Study and Analysis of Energy Conservation in Wireless Sensor Network

Yashaswini B K
M.Tech. Dept of TCE, RVCE Bengaluru, India.

Ranjani G
Assistant Professor, Dept of TCE, RVCE Bengaluru, India.

Abstract – Wireless sensor networks (WSN's) are becoming increasingly popular with the advent of the Internet of Things (IOT). Various real-world applications of WSNs such as in smart grids, smart farming and smart health would require a potential deployment of thousands or maybe hundreds of thousands of sensor nodes/actuators. To ensure proper working order and network efficiency of such a network of sensor nodes, an effective WSN management system has to be integrated. However the inherent challenges of WSNs such as sensor/actuator heterogeneity, application dependency and resource constraints have led to to challenges in implementing effective traditional WSN management. This difficulty in management increases as the WSN becomes larger. Energy conversation is a critical problem in wireless sensor networks (WSNs) so that the energy consumption must be minimized while satisfying application requirements. In this paper we will analyze the energy efficiency between the sensor nodes and also between the sensor nodes and the base station.

Index Terms – WSN (Wireless Sensor Network), Source node, Sink node, Switch node, And the Base station.

1. INTRODUCTION

In a typical WSN, nodes are powered by non-rechargeable batteries and thus energy is a scarce resource. It is imperative that energy conservation is considered across all layers of the protocol stack in order to minimizing the total network energy consumption and prolong the operational lifetime of the network.Wireless Sensor Networks (WSN's) consists of nodes that are capable of sensing the environment; these nodes have to collaborate with each other to fulfill assigned tasks as usually,a single node is not able to perform the task and the wireless communication is used to enable the collaboration.These sensor nodes are occupied with small battery and hence they are having limited energy resources. The replacement of sensor nodes is impossible in most of the situations as the applications of WSN are mostly in areas where human involvement is infeasible. Hence,energy efficiency is a main design issue that needs to be considered for enhancing the life duration of the network. In wireless sensor network, most of the energy consumption is spent on three activities: Sensing, data processing,and communication. Among these, the rate of energy consumption is more during communication. Thus , we need a mechanism to increase the network lifetime through reduced energy consumption. The researchers and the actual users had given much attention to wireless sensor networks.

WSN's has extensive potential applications. Nodes of a WSN are generally deployed to collect the interested data (temperature, chemicals, etc.) or just sense the presence or the absence of a phenomenon of interest in an information field. The amount of data collected by nodes varies with the application requirement of the WSN. The application requirement of the WSN. The application requirement can be simply embodied by source rates of nodes. Typically, the data generation and transmission rates of nodes are low by reason of the scare of power and the limitation of capacity of storage, processing and communication of nodes in WSN's. Therefore, the energy efficient approaches for the low rate setup should be explored for WSNs.

2. RELATED WORK

2.1 Energy Efficient Routing Protocols in WSN

Routing can be defined as an act of finding a path between the source node and the sink or destination node to perform data transmission. In WSNs, the network layer is responsible for routing of the incoming data. Routing in WSN is really challenging due to intrinsic characteristics that differentiates such networks from other networks.

A critical necessity in WSN is to achieve energy efficiency during routing as the sensor nodes are occupied with limited energy resources. The effective utilization of energy is the main issue in wireless sensor network. In most of the WSN applications, replacement of renewal of energy source is seldom possible. Hence, the efficient protocol should minimize the energy consumption, so as to maximize the network lifetime. This is the major reason for large part of the research in WSNs to focus on the development of energy efficient routing protocols. Routing protocols in WSNs are broadly classified into 4different categories on the basis of network structure, communication model, topology and reliabilty. The taxonomy of routing protocols are as shown in figure 1. This basic classification is further classified into

different types and number of protocols are proposed in each of these categories. Among these, hierarchical routing protocols are found to be more energy efficient than other protocols. Many routing protocols have been proposed in this category so far in order to decrease the energy consumption and maximize the network lifetime.

