# Performance Analysis of duty cycle over QOS parameters in WSN

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***Abstract*—Wireless Sensor Network (WSN) has a major issue of energy utilization after the deployment. As nodes have small size battery attached with them. Energy consumption can be controlled most at MAC layer. As all the data transmission and reception decisions are taken at this layer only. So there different properties of MAC which required to check according to the application need. There are different MAC protocols are available. In this paper performance analysis of S-MAC is done for different QOS parameters of WSN by varying the node density as well as CBR timing.**

***Keywords*—Wireless Sensor Network(WSN), Media Access Control (MAC), Duty cycle, Energy Efficiency, Quality of Service(QOS).***

## I. Introduction

Wireless Sensor Network is a network where many nodes communicate with each other wirelessly. Each of these nodes is equipped the ability to sense some environmental or other surrounding parameters [1]. Wireless Sensor Network becoming very popular, because of their limited resources and time-critical applications [2]. Nodes are provided with the batteries which are non rechargeable as well as non replaceable in most of the cases [3]. Medium Access Control Protocol plays major role in energy consumption of the nodes. Actual reception and transmission of packets occurs at the MAC layer only. So there are many properties of this layer which should be considered while using the MAC protocol in the application [4]. Primary attributes of consideration are energy efficiency, scalability and ability to adopt the changes in network topology density and size.

Sensor nodes, forwarding nodes, and base station are the three components of Wireless Sensor Network are shown in figure 1. Event detection, location sensing, continuous sensing, etc is done using Sensor nodes. The nodes which forward data towards base station are known as forwarding nodes. Base station is generally where central repository of the data is maintained. Analysis of data is done at base station and outcome is decided based on the result of the analysis. The main applications of senor network are in the areas intervention of human is not possible.

As the sensor nodes are deployed in remote area they have the limitation of size. This limitation ultimately results into reduction of battery and processing unit size. As battery size is small the energy is also limited, so energy must be utilized properly to increase network lifetime [5]. There are many people worked and working on energy consumptions by the nodes.

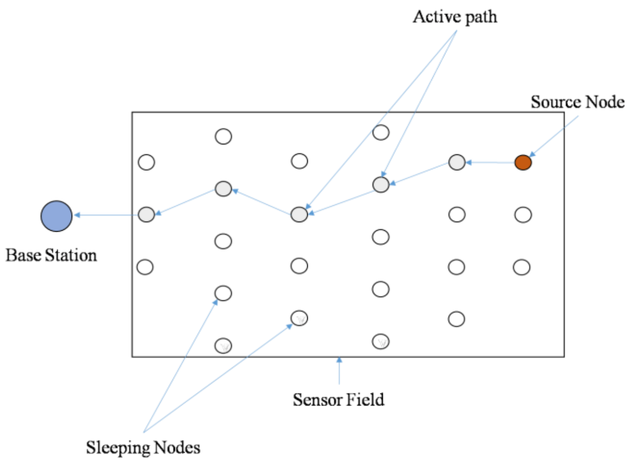


Figure 1: Wireless Sensor Network

The major energy wastage of the node is done in transmitting the packet with higher transmission power than required and waiting in listening state for next data packets to come. There are some solutions drawn to reduce this energy wastage. By using adaptive transmission power much energy of the nodes can be saved if the network is dense. This is done at node level. While to reduce overall energy consumption of the network periodic sleep/awake scheme is used [6].

There is lot of work done in adaptive transmission power by different authors. But the duty cycle management is yet an issue which not completely resolved. There are some solutions provided in duty cycle where in duty cycle is managed, but it is periodically i.e. statically managed.

SMAC is one of such variation of MAC layer protocol used in NS2 to manipulate the duty cycle of the nodes. The implementation of SMAC in a way, it gives better results when there is no traffic generated randomly and that is also for a short period of time. In SMAC each node can have its own periodic sleep/awake cycle. This cycle timings are calculated with the value of duty cycle mentioned by the user.

Performance of WSN is calculated from Quality of Service (QOS), provided by the network. Average energy consumption, Packet Delivery Ratio (PDR) , Reliability, Throughput, Delay are the main QOS parameters. The values for these parameters varies by many factors such as MAC protocol, routing protocol, reporting rate, density, packet size, and so on.

Congestion is an another challenge which affects the network lifetime [7]. To improve energy utilization congestion must also be controlled. When any node or link gets the data which is more than its processing capacity congestion is said to be occurred. Congestion occurs mainly when more number of packets thumbed into the network [8]. This happens due to many of the network conditions such as high reporting rate, density of the nodes [8].

Congestion adversely affect the network as packets are dropped it reduces PDR, throughput as the packets are not transmitted ahead from congestion point. Due to packet drop nodes need to retransmit the packets which leads to wastage of energy [9].

