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Performance Analysis of Different MAC Protocols for varying Packet Size in Wireless Sensor Network

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Abstract— **In wireless sensor network (WSN) there are number of sensor nodes present within a dense area. The sensor nodes sense the environmental changes and transmit the data to sink node. The challenging issues in WSN are energy efficiency, reachability, congestion, throughput, data aggregation, and security. To achieve Congestion control and Energy efficiency are the main parameter in the WSN. For efficient data transmission & to find out shortest path between the source and destination, MAC protocols and routing protocols are used. This paper proposes algorithm named MREEMRP, global sleep schedule MAC, survey of SMAC and introduces digital signature cryptography. There are various techniques introduced in this paper like PEGASIS chain and TSLS technique. It provides an advantage such as reduce the routing distance, avoid overhearing and scalability. This paper will be useful for beginners for study & achieving the QoS factors using MAC protocols.**

Keywords - **WSN, MAC, LEACH, Energy Consumption, QoS, Throughput, MANET.**

I. INTRODUCTION

Wireless sensor network is set of distributed nodes which are densely deployed in sensor field. Each sensor node is capable of performing some processing, gathering sensor information and communicating with other connected nodes in network. Applications of wireless sensor network are agriculture, military application in battlefield, biodiversity mapping, medicine, health care, fire detection.There are also certain limitations like bandwidth, limited computational power, limited power supply to individual nodes.

There are also certain challenges faced by the WSN like Energy-consumption by the nodes, throughput, delay, fault tolerance ,synchronization & cluster head selection[14],[15]. To work on them, there are various MAC protocols and algorithms introduced, which are as follows. One of them is MSEEMRP algorithm. The MREEMRP algorithm is compared with MSEERP. Analysis show that proposed algorithm gives better result for the parameters like average energy consumption, node density & data amount gathering [1].Techniques like scheduling in the network improves energy efficiency of the sensors. Therefore, global sleep schedule is introduced to achieve energy efficiency. MAC protocols with global sleep schedule reduce the energy of nodes to increase the lifetime of the nodes [2].To improve the network performance of the MAC protocol plays an important role. The advantage of schedule based MAC protocol and contention based MAC protocol is used to make the hybrid MAC protocol [3].

The network performance also differs according to its topology. Leader based enhanced butterfly (LEB) topology is an enhanced version of butterfly topology which is a combination of ad-hoc and hierarchical topology. It achieves end-to-end reachability in the network [4]. Security is one of the parameters to be achieved in the network. To achieve it, digital signature cryptography is introduced. In this encryption and decryption takes place by two protocols SET-IBS and SET-IBOOS provides security for data transmission [5]. In a network there are certain mobile nodes also, which have different protocols used. Among them is MANET. In mobile ad-hoc network there is absence of base station. At the time of packet transmission congestion occurs. Therefore, there are some techniques used to control the congestion in MANET [6]. In a network the main parameter to be achieved is energy efficiency. LEACH is energy efficient routing protocol. In LEACH header node dies early.

To overcome this PEGASIS chain mechanism is used [7]. WSN is divided into number of clusters. In each cluster, cluster head is present. The techniques used for cluster head selection are topology, coverage preservation, counting, and fuzzy logic based technique [8].To achieve QoS some algorithms are used among them is regular service guarantee algorithm. This algorithm is used with Time-Since-Last-Service (TSLS) to overcome from drawback of inefficiency in throughput [9].The neco-MAC includes four different MAC protocols with Network Coding Aware(NCA) technique[10]. Hybridisation is also carried out to improve

network performance. Real-time wireless data acquisition media access control (MAC) protocol provides the requirements of high throughput, low end-to-end latency, low energy consumption and accurate time synchronization. A hybrid protocol, combining the advantages of TDMA and FHSS is used for collision prevention and anti-jamming[11]. SMAC is a protocol used to design network for mission critical applications. In these applications , the data sensed and should be transmitted within time . If not then the situation will be adverse. Hence, with the help of SMAC we can achieve maximum throughput, latency, packet delivery ratio , and with sensors consuming minimum amount of residual energy[12].