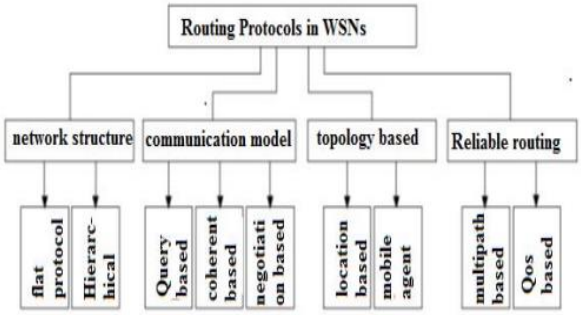

Figure.1 Classification of routing protocols in WSN

2.2. Hierarchical routing protocols in WSN

Hierarchical routing protocols is a class of routing protocols that offers greater savings in total energy consumption of the WSN. In hierarchical routing protocols, number of nodes are grouped together to form clusters and each cluster is assigned an elected cluster head. The figure.2 shows a typical clustered network.

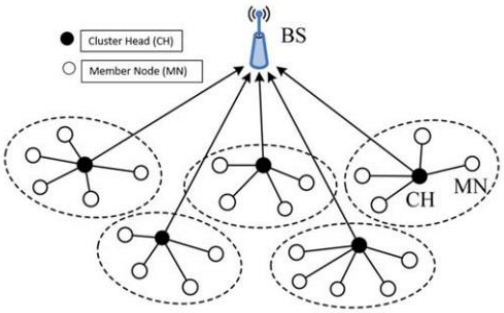

Figure.2 A typical clustered Architecture

The responsibilities of head nodes include collection and aggregation of the data from each of their clusters and transmitting these aggregated data to the base station. This data aggregation in the head nodes results in great reduction in the energy consumption in the network. The less the energy consumption, the more the network lifetime. The main idea of developing cluster-based routing protocols is to reduce the network traffic towards the destination. This method of clustering may introduce overhead due to the cluster configuration, but it has also been identified that the cluster based protocols exhibit efficient energy utilization and performance when compared to network topologies for large scale WSNs. This approach of clustering offers several benefits over other routing protocols.

2.3. Advantages of clustering nodes includes

- Manageable Network Size: In clustering techniques, sensor nodes are organized in different groups. Head of groups deals with base station for transmitting data signals. Every nodes need not to contact base station directly. Thus, Base station is receiving message packets from less number of nodes as compared to other categories of routing protocol.
- Balanced Load Distribution: Due to division of network in different cluster, the overall work is divided that helps to divide the energy consumption among all the nodes. In at routing,the nodes situated far from base station dies first to node as compared to node nearby base station due to more energy consumption. Through clustering all the nodes has assigned work to accomplish.
- Data Fusion/ Aggregation: In clustering method, following particular hierarchy, nodes send the data signals to next level. At cluster head, data is either aggregated to reduce the amount of redundant data signals or fused to combine data signals in single packet. This process saves lot of bandwidth of communication channel.
- Stable Network Lifetime: By load distribution among several nodes, network can maintain network lifetime for longer duration. As each node consumes some amount of energy in each round, that minimizes the possibility of death of nodes of particular area. In these type of algorithms, if network becomes nonfunctional then it includes death of nodes from most of the part of the network after number of rounds of algorithm. Stability of network can be maintained for longer duration comparing from other types of algorithms.
- Collision Prevention: In sensor network with a model of communication, multiple nodes have to send message to base station at same time that can result in collision of packets. On the other hand, clustering technique uses unique spreading factor method or any other method to prevent clashes.

3. Proposed Modeling

In the architecture the different colour indicates different nodes, the list is as mentioned below.

Green : Indicates Sensor node.

