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# Energy Efficient Beacon Scheduling in WSN

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***Abstract*: In wireless sensor network the main source of energy consumption is Idle listening. Keeping energy consumption in mind the wireless sensor network should quickly sensing data. The communication between the nodes is only possible when both nodes are in active state. In this paper, we have implemented a modified beacon scheduling in the recipient MAC protocol. the data will be transmitted to the node in the active state thus effectively saving the energy consumption in the idle state. For transmission of data, synchronization of all nodes is important. Each node has its defined time slot to avoid collision of data. The receiver node sends a beacon frame request to the slave node in active state in response to it the slave node sends data frame if any to the node. The communication takes place only in the active state thus saving the energy in passive state (sleep state). The system is simulated in visual basic software and the graphs are plotted accordingly. It also shows the active and sleepy state of the network.***

***Keywords* : Beacon scheduling, MAC protocol, Visual basic software, wireless sensor network.***

## I. INTRODUCTION

Wsn is tremendously growing in all sectors now-a-days. WSN is an active research area in telecommunication and computer science. The most common research area of WSN is area monitoring, healthcare monitoring, fire detecting, threat detection data logging. Thus huge amount of data is collected when event is detected. For high throughput and reliable data transmission the channel should deliver the variable data in timely fashion.

The data is transmitted from the source node to the sink node depending upon active and sleep state, this strategy helps in saving the energy consumption while remaining in sleep mode. The receiver node send a signal that it is in active state to receive data, whenever no signal is detected it goes in sleep mode thus efficiently saving energy. Each node switches between the active and sleep mode occasionally.

The nodes sending data at the same time may cause data congestion and collision. Thus synchronization with receiver node is more important to avoid data congestion. The traditional approach mainly focuses on the bandwidth and the quality of service.

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Thus there are many chances of data collision and congestion as time slots are not distributed to the nodes. In traditional beacon scheduling, any slave can send beacon request frames at any time, this increased the chances of data collision and congestion.

In this paper, we mainly focus on the improvement of the energy efficiency and avoiding the data congestion and collision. This paper proposes a modified beacon scheduling method for RI-MAC. The communication is initiated by transferring the beacon request frame by receiver to the slave node1 stating that it is in active and ready to communicate, thus the slave node1 than transfers the data frame to the receiver. If no data frame is available it goes into passive state. This saves the battery life of the device while in sleep state. Thus the receiver then sends the beacon frame to the other slave node2. At a time only one node communicates with the receiver node. This in turn avoids data collision and congestion. The system is simulated in visual basic and the results are plotted accordingly.

In this paper section II gives the research carried out on this topic, section III and section IV give the design implementation of the modified beacon scheduling for RI MAC and the detailed components specification. Section V shows the simulated result of the paper and section VI concludes the paper.

## II. LITERATURE REVIEW

Many authors came up with their own technique of improving energy efficiency and avoiding data congestion.
In 2013, Pei Huang, Chen Wang and Li Xiao, they proposed a RC-MAC protocol that intermingle the receiver centric scheduling and the duty cycle. RC-MAC protocol handles the asynchronous traffic driven by any event by using the tree structure data gathering of WSN to assist scheduling of medium access. This improves the throughput and the energy efficiency.[1]
In 2014, Yuan Zhang, Limin Sun, Houbing Song, Xiaojun Cao, they proposed a system architecture for healthcare application which is a three layer network which provides less energy consumption and more data delivery. The main goal of the design was the awareness, trustworthiness and security.[2]
In 2014, Myounggyu Won, Taejoon Park, and Sang H. Son, they proposed a system to uniformly perform in the highly asymmetric links. They implemented a hybrid approach to address the issue of asymmetric links. For this the sender initiated and the receiver initiated design principles were used.[3] In 2016, Shuguo Zhuo, Zhi Wang, Ye-Qiong Song, Zhibo Wang, and Luis Almeida, they presented iQueue MAC that provides low delay transmission.

