiency and the other important feature consists of latency, fairness, bandwidth, and throughput [7]. In this study, we focus on the S-MAC Protocol.

II. RELATED WORK

Moshaddique Al Ameen [6]- This paper proposed the various energy saving mechanism that is proposed for MAC protocol in wireless sensor network and discusses the detailed mechanism and their strength and weakness and also discusses MAC protocol that uses existing energy saving mechanism. MACs use a variety of approaches to save energy and give optimal performance. Hence energy efficiency, though the main requirement in a MAC protocol, be contingent on a particular network and application area. Wei Ye [7] -This paper proposes S-MAC, a medium-access control (MAC) protocol designed for wireless sensor networks. A network of these devices will collaborate for a common application such as environmental monitoring. We suppose sensor networks to be organized in an ad hoc fashion, with specific nodes remaining largely inactive for long periods of time, but then becoming unexpectedly active when something is detected. S-MAC uses three novel techniques to reduce energy consumption and support self-configuration. Neighbouring nodes form virtual clusters to auto-synchronize on sleep schedules. Inspired by PAMAS, S-MAC also sets the transistor to sleep during transmissions of other nodes. Unlike PAMAS, it only uses in-channel signalling. We evaluate our implementation of SMAC over a sample sensor node, the Mote, developed at University of California, Berkeley. Thibault Bernard [8]-This paper proposed that one of the major of wireless sensor network is an energy efficient MAC protocol. This study presents a MAC protocol adapted to a class of wireless sensor network. It is used for nodes located within the same radio range. In this case, a node executes a code during a small period and in the rest of the time, it moves to a sleeping mode.it maintains an abstract ring which ensures the ordered communication and avoids collisions.

III. PERFORMANCE EVALUATION

In this study, we had to limit the research to S-MAC protocol that has been implemented using the Mat lab platform. S-MAC implements a power management scheme included with the MAC layer, therefore in all the experiments varying MAC protocol meant also varying power management scheme. Within the protocol, this study looks at performance differences with low energy node and without low energy node. A MAC protocol is design for wireless sensor network for the following features, the first and the important feature is energy efficiency and the other important feature consists of latency, fairness, bandwidth, and throughput [7].

A. S-MAC Protocol

S-MAC stands for Sensor Medium Access Control. S-MAC is a contention- based protocol. It is the first protocol of MAC layer protocol for sensor networks as energy limitation of battery driven sensor nodes. The goal of the S-MAC protocol is to reduces unnecessary energy consumption. The main idea of saving energy is to switch off the radio transmitter when the lack of communication process is taking place [13].

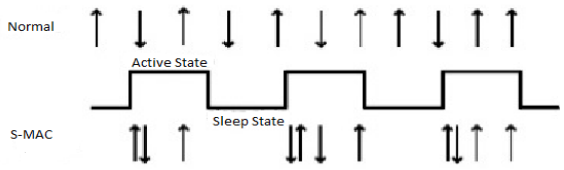


Figure 5.1: S-MAC Protocol Design

S-MAC based on a duty-cycle approach. Duty cycle parameters (sleep and listen periods) are decided earlier and may be inefficient for the actual traffic characteristics in the network. Nodes periodically change between a listen state and a sleep state. Each node chooses its own schedule, although it is preferred when nodes synchronize their schedules such that nodes listen or sleep at the same time. Exploits the sleep mode of wireless radios to trade energy for throughput and latency collision avoidance is based on RTS/CTS [7].

It consist three major components as;

- Periodic listen and sleep
- Collision and overhearing avoidance
- Message passing

In many sensor network applications, if no sensing event ensues, then nodes remain idle for a long period. The data rate during this period is significantly low. Keep all the time nodes listening is not compulsory. SMAC protocol reduces the listening time by consenting node to go into periodic sleep mode [4].