Red : Indicates source node in cluster 1

Orange : Source node in cluster 2

Blue : Source node in cluster 3

Green : Source node in cluster 4

Pink : Source node in cluster 5

Black : Destination nodes in each cluster.

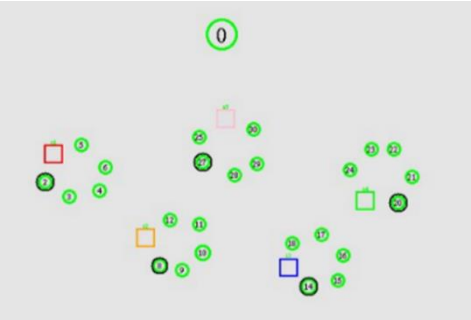

Figure.3 the clustered network of WSN

In the architecture shown in Fig.3 there are 30 sensor nodes named from 1-30. the zeroth sensor node indicates the base station, the main aim of base station is to collect the data from each of the switch node.

3.1. The steps to Design the Wireless Sensor Network

The design is done using the NS2 tool.

Step 1: The first step is to design the network with the selected number of sensor nodes each node is designed with specific energy in joules.

Step 2: with minimum of 5-6 sensor nodes will make it as a one cluster. Similarly five more clusters are created which is collection of sensor nodes.

Step 3: In each cluster node one node will be made as a source node by giving highest energy and other one will be made as a destination node, the same will be repeated for all the five clusters.

Step 4: Initially the hello packet transmission is performed to determine the connection between the nodes. Its the user choice to make the connection between the nodes. The user can select any sensor nodes eg. 1-2, 2-4, 3-5. and also from one cluster to another 6-7,7-9 in this way the user can able to connect the sensor nodes.

Step 5: Once all the sensor nodes are connected carefully it will start to transmit the data within the cluster, and it is dine by using the distance formula..

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

The source node will determine the distance within the cluster and which nodes has a very less distance to the source node will be made as destination node, and the source node will send or transmit the data only to that node which has a less distance.

The distance will be determined by taking source node value x1,y1 and any other node in the cluster x2,y2 the same procedure will be done for all the five clusters. Hence the destination node will be determined.

Step 6 : The next step is to determine the switch node. In each cluster any one node will be made as a switch node, the job of a switch node is to collect the data from the entire sensor nodes in that particular cluster. Hence transmitting the data to the base station. In the research work the switch node is named in each of the cluster for the better understanding purpose.

Step 7: Once the switch node is determined the aim of the switch is node is to collect the data from all the sensor nodes in the network and once it collects the data it will transmit the same to the base station.

This is done for all the clusters in the entire network. Finally all the transmitted data will be present at the base station. These are the basic steps that are done in this work. The user will be allowed to encrypt the data at the source end and decrypt the data at the destination end.During the run time the energy level in each sensor node will be varying, and the sensor node which has the highest energy as well as lowest energy can be seen.

3.2. Transmission between source node and base station

It's necessary to analyze the energy consumption while transmitting the data from source node to base station without any intermediate transmission. The main aim is to conserve the energy in the network. Instead of transmitting the data from source node to destination node and then transmitting it ti switch node and making it to transmit to the base station, here the data can be directly sent from source node to base station in one way, it will avoid more energy consumption and also traffic can be avoided since the data is transmitted directly to the base station.

Another advantage is the life time of the network can also be improved, since much of the nodes will not involve in any kind of transmission. The destination node can be used only when it is required otherwise direct transmission from source to base station will be the better way to conserve the energy usage.

3.3. Finding the switch node in the cluster

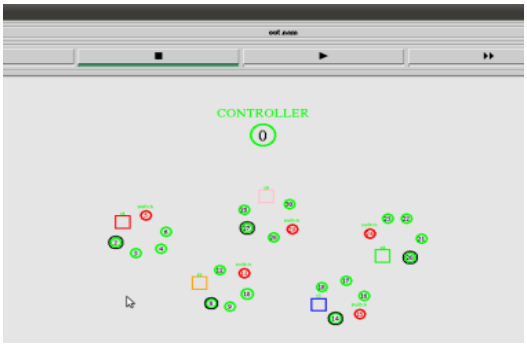

Figure. 4 The simulation results for identifying the switch node in each cluster

It is necessary to identify the switch node in each of the cluster for transmitting the data collected to the base station.

