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A Survey on "Energy Efficient MAC Protocols with Differentiation in Traffic for Wireless Sensor Networks"

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Abstract: ***In Wireless Sensor Network (WSN) there are sensor nodes deployed to communicate with the physical world. These nodes are battery operated which consumes more power. One of the major issue for power consumption is to make an energy efficient medium access (MAC) protocol in the WSN. These sensor nodes are also affected by external factors like Packet Delivery Ratio (PDR), Throughput, End to End Delay and Latency to degrade the Quality of Services (QoS). Different traffic loads plays an important role in energy consumption. In this paper, we surveyed some MAC protocols for WSN and compare their design and behavior in accordance with different Traffic of loads.***

Keywords: Medium access control protocol (MAC), Wireless sensor network, Traffic loads, energy efficiency, Quality of Services (QOS)

1. Introduction

Wireless Sensor Network is a network which has grown its significance in the recent years. WSN supports in numerous applications such as monitoring, military, industrial, etc. The purpose of WSN is to collect and process data from source and transmit information to the target sites. There are sensor nodes which consume power as they are battery operated. The Battery is power confined and is difficult to replace or change. The sensor node energy is mostly consumed by the radio part of the node and the other sources of energy wastage are idle listening, over hearing, collision and overhead. For Better Lifetime of sensor nodes we need power consumption.

For Better Quality of services (QoS), the working of SMAC protocol, TMAC protocol , IHMAC protocol, RIMAC protocol are analyzed with different Traffic loads. There are different approaches such as CSMA, TDMA and combination of CSMA and TDMA used by this MAC protocols.

Major Headings

1.1. Types of MAC Techniques

In WSN, many energy efficient MAC protocols are present. This are classified into four categories which is been shown in fig. 1.

1.1.1 Contention based MAC protocol

The Basic approach of Contention based MAC protocols are Carrier Sense Multiple Access (CSMA) and Carrier Sense Multiple Access/ Collision Avoidance (CSMA/CA)[1]. The principle of CSMA is "sense before transmission". CSMA/CA avoids the collision. Advantage of these MAC protocol is to increase scalability and adaptability. Under this category the protocols are T-MAC, S-MAC, U-MAC.

1.1.2 TDMA based MAC protocol

Time division multiple access is channel access method for shared medium network. In this method, the channel is divided into time slots which is share among simultaneous users. TDMA has an important advantage that of clashing between adjacent node is avoided. By this collision is avoided, so energy wastage due to collision is reduced. TDMA-based MAC protocols are µ-MAC, DEE-MAC, SPARE MAC.

1.1.3 Hybrid based MAC protocol

It is integration of contention-based MAC and TDMA-based MAC. The hybrid protocols can save higher energy and supply better scalability and flexibility in comparison to these two methods. Hybrid protocols are A-MAC, IH-MAC, IEEE 802.15.4 and Z-MAC.

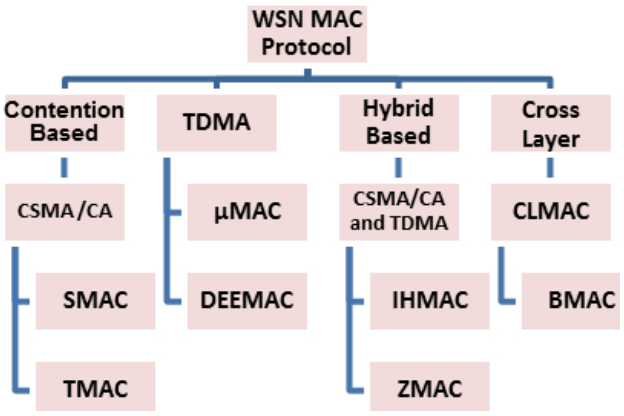

Figure 1: WSN MAC Protocol Techniques

1.1.4 Cross layer based MAC protocol

In cross layer MAC, we maintain the relation between each layer for improving consumption of energy. This is designed by integrating the characteristics of the physical layer and the MAC layer. The introduction of new cross layer MAC protocol are BMAC and CLMAC.