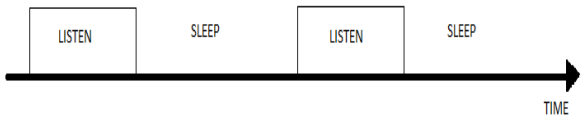


Figure 5.2: Periodic Listen and Sleep

In periodical listen/sleep cycles, as shown in Figure Periodic Listen and Sleep, during the period of listening, the nodes converse synchronization messages (SYNC) and during the period of sleeping, it shut down the radio device and set the timer to alert itself in advanced. During the receivers listening period, if a node needs to send data, it has to lead an RTS request. If the more energy can be saved then the sleep periods can be longer. A sender must wait for a long time until the receiver not awake. Each node has its individual listen/sleep cycles. Firstly, the node listens to its neighbours for a certain amount of time, in order to verify an energy efficient listen/sleep cycle after fetching in a network area. If the node monitors the listen/sleep cycle; in the case of accepting the SYNC message which is specified by this SYNC message then a node is called follower [11]. If the node does not accept SYNC message, it selects its individual to listen/sleep cycle and starts transmission of SYNC packets then it is known as a synchronizer. A SYNC packet is quite small and delivers data about the sender's address and consequent sleep dimension. Each node sets up a schedule table that holds the information about schedules of all identified neighbours nodes. To confirm that when every node can send a SYNC for communicating their schedules to the neighbour nodes then the follower nodes waits for a random delay after getting a SYNC and transmission their own schedules communicating a SYNC packet. Periodic sleep may consequence in high latency. The latency caused by periodic sleep is known as sleep delay [5].

The communication among nodes takes place when S-MAC protocol exchanges packets; this process starts with Carrier Sense (CS) to avoid a collision. Then monitored by Read to Send and Clear to Send (RTS/CTS) packets exchanged for a unicast form of data packets. The data communication takes place when transmission of the packets successfully transmitted. In the nodes in WSN with S -MAC protocol retain on the listen to state for 10 seconds in every 2 minutes. When S-MAC is in the sleep state or if its neighbours are engaged in communication then the node is not involved in broadcast or reception. The sleep state departures in S-MAC protocol to decrease collision and overhearing. The node awake at the end of its neighbour's broadcast to transmit the packets [4]. This task is executed by overhearing neighbour's RTS and CTS conversations and then the node goes to sleep and attends the purpose of decreasing latency. This performance of S-MAC protocol is known as adaptive listening and the performance for enhancing power consumption is known as message passing [3].

B. Experimental Overview

The proposed MAC protocol has been implemented in Mat lab software and is evaluated from the energy efficiency technique repository. The goal of the experimentation is to show the ultimate trade-offs of energy, latency, and throughput in MAC protocol of WSN. As a comparison, we use the energy efficiency technologies to compute the energy, throughput, and latency can provide results for MAC Protocol over Wireless sensor network. The objective purpose of the experiment is the total energy consumption for transmitting and receiving packets.

Firstly, the initiator sends the signal to the base station, it sends the signal to each node one by one and notices the elapsed time between sending the signal and receiving acknowledge. The base station sends a signal to ten nodes and calculated the elapsed time.

Table 5.1: The elapsed time for each node in WSN

Node	Elapsed time
Node 1	10.4270
Node 2	10.7190
Node 3	10.6580
Node 4	11.6880
Node 5	10.7840
Node 6	10.3750
Node 7	9.8930
Node 8	9.4220
Node 9	9.7830
Node 10	8.3280

IV. RESULT ANALYSIS

In this section, a comparative study is done to authenticate the results of energy efficient MAC protocol. The parameters used are performance, Delay, Throughput. Mat lab simulator

is used with 10 numbers of nodes for the comparison of these parameters. The following parameters should be evaluated in proposed model

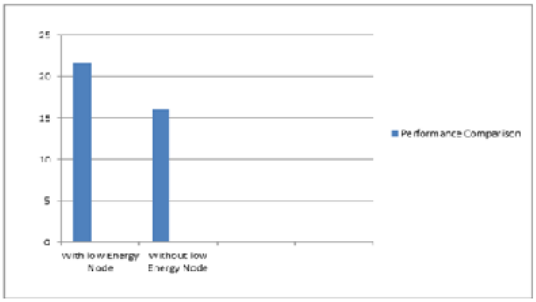
Energy Consumption

One of the most important attributes for sensor networks, the sensor node consist battery power and it is complicated to change or recharge batteries for these sensor nodes. It affects the overall node lifetime. It is also defined as the proportion of the total energy expended to the total energy conducted. The result is in the reduced amount which means improved efficiency. The performance of energy consumption is increasing by transmitting data with low energy node and when it transmits data without low energy node it consumes less energy.

Energy Efficiency = Total energy expended/ Total energy conducted

Table 5.2 Performance between with low energy nodes and without low energy nodes

Node	Elapsed time
	Throughput
With low energy nodes	32.4075
Without low energy nodes	23.937



Figures 5.8: Performance of sending packets with low energy nodes and without low energy node.