For the better understanding purpose it is marked in red colour, the function of the switch node is to collect the data from each of the sensor nodes with in the cluster and ultimately the data collected has to be dent to the base station for the further application. The architecture is as shown in the Figure.4

3.4. Energy Conservation in sensor nodes

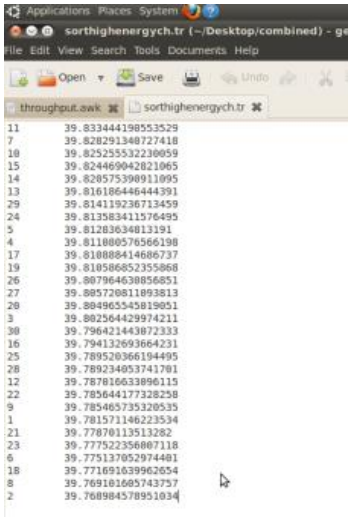

Figure.5. the simulation results of energy Conservation in sensor nodes

The obtained results shows that how much energy is conserved in each of the senor nodes and depending on it's easy to identify that which node has consumed more energy and which node has consumed less energy, Figure 5. shows the list of sensor nodes along with their energy consumption.

This shows that the senor node eleven has consumed more energy and sensor node two has consumed less energy.

4. RESULTS AND DISCUSSIONS

The output of the simulation results can be analyzed with different graphs they are,

- Bit Error Rate
- Control Overhead
- Through-put
- Packet Delivery Ratio

4.1. Bit Error Rate

It is the rate at which the error has caused in the network and it can be measured using the formula.

$$BER = 1/(2*SNR) \quad \ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

The performance of any network or the digital receiver systems can be analyzed with BER.In any digital transmission system the number of bit errors is the number of received bits of data stream over a communication channel that have been altered due to noise, interference,distortion or bit synchronization errors as shown in Figure.6

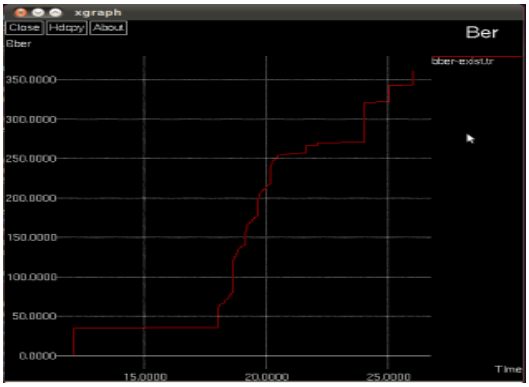

Figure.6. The simulation graph of Bit Error Rate

4.2. Control-Overhead

The network needs to convey control information (Protocol information) about this state to the controller so that the controller can make efficient decisions. Thus there is a trade-off in the amount of control information sent to the controller (as overhead) and the performance of the network control algorithms as shown in Figure.7

Figure.7. The simulation graph of Control overhead

4.3. Packet Delivery Ratio

It defines the ratio of the number of packets sent by the source node and the number of packets received by the destination node. The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out out by the sender.

The graph mentioned in Figure.8. shows ratio of the number of packets that are received at the destination node to the total number of packets sent at the source node.

