

HISTORY BASED CONTENTION WINDOW CONTROL PROTOCOL FOR ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORK

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ABSTRACT

The earlier work described in the literature involves different schemes or algorithm that are implemented at the network layer or at the physical layer of TCP/IP to endorse energy saving so that the network of any system remains sustainable for long time. The techniques discussed in this paper uses the history based contention window control over packet routing in the network layer. The main idea behind this scheme is to control the time of every node which delivers the packet but if in case the proximity node or network does not accept the incoming packets because it is busy, then the transmitter node has to either wait or it tries randomly to deliver the same. This causes the whole system to use more of its energy and this is the main reason that conventionally many other protocols are not good for the system. But our system and our history based contention window control scheme has proved to be worthy as it is good in terms of the time allocation providing the system either to wait or to access other node for the transmission of the system. The energy being consumed has reduced considerably and the efficiency and throughput has increased because of reduced energy consumption.

Keywords: Ad-Hoc Network, Contention Window, Matlab, Wireless Sensor Network

I INTRODUCTION

Wireless Sensor Networks consists of individual nodes that are able to interact with their environment by sensing or controlling physical parameter; these nodes have to collaborate in order to fulfil their tasks as usually, a single node is incapable of doing so; and they use wireless communication to enable this collaboration [1].

II WIRELESS SENSOR NETWORK

A sensor network is a deployment of massive numbers of small, inexpensive, self powered devices that can sense, compute, and communicate with other devices for the purpose of gathering local information to make global decisions about a physical environment” [1].

Sensor network development was initiated by the United States during the Cold War [2]. A network of acoustic sensors was placed at strategic locations on the bottom of the ocean to detect and track Soviet submarines. This

system of acoustic sensors was called the Sound Surveillance System (SOSUS). Human operators played an important role in these systems.

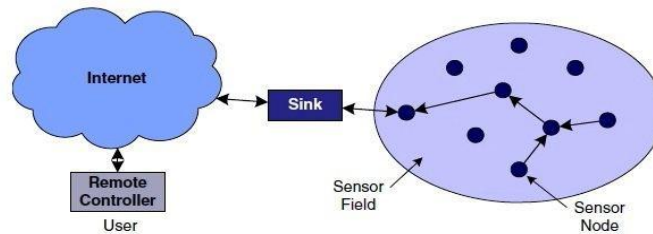


Figure. 2.1: Typical WSN

The sensor network was wired network that did not have the energy bandwidth constraints of wireless system. Modern research on sensor networks started around 1980 with the Distributed Sensor Networks (DSN) program at the Defence Advanced Research Projects Agency (DARPA). These included acoustic sensors communication (a high-level protocols that link processes working on a common application in a resource-sharing network), processing techniques, algorithms (including self-location algorithms for sensors), and distributed software (dynamically modifiable distributed systems and language design). Recent advances in computing and communication have caused a significant shift in sensor network research and brought it closer to achieving the original vision. Small and inexpensive sensors based upon micro-electro-mechanical system (MEMS) technology, wireless networking, and inexpensive low-power processors allow the deployment of wireless ad hoc networks for various applications. Thus, the program developed with new networking techniques is suitable for highly dynamic *ad hoc* environments. Wireless networks based upon IEEE 802.11 standards [9] can now provide bandwidth approaching those of wired networks. At the same time, the IEEE has noticed the low expense and high capabilities that sensor networks offer. The organization has defined the IEEE 802.15 standard [5] for personal area networks (PANs), with “personal networks” defined to have a radius of 5 to 10 m. Networks of short-range sensors are the ideal technology to be employed in PANs. Furthermore, increases in chip capacity and processor production capabilities have reduced the energy per bit requirement for both computing and communication. Sensing, computing, and communications can now be performed on a single chip, further reducing the cost and allowing deployment in ever-larger numbers.

2.1 Wireless Sensor Network Model

Unlike their ancestor ad-hoc networks, WSNs are resource limited, they are deployed densely, they are prone to failures, the number of nodes in WSNs is several orders higher than that of ad hoc networks, WSN network topology is constantly changing, WSNs use broadcast communication mediums and finally sensor nodes don't have a global identification tags [3]. The major components of a typical sensor network are:

- *Sensor Field*: A sensor field can be considered as the area in which the nodes are placed.