Congestion can be controlled by avoidance or by reducing. As per the requirement of the application congestion control mechanism is applied. To control the congestion its detection is necessary. Congestion can be detected at node level or at link level by measuring buffer occupancy and by measuring links busyness.

## II. Related Work

An author Ruqiang Yan, proposed an Energy aware sensor node design. In this author has considered both the energy consumptions i.e. at the node-level and network-level. Node-level energy saving is achieved by adjusting the transmission power as per the requirement. Network-level energy saving is done using periodic sleep/awake scheme. Also author has shown results for two network design scheme. In first scheme all the nodes communicate directly to the Central Repository Unit (CRU). Whereas in second scheme clustering is done and only cluster head communicate to the CRU. Although graphs have shown very good results for energy savings, this kind of network schemes can be used only where the data generation is periodic and CRU is located at the central part of network [10].

Energy harvesting is also one of the options to maximize the network lifetime. An author Andrea Castagnetti proposed a joint duty-cycle and transmission power management for energy harvesting. In this paper author has designed a sensor node with energy harvesting unit attached to it. In this paper also author has used adaptive transmission power as well as periodic sleep/awake scheme. But the energy harvesting unit added at the node improves its network lifetime. Based on environmental conditions the energy harvested at the nodes varies. Next wake up period is calculated with the help of energy harvested by the node at this transmission period. Transmission power is calculated based on the feedback from the base station. This paper shown the results which are better, but this system also can be implemented where the base station is at the centre and all nodes can directly communicate with the base station [11].

An author Fengyuan Ren has proposed a Traffic-Aware Dynamic Routing (TADR) to Alleviate Congestion in WSN. In this paper author has an algorithm which reduces the congestion by routing packets away from the congestion areas along ideal and unloaded nodes. When the congestion is detected at the any node, that node informs its parent. Congestion is detected at the node based on the buffer occupancy. Then the parent node finds another path towards the destination and route the packets through that path. This helps in utilizing the energy of nodes which are unloaded. This improves the overall network throughput as well as PDR. But if there is no congestion then this algorithm allows the traffic to go through the shortest path only. This may result into higher utilization of the nodes on the shortest path. If the congestion has occurred at all the available paths then there are chances of looping [12].

## III. Performance Analysis

Simulation scenario contains 1 UDP agents who generate traffic, one destination node, and remaining nodes are common nodes. Packet Size is 50Bytes and reporting rate 10 packets/sec. Density of the nodes varies from 25-100. All the nodes are static. It uses Ad-hoc On Demand Vector (AODV) routing protocol and S-MAC with no synchronization and duty cycle value 10%. Grid topology is used in this scenario.

Figure 2 shows the PDR as a fuction of CBR time. As the time of CBR increases more number of packets are thumbed in the network. This increases the chaces of congestion in the network. As each node folllows its independent duty cycle irrespective of the CBR running, the packets get droped as the buffer of the node occupies. This results into loss of PDR. As the duty cycle is irrespective of the node density the results are going hand in hand for different node density.

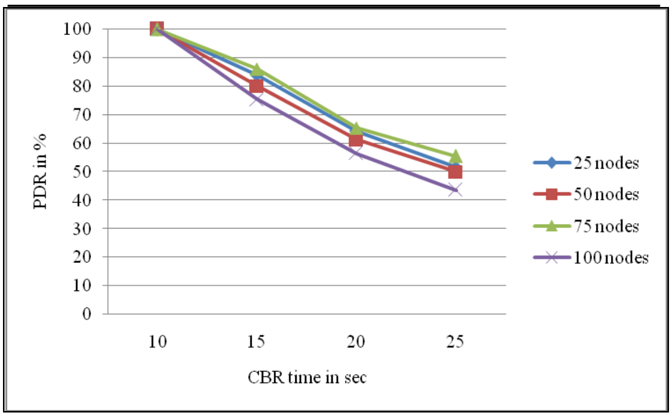


Figure 2: PDR as a function of CBR time

Figure 3 depicts delay as a function of CBR time. Delay is minimum if the packets reach to the destination soon. In case of SMAC each node has its independent duty cycle, the nodes transmit the data only when they are awake. So as the time of CBR increases it requires more duty cycles to transmit the data towards the destination which inturn increases the delay. This delay also increses as per the density because as the density increases packet need to traverse more number of nodes.