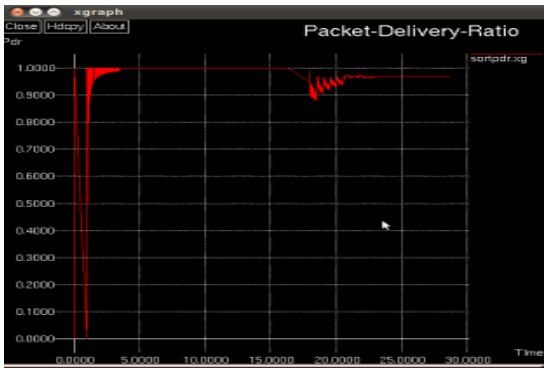

Figure.8. The simulation graph of Packet Delivery ratio

4.4. Throughput

In data transmission network throughput is the amount of data moved successfully from one place to another in a given period. The throughput of any communication link is measured in bits per second (bits/sec), kilobits per second (kbit/s). The graph shown in the Figure.9 gives the obtained throughput for the designed network.

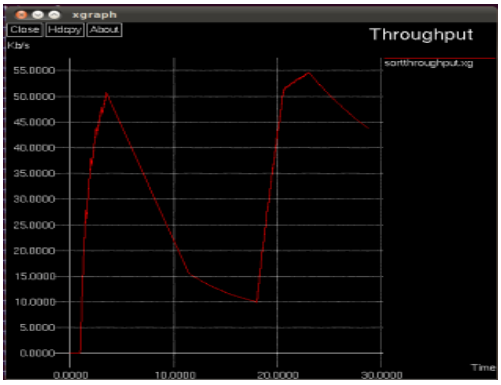

Figure.9. The simulation graph of Throughput

5. CONCLUSION

This paper looked at challenges experienced in design of WSN's as well as making critical analysis as to which node has to be made as source and destination nodes. In this paper it's also given the idea of how to select the destination node and when it is useful, and also two different ways of transmitting the data within the network, and analyzing which one is better for the purpose of energy consumption.

REFERENCES.

[1] C. Namesh and D.B. Ramakrishna "Analysis of vbf protocol underwater sensor network for star and moving nodes," *Internation Journal of Computer Networks an Applications*, vol. 2, no. 1, pp. 20– 2 2015.

[2] Paul T. Congdon, Prasant Malhotra Matthew and Venkatesh Akella simultaneously reducing latenc and power consumption openflow switches, "*IEEEIAC Transactions on Networking, vol.2 pp. 1007-1019,2014.*

[3] R.Mitra, D. Nandy, "A Survey o Clustering Techniques for Wireless Sensor Network", Int. J. of Resear in Computer Science Vol. 2 Issue (2012), pp. 51-57.

[4] M. Younis, M. Youssef, K. Arish "Energyaware management in cluster based sensor networks", Comput Networks, 43 (5), (2003), pp. 64 668.

[5] A. A. Abbasi, M. Younis, "A surv on clustering algorithms for wireless sensor networks," Comput Communications, vol. 30, no. 14- 1 (2007), pp. 2826–2841.

[6] K. Akkaya, M. Younis, "A survey o routing protocols for wireless sens networks," Ad Hoc Networks, vol. no. 39, (2005), pp. 325–349

[7] Carlos J. Bernardos, Antonio De La Oliva, Pablo Serrano, Albert Banchs, Luis M. Contreras, Hao Jin, and Juan Carlos Zuniga , "An Architecture For Software Defined Wireless Networking," *IEEE Wireless Communications*, vol. 21 , pp. 52-61 ,2014

[8] Chee-Yee Chong, and SrikantaP .Kumar, "*Sensor Networks: Evolution, Opportunities, and Challenges," Proceedings of IEEE*, vol. 91, pp. 1247 -1255, 2013.

[9] Alejandro De Gante , and Mohamed Asian , and Ashraf Matrawy , " Smart Wireless Sensor Network Management on Software- Defmed Networking," *27th IEEE Biennial Symposium on QBSC* , pp . 71-75, 2014.

[10] Claude Chaudet, and Y oram Haddad, "Wireless Software Defined Networks: Challenges, Oppurtunities," *IEEE international Conference on COMCAS*, pp. 1-5,2013.