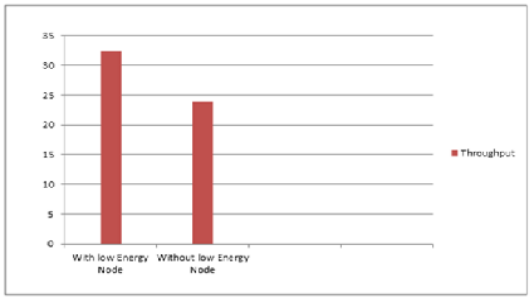
Throughput

The amount of data sent to a certain node over the period of time. Whole system throughput can be intended by cumulating the throughput of all the nodes in the system. The throughput for different situations depends on the speed and route of the nodes in that state. As the communication range extends, it effects on throughput. Node throughput can be calculated by the following formula,

Throughput = Amount of Data sent / Time

Table 5.3 Throughput between with low energy nodes and without low energy nodes

Node	Elapsed time
	Performance
With low energy nodes	21.6050
Without low energy nodes	15.9580



Figures 5.9: Throughput of sending packets with low energy nodes and without low energy node.

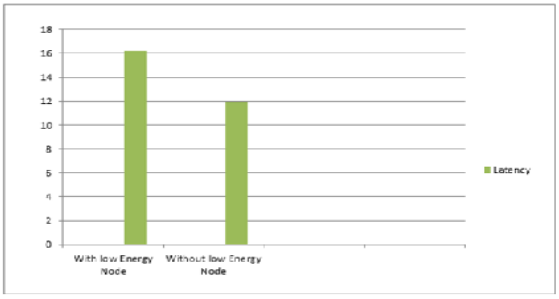
End to End Delay:

End-to-end Delay is time duration between packet's generation at the sender and the receiver gets it. Mathematically, end-to-end delay is calculated by the formula,

End to End Delay = Packet sending time/ Packet receiving time

Table 5.4 End to End delay between with low energy nodes and without low energy nodes

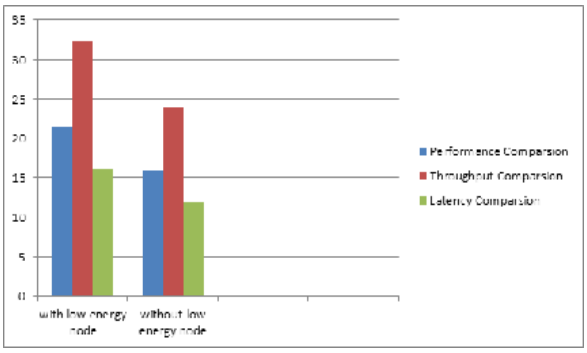
Node	Elapsed time
	End to End Delay
With low energy nodes	16.2037
Without low energy nodes	11.9685



Figures 5.10: End to End delay of sending packets with low energy nodes and without low energy node.

Table5.5: Performances of Elapsed Time in term of energy consumption, throughput and latency.

Nodes	Elapsed time		
	Energy consumption	Throughput	Latency
With low energy node	21.6050	32.4075	16.20375
Without low energy node	15.9580	23.937	11.9685



Figures 5.11: Result of elapsed time for energy consumption, throughput and latency

V. CONCLUSION

The main objective of this paper was to study the MAC protocols in Wireless Sensor Network in order to know about the low energy consumption MAC protocol used by Wireless Sensor Network. In this study, we have shown that energy efficiency technique widely used for calculating the energy consumption which can provide the results of MAC protocols in WSN. During the communication, we ensure that base station transmits data to the node at an equal interval of time and get acknowledge from nodes. In this communication, energy efficiency technique detects the low energy nodes that consume extra power and after finding the low energy nodes it removes the low energy nodes. This is collision free and high energy saving approach.

Simulation results in Mat lab will point out that low energy consumption S-MAC protocol is capable of improving energy efficiency that is used by Wireless Sensor Network. Simulation result shows the comparison between the low energy node and without low energy node. In this comparison, we, show that if the low energy node is detected and it removes from the Wireless Sensor Network than it will improve the performance of the energy consumption. It is used for balance the energy consumption, thus extend the lifetime of Wireless Sensor Network.

REFERENCES

[1]. Deepika Bishnoi1, Dr. Sunil Nandal, "*A Comparative Study of Contention-Based Mac Protocol for Wireless Sensor Network*", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol.5, Issue VI, June 201.

[2]. Bhavana Narain, Anuradha Sharma, Sanjay Kumar and Vinod Patle, "*Energy Efficient MAC Protocol for Wireless Sensor Network: A Survey*," International Journal of Computer Science & Engineering Survey (IJCSES), Vol. 2, No.3, August 2011.