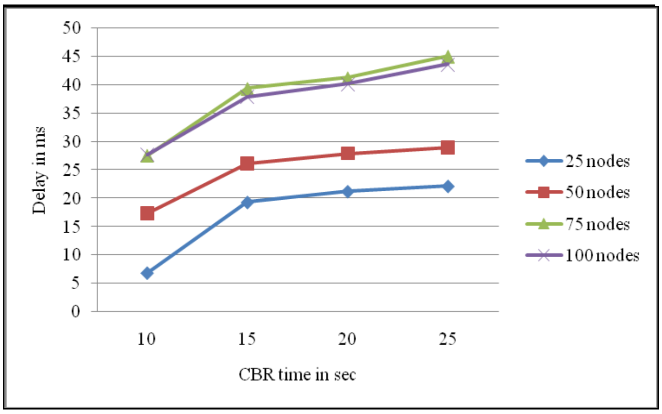


Figure 3: Delay as a function of CBR time

Figure 4 shows the average energy consumption as a fuction of CBR time. As the CBR time increases more number of packets gets thumbed into the network. So it requires more transmission to reach to the destination, which in turn increases energy consumption. But after a particular threshold the average energy consumption is constant as congestion in the network increases many nodes don't get packet to transmit.

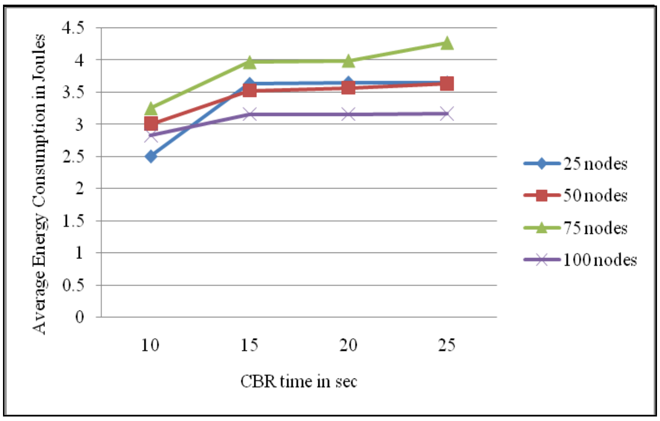


Figure 4: Average Energy Consumption as a function of Density

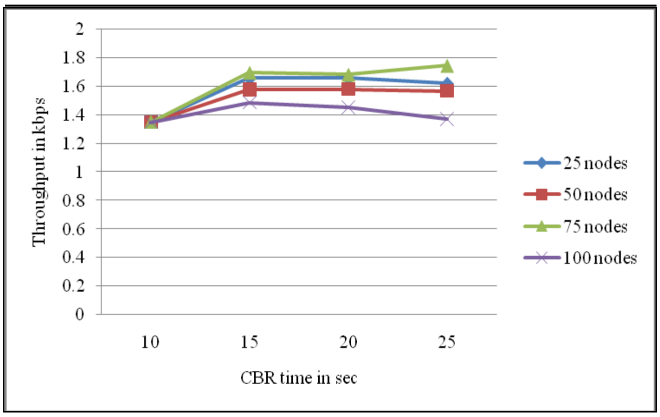


Figure 5: Throughput as a function of CBR time

Figure 5 represents Throughput as a function of CBR time. Throughput of the network is maximum when all the node process the data. But in this scenario nodes are working with thir independent duty cycles. So at a peticular instance of time less numbers of nodes are processing the data. So the throughput of the network is constant irrespective of node density.

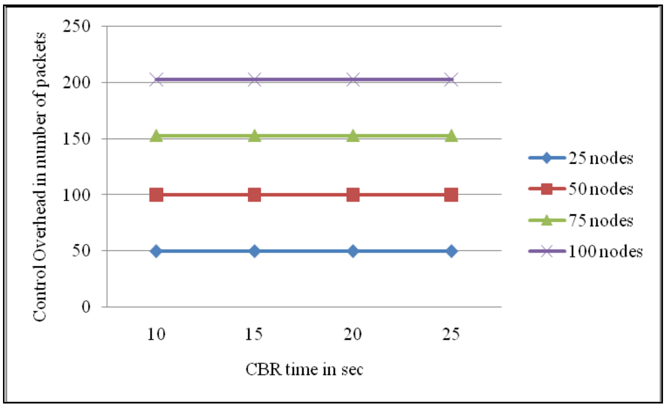


Figure 6: Control overhead as a function of CBR time

Control overhead as a function of CBR time is portrayed in the figure 6. Control overhead are nothing but the control packets sent in the network during data transmission. As the number of nodes in the network increases more control packets are flooded in the network. As the control overhead are dependant on node density not time. They are constant irrespective of CBR time.

## IV. Conclusion

Energy consumption is mainly the function of MAC layer. In this paper simulation results of SMAC are drawn to show its behaviour in different node density and CBR running time. From Figure 2 we can conclude that as the CBR timing increases the PDR decreases irrespective of the density. From Figure 3 and Figure 4 we can conclude that the threshold is of CBR timing is 15 sec, as after 15 sec average energy consumption and throughput remains constant. From Figure 6 we can infer that as number of nodes in the network increase, control overhead also increases which are irrespective of CBR running time.

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