- *Sensor Nodes:* Sensors nodes are the heart of the network. They are in charge of collecting data and routing this information back to a sink.
- *Sink:* A sink is a sensor node with the specific task of receiving, processing and storing data from the other sensor nodes. They serve to reduce the total number of messages that need to be sent, hence reducing the overall energy requirements of the network. Sinks are also known as data aggregation points.
- *Task Manager:* The task manager also known as base station is a centralised point of control within the network, which extracts information from the network and disseminates control information back into the network. It also serves as a gateway to other networks, a powerful data processing and storage centre and an access point for a human interface. The base station is either a laptop or a work station.

Data is streamed to these workstations either via the internet, wireless channels, satellite etc. So, hundreds to several thousand nodes are deployed throughout a sensor field to create a wireless multi-hop network. Nodes can use wireless communication media such as infrared, radio, optical media or Bluetooth for their communications. The transmission range of the nodes varies according to the communication protocol is used.

2.2 The Sensor Node

A sensor is a small device that has a micro-sensor technology, low power signal processing, low power computation and a short-range communications capability. Sensor nodes are conventionally made up of four basic components as shown in Figure 2.2: a sensor, a processor, a radio transceiver and a power supply/battery [3].

Additional components may include Analog-to-Digital Converter (ADC), location finding systems, mobilizers that are required to move the node in specific applications and power generators. The analog signals are measured by the sensors are digitized via an ADC and in turn fed into the processor. The processor and its associated memory commonly RAM is used to manage the procedures that make the sensor node carry out its assigned sensing and collaboration tasks.

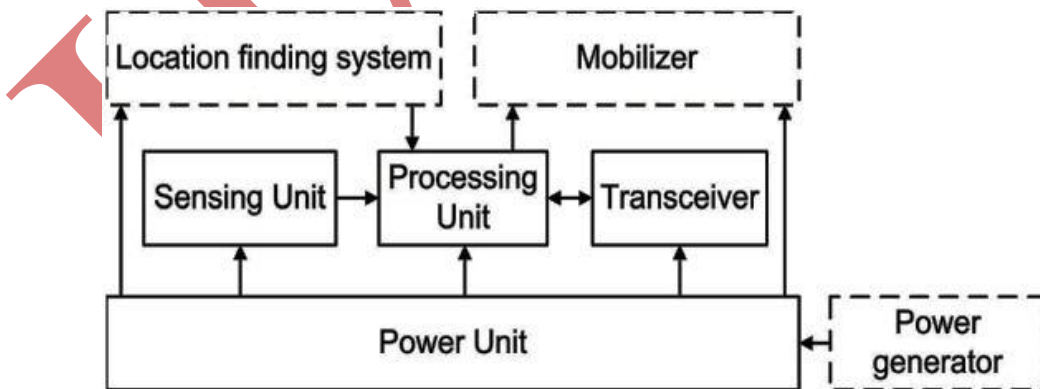


Figure. 2.2: General Architecture of A Sensor Node

The radio transceiver connects the node with the network and serves as the communication medium of the node. Memories like EEPROM or flash are used to store the program code. The power supply/battery is the most important component of the sensor node because it implicitly determines the lifetime of the entire network. Due to

size limitations of AA batteries or quartz, cells are used as the primary sources of power. To give an indication of the energy consumption involved, the average sensor node will expend approximately 4.8mA receiving a message, 12mA transmits a packet and 5 μ A sleeping [3]. In addition the CPU uses on average 5.5mA when in active mode.

III PROBLEM IDENTIFICATION & ISSUES

3.1 Cellular and Ad Hoc Wireless Networks

The current cellular networks are classified as the infrastructure dependent networks. The path setup between two nodes is completed through the base station. Ad hoc wireless networks are capable of operating without the support of any fixed infrastructure. The absence of any central control system makes the routing complex compared to cellular networks. The path setup between two nodes in ad hoc network is done through intermediate nodes. For the distributive system to work the mobile nodes of ad hoc network are needed to be more complex than that of cellular networks.

3.2 Exposed Terminal problem

In wireless networks, the exposed node problem occurs when a node is prevented from sending packets to other nodes due to a neighboring transmitter. Consider an example of 4 nodes labeled R1, S1, S2, and R2, where the two receivers are out of range of each other, yet the two transmitters in the middle are in range of each other. Here, if a transmission between S1 and R1 is taking place, node S2 is prevented from transmitting to R2 as it concludes after carrier sense that it will interfere with the transmission by its neighbor S1. However note that R2 could still receive the transmission of S2 without interference because it is out of range from S1.