They used a hybrid approach of CSMA/TDMA MAC for variable traffic. The iQueue MAC is able to work in both the single channel and multi-channel mode.[4] In 2014, Ricardo C. Carno, Deigo Passos,Luiz C. S. Magalhes and Celio V.N Albuquerque, they presented a brief theory on the strength and weakness of the network deployment. They also stated the challenges of duty cycle.
the future complexity and the ease to improve the network lifetime.[5]
In 2017, Akihiro Fujimoto, Yukari Masui, Takuya Yoshihiro and Fumitaka Uchio, they proposed a method to improve the data collection delay, and implemented energy efficient technique by scheduling the becon transmission for receiver initiated MAC protocol. A time slot is selected for transmission from its slave node to the master node without much delay [6].
In 2011, Luis M. N Oliveira, Joel J.P.C Rodrigues provided a brief review on the environmental monitoring systems based on wireless sensor network. They concluded that the WSN is the growing field and data from different systems and location can merge together and can be retrieved from anywhere [7].
In 2009, Meghan GUNN and Simon G.M. KOO, they gave a comparative study on MAC protocol. They provided a study on how to improve the overall performance by comparing the MAC protocols design and identifying their design issue [8].
Many research is carried out in receiver initiated MAC. Each and every researcher have tried to improve their system is terms of energy efficiency and reducing the transmission delay. Thus a modified beacon scheduling at the receiver node will improve the transmission delay thus reducing the variable load. Thus an energy efficient wireless sensor network can be implemented using a modified beacon scheduling.

## III. SYSTEM DESIGN

The system architecture is shown below. It consists of two units:

i) Slave nodes( Transmitter unit)
ii) Master node (Receiver unit)

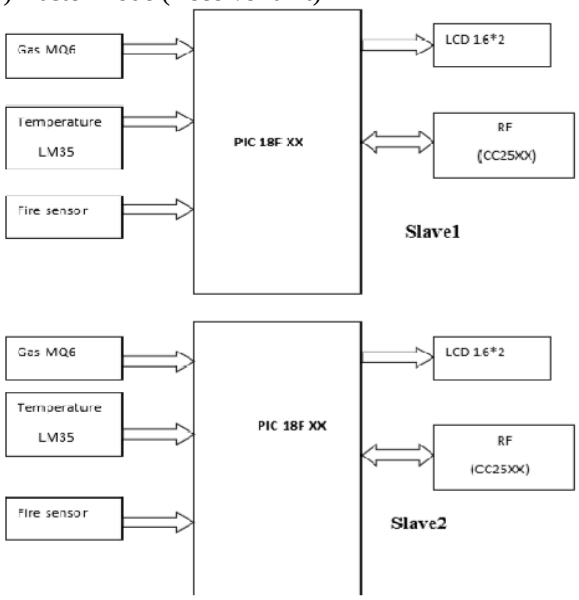



**Figure 3.(a): Slave node.**

Two slave nodes are shown in figure. Each slave node has some of the monitoring components mainly used in wireless communication network. The slave node are deployed at two different places to monitor data in that particular area. The sensor senses the environmental data and sends it to the controller for future process of analog data to digital conversion. The microcontroller used in this system is PIC18F452X. The sensors are interfaced to the controller. The gas sensor used in this system is MQ6 which senses the combustible gases in the environment. A temperature sensor LM35 is used to measure the temperature of the environment. The LCD shows the value of the measured sensor data. The microcontroller does the process of the sensed data and the communication between the slave node and the receiver node is established by the RF transceiver.

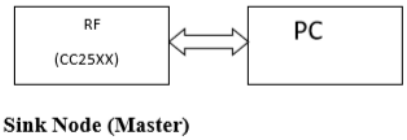



**Figure 3(b). Master Node**

The data communication undergoes two stage:
1) Beacon request broadcast stage: In this stage the receiver node send a beacon request frame to the entire network. The entire slave node receives the request frame and only the active state sends the data to the receiver node.
2) Beacon data communication stage: In this stage, the status information of all the nodes is allocated to the receiver node (Master node). The transmission between the slave and master is only achieved in active state. A slave node is set to be active when the sensed data reaches a predefined value set by the microcontroller. If the sensed value does not reach the threshold value set, the slave node is set to be in its passive state and no transmission of data is done between the receiver and the passive state, thus this saves the energy as it only operates in the active state and since only the active node sends data here data collision and data congestion is also avoided.