[3]. Meghan GUNN, Simon G. M. KOO, "*A Comparative Study of Medium Access Control Protocols for Wireless Sensor Networks*", Int. J. Communications, Network and System Sciences, vol. 2, September 2009.

[4]. Wei Ye, John Heideman and Deborah Estrin, "*Medium Access Control With Coordinated Adaptive Sleeping for Wireless Sensor Networks*," IEEE. ACM Transaction on Networking, Vol. 12, No. 3, June 2004.

[5]. Awatef Balobaid, "*A Survey and Comparative Study on Different Energy Efficient MAC-Protocols for Wireless Sensor Networks*," International Conference on Internet of Things and Applications (IOTA) Maharashtra Institute of Technology, Pune, India 22 - 24 January, 2016.

[6]. Moshaddique Al Ameen, S. M. Riazullslam and Kyungsup Kwak, "*Energy Saving Mechanism for MAC Protocols in Wireless Sensor Networks*," International Journal of Distributed Sensor Networks, October 2010.

[7]. Wei Ye, John Heidemann, Deborah Estrin, "*An Energy-Efficient MAC Protocol for Wireless Sensor Networks*," Twenty-First Annual Joint Conferences of the IEEE Computer and Communications Societies Proceedings. IEEE. Vol. 3, 2002.

[8]. Thibault Bernard and Hac`ene Fouchal, "*A Low Energy Consumption MAC Protocol for WSN*," Ad-hoc and Sensor Networking Symposium, IEEE. 2012.

[9]. Subhasis Dash, Amulya Ratna Swain, Anuja Ajay, *"Realible energy Aware Multi Token Based MAC Protocol for WSN*," 26th IEEE. International Conference on Advanced Information Networking and Applications, 2012.

[10]. Khalil F. Ramadan, M. I. Dessouky, Mohammed Abd-Elnaby, Fathi E. Abd El-Samie, "*Energy–Efficient Dual-Layer MAC Protocol with Adaptive Layer Duration for WSNS*," IEEE. Vol.16, 2016.

[11]. P.T.Kalaivaani and A.Rajeswari, "*An Energy Efficient analysis Of S-MAC and H-MAC Protocols for Wireless Sensor Networks*," International Journal of Computer Networks & Communications (IJCNC) Vol.5, No.2, March 2013.

[12]. U. Korupolu, S. Kartik, GK. Chakravarthi, "*An Efficient Approach for Secure Data Aggregation Method in Wireless Sensor Networks with the impact of Collusion Attacks*", International Journal of Scientific Research in Computer Science and Engineering, Vol.4, Issue.3, pp.26-29, 2016.

[13]. Rachid Aouami, Mounir Rifi, Mohamed Ouzzif, "*Comparative analysis of contention Oriented Power Saving based medium access control Protocols for Wireless Sensor Networks*," IEEE. 2004.

[14]. Chiara Buratti, Andrea Conti, Davide Dardari, and Roberto Verdone, "*An Overview on Wireless Sensor Networks Technology and Evolution*", Sensor, Vol. 9, 2009.

[15]. Anitha K, Usha S,"*A Scheduled Based MAC Protocols for Wireless Sensor Network: A Survey*", International Journal of Advanced Networking & Applications.

[16]. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "*Wireless Sensor Networks Technology, protocol, and Applications*, Wiley-Interscience, 2007.

[17]. Manju Bhardwaj, "*Faulty Link Detection in Cluster based Energy Efficient Wireless Sensor Networks*", International Journal of Scientific Research in Network Security and Communication, Vol.5, Issue.3, pp.1-8, 2017.

Author

Ms Deepika Bishnoi received her Bachelor of Technology degree in Computer Engineering from Guru Jambeshwer University of Science & Technology, hisar, hayana, India in year 2015. She is currently pursuing Master of Technology in Computer Engineering from Guru Jambeshwer University of Science & Technology, hisar, hayana, India in year 2017. Her research interests in wireless communication and computer networking.

Dr. Sunil Kumar Nandal received his Ph. D from Deptt of Computer Science & Engineering, Guru Jambeshwer University of Science & Technology, hisar, Haryana, India in year 2014.He has been working as Assistant Professor in Computer Science & Engineering departme nt of GJUS&T-Hisar, Haryan, India. His area of research is Ubiquitous Computing, Distributed Computing and Computer Networks.