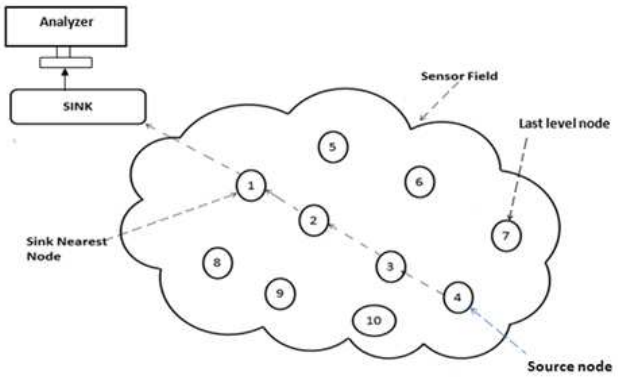

Figure 1: Structure of Wireless Sensor Network

Figure 1 shows structure of wireless sensor networks consist of small nodes with sensing, computation, micro sensor, and microprocessor hardware and wireless communications capabilities. A sensor node is a low cost, resource constrained device, and battery powered device. Sensor individually sense the physical quantities from the environmental area for example noise, pressure, human movement etc. Sensed quantity is in the form of an analog signal which is then converted into digital signal and transferred to the gateway or sink node. After collecting the data, the sink transfers the data to control station which will then take action to control the generated event. The collection of data from all sensor nodes is known as data aggregation. In WSN data aggregation is gathering or collection of data from different sensor nodes for analysis of the sensed data. In a Wireless Sensor Network, the communication carried out between source and destination node. The nodes which are within the first hop (present nearest to the sink) have a lot of congestion due to the upcoming data packets from all the sensor nodes in the network. The congestion may cause data loss, less throughput, increased delay and data may not be sent reliably. The data loss within the first hop and sink is known as energy hole problem. To increase the performance of network there are certain protocols designed for efficient and reliable data transmission. The protocols are classified as MAC protocol and routing protocol. Most of the attention, however, has been given to the routing protocols since they might differ depending on the application and network architecture. Wireless sensor networks have limited energy resources, So WSNs operations must be energy efficient in order to maximize the network lifetime.

II. LITERATURE SURVEY

In this paper Energy-Efficient Mobile Routing Algorithm uses an algorithm named Mobile Relay Energy Efficient Mobile Routing Protocol (MREEMRP). It uses virtual grid topology. In grid topology the cluster head is selected on the basis of large amount of residual energy of nodes and the weighted sum of co-ordinate distance between a node and a cluster barycentre. The Mobile Relay node locates its own position and move freely in the network. The mobile relay broadcast its information to its neighbouring node. The MREEMRP reduces the routing path length. The algorithm MREEMRP is compared with MSEERP. The analysis showed that the proposed algorithm shows better result for the parameters like total energy consumption, active node number, data amount gathering node received [1].

Mac protocols are designed to be Energy Efficient. S-MAC requires some nodes to follow multiple sleep schedule which causes more often wakeup mechanism, It leads to eliminate the energy of a Network. In S-MAC some nodes need to stay awake longer than any nodes, to overcome this drawback proposed technique is produced. In proposed technique when connectivity is established between two or more isolated clusters, each cluster will follow its individual chosen schedule. When a new node is introduced in the common neighbourhood of the clusters, all nodes of these clusters form a single cluster by adopting the schedule of one of the cluster. In this process when the clusters are merged, nodes will follow exactly one duty cycle, avoiding the problems associated with multiple schedule. The parameters achieved by this techniques are

a. Lifespan of the first node died.
b. Total Energy Consumption of the network.
c. Average Lifespan of the node [2].

This paper tells the current state of the Medium Access Control (MAC) protocol in WSN. The categories of MAC protocols addressed in this paper have it strength and weakness. While scheduled based MAC protocol need to keep strict clock synchronization among nodes. The schedule based MAC protocol is used to avoid overhearing and idle listening by scheduling transmit and listen periods but have strict time synchronization requirements. The schedule based MAC protocol we have TDMA and FDMA. The Contention based protocols are based on Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) technique and have higher costs for message collisions, overhearing and idle listening.

To overcome the drawback of Schedule based Mac protocol and Contention based Mac protocol Hybrid Mac protocol is introduced. Hybrid protocols were developed to combine the advantages of the CSMA, TDMA and other energy efficient MAC protocols to maximize energy efficiency, improve latency and spectrum utilization. . The development of Hybrid MAC protocol which is energy efficient and also focuses on scalability, reliability and less complex is of great importance[3].