## IV. HARDWARE DESCRIPTION

### A. MQ6

This gas sensor is mainly used to sense the combustible gases like, LPG, iso-butane, propane etc. they are less sensitive to smoke and alcohol. They are easy to interface with any microcontroller. It operates on 5v power supply and has long life and fast response to the combustible gases. The output of this sensor is analog in nature and need to be converted in digital form so this sensor is connected to the inbuilt 10bit ADC of PIC controller. A predefined value is set, as the value of this sensor reaches above the predefined value the slave node goes in the active state to transmit the data to the receiver node.

### B. LM35

It is basically used in many industrial applications to measure the environmental temperature.

They are directly calibrated in Celsius. The operating voltage is from 4V to 30V. the main advantage of using LM35 is that its output is calibrated in centigrade scale and does not need any calculation to obtain the value in Celsius.

The device has low self-heating as it only draws 60 micro Ampere from the supply.

### C. LCD Display

The sensed value of the sensors is shown on the LCD. Here 16X2 LCD is used, which operates on 5V power supply and can be easily interfaced with the PIC controller. It is programmer friendly, low in cost and easily available. It has inbuilt contrast level, when grounded we get maximum contrast.

### D. RF Transceiver

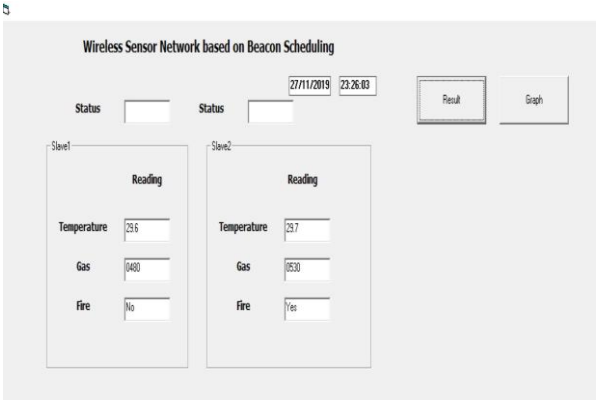
The communication between the slave node and the master node is achieved by RF transceiver. It is a low cost, high performance device. It is used in industrial, scientific and medical application and also used for short range devices. Due to fast settling frequency synthesizers it is suitable for multichannel system and frequency hopping system.

### E. PIC18F4520

The controller is the heart of the system, we have used PIC18F4520 controller. It gives high performance upto 10MIPS. Its operating voltage range is from 2.2V to 5.5V. It has 32kb program memory size. And SRAM of 1536kb . it has one 8bit timer and three X 16 bit timers. It has 13 channels, 10 bit ADC. Its operating range is from -40 degree C to 125 degree Celsius. It has inbuilt one UART, one SPI and one I2C.

## V. RESULT

The system is simulated in the visual basic software. The VB software is easy to learn and use. The software gives an ease to create simple and complex GUI applications. The components are provided to the programmer by visual basic program itself to create applications. It gives high security of data and mainly used to interface data based system.


The results are observed in VB software, this software also shows the graphical representation of the data. The data is shown with the date and time. The sensor data of two slaves is shown; it gives the value of the data sensed. The slave node is set to be in active state when the data value exceeds the threshold value. When the data value is below the threshold value the slave node remains in the passive state and no communication is established between the master node and the slave node.

## VI. CONCLUSION

In this paper, we have implemented a modified beacon scheduling for recipient MAC protocol. The time division multiplexing technique is used to assign time slot to each and every node so that the node will transmit the data in the given time slot only, thus avoiding data congestion and data collision. The energy efficiency is improved thus by modifying the beacon scheduling. The transmission takes place only in the active state thus saving the energy. The whole system is simulated in visual basic software and the values and the graphs are plot accordingly. The status of the nodes is also shown in this software. The active and passive state of the node is decided by setting a threshold value beyond which the node will be in active state and will transmit the data. The modified beacon scheduling maintains comparable energy efficiency and achieves high performance in packet delivery.

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## AUTHORS PROFILE

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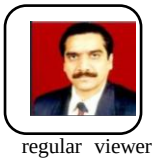

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