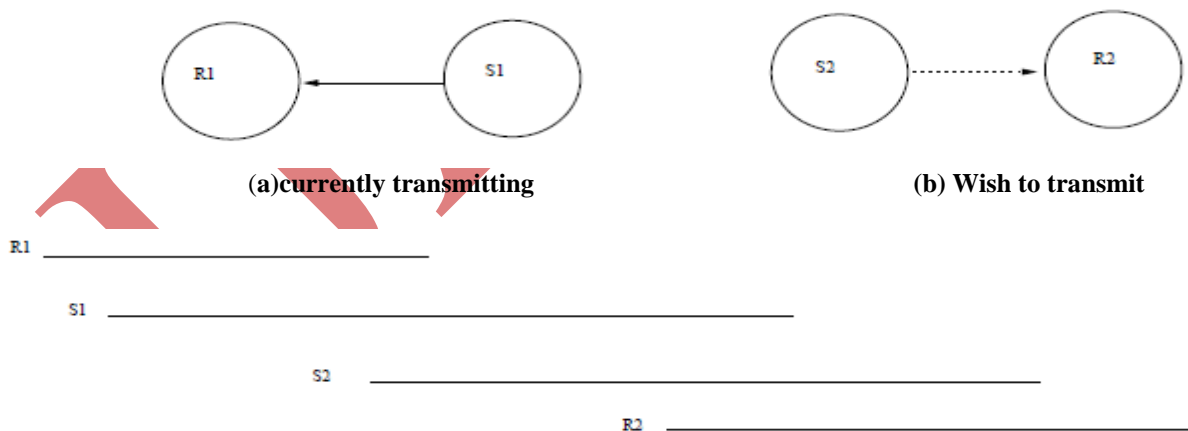


Figure 3.1: Exposed Terminal Problem

3.2 Algorithm for RTS Threshold

To set the RTS-Threshold dynamically, we need to observe the current distribution of packet size in the network. But for this, we need information from all the active nodes. This necessitates inter-layer communication (Routing-MAC layer). Let us denote P_i be the probability that a packet's size is less than or equal to S_i . Then, mathematically:

$$P_i = P_r \{S \leq s_i\} = \left(\frac{\sum_{j=1}^i f_j}{\sum_{k=1}^n f_k} \right)$$

Let, P_r is the greatest probability less than η , P_s is the packet size at P_r , C_r is the least probability greater than η , and C_s is the packet size at C_r . Using linear interpolation the traffic observer calculates the current RTS-Threshold using the equation below

$$RT_{current} = \left[P_s + \frac{(\eta - P_r) * (C_s - P_s)}{(C_r - P_r)} \right]$$

The average RTS-Threshold is updated as

$$RT_{average} = [\alpha * RT_{preview} + (1 - \alpha) * RT_{current}]$$

where, $RT_{preview}$ = previous RTS-Threshold and controls the relative weight of recent and past history of RTS-Threshold calculation. The value of α lies between 0 to 1.

IV MATERIALS AND METHODS

We propose a novel backoff mechanism, in which the history of packet lost is taken into account for Contention Window size optimization. The packet lost involves packet collision and channel error. In this study, we utilize two parameters x and y , that are used to update CW value. We check the channel and if the packet lost rate is increased because of channel error or collision, we increase the CW size for decreasing the packet lost and when the packet lost rate of the channel is decreased we decrease the CW size slowly for increasing the throughput. The CS (Channel State) is three elements array that is updated upon each transmission trial, i.e. each time the station transmits the packet successfully and receives the acknowledgement (ACK for data and CTS for RTS packets) or when the packet becomes collide because of channel error or collision. When we store the new channel state, the oldest channel state in the CS array is removed and the remaining stored states are shifted to the left.

V SIMULATION AND RESULTS

The first section calculates the different network data by using some data nodes transmission time acknowledgement packets, transmitted packets and many other requirements. The second section discusses the same using a GUI built in MATLAB R 2010a version which tries to bring upon user and programming interface in a lucid fashion.

- Three types of simulation schemes have been preferred over the entire network.
- There is one channel model AWGN used in the simulations.
- The different outputs of the simulation are: estimate of successful, acknowledged and failed packets.

The table 5.1 describes the work of two different authors and there comparison with the work done in the thesis. The major techniques used in the present work are related to DIFS, SIFS, RTS/CTS and History based contention

window. The work done by the authors are referenced and their respective results are also discussed. The thesis strives to give better results by using iterative clipping and filtering techniques, which is a low cost better performing technique when compared on the cumulative distribution function. In the work proposed History based contention window tends to give good results, which is required.