To achieve an efficient network performance, there should be a specific and reliable topology to be used, one of them known is butterfly topology. There are certain topologies used like Ad-Hoc and hierarchical network. Butterfly topology is the combination of Ad-hoc and hierarchical topology which gives drastically better performance. This butterfly topology ensures high end reachability. Here leader nodes of the cluster are responsible for the communication. This communication can be between nodes within clusters and also between neighbouring cluster nodes. If in case the leader nodes fail then there is another leader node available as a substitute to continue the work of the previous leader node, this working is applied in the similar way for the cluster nodes as well. This work of exchanging the privilege is done by the leader node itself. Increased reachability is obtained due to enhanced butterfly network, which ensures to reach every possible sensor node in the network. Increased energy efficiency is obtained due to clustered hierarchy as well [4].

III Result Analysis

In our scenario, we have taken 11 numbers of nodes for simulation. Use Ad-hoc On Demand Distance Vector (AODV) Routing Protocol. CSMA (802.11), ZigBee (802.15.4), Time Division Multiple Access (TDMA). Sensor MAC (SMAC) MAC protocols are used in scenario. Varying the Packet size from 50 to 250 bytes and reporting rate is 0.1. Nodes are deployed in chain topology. Simulation part done using NS2 tool.

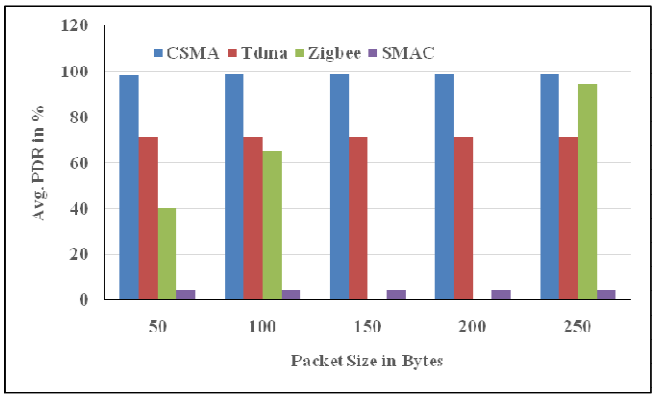

Figure 2 : Average PDR for Packet Size

Figure 2 shows performance analysis of different MAC protocols. For parameter, packet delivery ratio it is found that the results of CSMA are more efficient than all the other MAC protocols. It efficient because of it's RTS, CTS signal mechanism. While, TDMA is better than ZigBee IEEE 802.15.4 and SMAC but less efficient than CSMA. The performance of SMAC remains constant throughout, because it is used for small range communication. ZigBee IEEE 802.15.4 is also used for small area network but it shows a variable performance above. It gives results for all different packet sizes but for packet size 150 and 200, it gives result as zero.

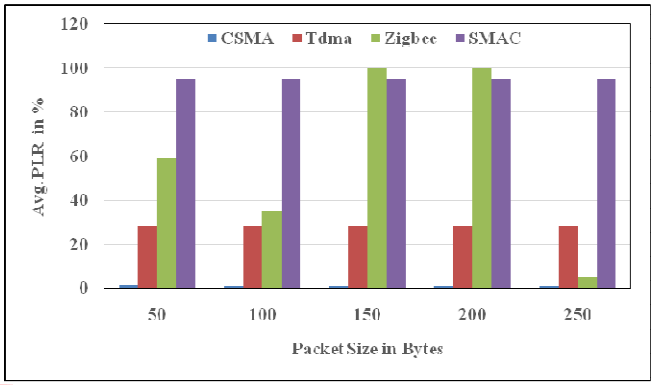

Figure 3 : Average PLR for Packet Size

In figure 3, for parameter packet loss ratio it is found that lesser the PLR, more efficient is the performance of protocols. It shows that PLR of SMAC is the highest, than other protocols. Therefore, SMAC is not good in performance. The lowest results are of CSMA, hence CSMA is found efficient. TDMA remains constant. While, the PLR of ZigBee IEEE 802.15.4 is highest at packet size 150 and 200. Thus, packet loss is more for ZigBee IEEE 802.15.4 at size 150 and 200.

IV. CONCLUSION

This paper has proposed various protocols, techniques as well as topology. It has its own strengths and weaknesses. To minimize the weaknesses we have studied different protocols like MAC, SMAC, LEACH, PEGASIS and neco-MAC. We have also studied various techniques such as global sleep schedule, MSEEMRP algorithm, Leader Based Enhanced Butterfly (LEB) topology and tree topology. Using the proposed algorithms beginners can achieve QoS like energy efficiency, overhead, reachability, throughput, and congestion control. Hence this paper summarizes that, using different Mac protocols, network topologies and techniques we can improve the network performance.

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