2. Related Work

Comparing Energy-Saving MAC Protocols for Wireless Sensor Networks concept given by [1] compared two MAC protocols, S-MAC and T-MAC based on traffic variation. S-MAC suffers from overprovisioning since its duty cycle is assigned a large value. Low power listening feature of T-MAC saves lots of energy but when compared to CSMA/CA and S-MAC fails to handle peak time loads.

In the year 2008, authors Yanjun Sun, Omer Gurewitz and David B. Johnson gave the concept of [2]RI-MAC, a Receiver Initiated MAC asynchronous duty cycle mac protocol for dynamic traffic loads in WSN. It showed that the time taken for sender and receiver to communicate can be significantly reduced

Later in the year 2009, Meghan Gunn and Simon Koo surveyed mac protocols and found that as WSN involves mobile nodes which fall short of energy[3] because of the size limitation and their mobile nature, long lasting lifetime of nodes is a critical issue. Each protocol works its best in different environments. In this paper, there are protocols SMAC (Sensor MAC), TMAC (Timeout MAC), Traffic-Adaptive MAC (TRAMA)[7].

Mohammad Arifuzzaman and Mitsuji Matsumoto presented a concept about parallel transmission of data packets in WSN. EP-MAC[5] protocol based on TDMA approach removes the drawback of scheduled based approach in MAC by utilizing contention based scheme. This improves the lifetime of sensor nodes.

In the year 2013, the authors Mohammad Arifuzzaman, Mitsuji Matsumoto and Takuro Sato gave the idea of Intelligent Hybrid MAC(IH-MAC)[6] using the combination of CSMA and TDMA approach by switching from Broadcast scheduling[6] to Link scheduling and vice versa for different Traffic loads. IHMAC uses Request-to-send and Clear-to-send to minimize the transmission power between neighbors. For the reduction in delay, IHMAC protocol [6]uses the concept of Parallel Transmission. Due to this improvement, the energy efficiency is increased for different traffic loads.

Many different MAC protocols are been studied for the betterment of energy efficiency property such as in [7] by S. Agarwal, V. Jain, and K. Goswami in 2014 and in the hybrid MAC protocol, a new protocol traffic adaptive hybrid MAC protocol[8] is been introduced which gives better energy efficiency in some cases. As, for working in different traffic loads more working is needed in hybrid MAC protocols as there is more scope and area to grow in this protocol.

3. Problem Addressed

- To Design more energy efficient MAC Protocol
- To get better results under low Traffic load by duty cycle scheduling. When compared to [1]XMAC, RI-MAC gives higher throughput and higher packet delivery ratio.

4. Comparison Chart

Following table1 lists out the different protocols and their advancements

Table 1: Different MAC Protocols with Parameters

Parameters	*SMAC*	*TMAC*	*RIMAC*	*IHMAC*
Time Synchronization	Yes	No	No	Yes
Access Method	TDMA	CSMA/CA	CSMA /CA	TDMA and CSMA/CA
Sleep Latency	More	More than IHMAC	Less	Less
Energy Conservation	Less	More than SMAC	More than SMAC	More
End-to-end Delay	More	Less than SMAC	Very Less	Less
Packet delivery ratio	Less	More than SMAC	More	More

5. Conclusion

We have presented the survey on various type of energy efficient MAC protocol of WSN which is prominence on the energy efficiency; it is a critical issue for WSN. Because sensor nodes are hold batteries for control power in network, for appliance of WSN reduction in energy consumption is essential, and the MAC protocol in WSN is the most important influential aspect in WSN energy performance. So key problem is designing energy efficient MAC protocol. Depending on the traffic load, our protocol improves the energy consumption significantly when compared to the contention-based protocols of S-MAC and T-MAC. This is due to the fact that one node is elected as cluster head which consumes energy and most of the other nodes within the cluster go to sleep. In our research we have analyzed contention-based protocols up to 60 nodes, and in the future, simulations can be done with more number of nodes and also with other existing protocols with different parameters.

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