Table 5.1: Simulation Parameters

Parameter	Work done by Ali Balador	Thesis work
Number of stations	50	10,15,30
Simulation time	600	2,0.2,0.4
Frame Size	512	200,80,20
Channel	AWGN	AWGN
Time Scale for random motion	0-20	0-10
Range of each station	250	6,10,6

5.1 GUI Interface

An interesting interface in MATLAB was developed using MATLAB GUIDE to understand the imperative functioning of the whole algorithm. It is strongly recommended that using GUIDE in MATLAB for such developments helps us to bring change in the overall system.

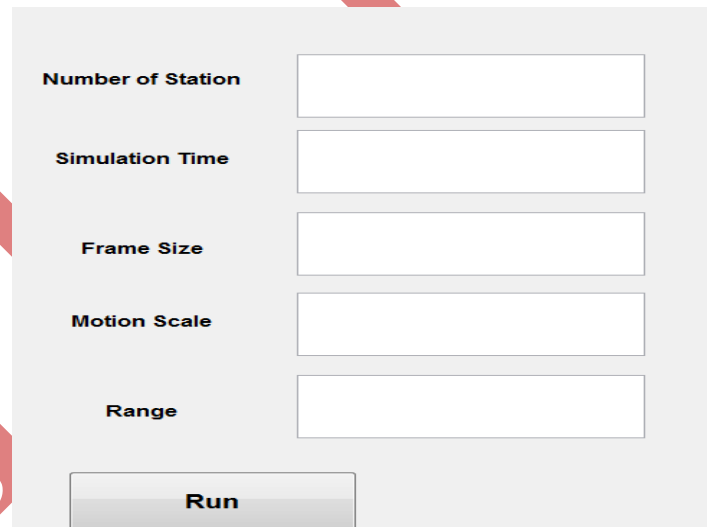


Figure. 1.3: GUI Interface

The report intends to bring upon the subject of energy utilisation using different schemes out of which the thesis provides a step by step approach towards the development of the entire model over the same subject. The initial step was to design those pre requisites inputs which are towards the progress of the model. There is small figure which express the development of the input section phase.

Next is the section in wholesome which has different outputs produced as the part of the thesis. The overall section of output is again shown as a figure in the report.

Estimated Simulation time	
Total Transmission	
Successful Transmission	
Total Collisions	
Unreachable Packets	
Total Acknowledgement	
Successful Acknowledgement	
Acknowledged Collision	
Unreachable Acknowledgement	
Efficiency	

Figure. 1.4: GUI Interface

The final development of the guide includes the different figures clubbed all together to enhance the feature of the complete system.

The screenshot shows a window titled "project_GUI" with the main heading "Energy efficient based routing protocol in wireless sensor network". On the left side, there are five input fields: "Number of Station", "Simulation Time", "Frame Size", "Motion Scale", and "Range", each with a corresponding text box. Below these fields is a "Run" button. On the right side, there is a list of output metrics, each with a corresponding text box: "Estimated Simulation time", "Total Transmission", "Successful Transmission", "Total Collisions", "Unreachable Packets", "Total Acknowledgement", "Successful Acknowledgement", "Acknowledged Collision", "Unreachable Acknowledgement", and "Efficiency".

Figure. 1.5: Overall GUI Interface

It has tried to give better outputs over the same simulation by using DCF scheme and projecting using HBCWC as the proposed matter. Later in the section another important task is to consider the final results which the thesis has tried to showcase. The results are discussed for different users, simulation time and many other parameters given in the Table No 1.2. The important parameter which has the frame size for the base is 512 packets and 200, 80, 20 packets. The channel assumed is white Gaussian noise for random time packets between 0- 20.

VI CONCLUSION

Routing is a significant issue in Wireless Sensor Networks. The objectives listed in the problem statement have been carried out properly. We sincerely hope that our work will contribute in providing further research directions in the area of routing. Since energy of the nodes is a constraint in wireless sensor network, so a fix amount of energy is given to the network. As the simulation time increases, nodes in the network continuously lose its energy and after a fix simulation time network collapse.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to my esteemed and worthy supervisor, **Mr. ParvinKaushik** Assistant Professor, Department of Electronics and Communication Engineering, KIET Ghaziabad for his valuable guidance in carrying out this paper. I would like to express sincere thanks to Dr. Sanjay Sharma, Professor, Department of Electronics and Communication Engineering, KIET Ghaziabad, for his moral support, effective supervision and encouragement.

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