Clock Synchronization Approach for Wireless Sensor Networks to Increase Network Lifetime

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Abstract-The wireless sensor networks is the type of network which is used to sense the environmental conditions like temperature, pressure etc. This type of network is generally deployed on the far places like oceans, forests and deserts in such places it is very difficult to recharge or replace battery of these sensor nodes. To reduce energy consumption of these sensor nodes various techniques has been applied so far. In this work, further enhancement will be proposed in RFID protocol for clock synchronization. The enhancement will be based on RTS and CTS packets, in this technique cluster head nodes send RTS packets. The sensor nodes receive RTS packet and revert back with CTS packets are synchronization their clocks. The proposed technique has been implemented in simulated environmental conditions. The graphical results show that proposed technique performs batter than LEACH, RFID protocol in terms of throughput, energy and packetloss in the network.

Keywords-Clock Synchronization; RFID; LEACH.

I. INTRODUCTION

The recent enhancements made in the technology involving wireless sensor networks has provided great innovations within the applications that involve it such as the mechanical monitoring, traffic monitoring, cropping, etc. advance creative and productive thoughts are to be generated within this area such that their usage can be more helpful [1]. In the information routing, compression as well as network aggregation, various analyzed methods have been introduced in the recent years. There are numerous nodes deployed within specific area in a wireless sensor network. These nodes are deployed in order to monitor the surrounding area of those nodes. In order to provide communication amongst the nodes present in the network, the sensor hub is present in the network, which consists of sensors, actuators, memory and processor. In order to transmit the data through sensor nodes utilizing radio frequencies, infrared, and so on [2]. There is no wired connection present within these networks. A random fashion is set across the nodes and the messages are transferred which thus provides an ad-hoc network environment within the networks. The battery present within the nodes of WSN is of smaller size. In addition, the nodes are located at far distances where human is not able to reach [3]. Therefore, the major concern within the WSNs is the usage of battery within them. This also affects the overall lifetime of the nodes and thus the deployment of the network. The sizes of various constraints such as battery size, processors, information-storing memory and so on are important within these networks. The consumption of energy is required to be advanced within the networks with the help of various optimization algorithms. Various time constraints are present within the detected and routing information sent across the WSNs. Before any alterations, the network can utilize the information. For communicating the information across the network, the energy consumed is more as compared to the other executions [4]. Thus, it is very important to address the energy conservation issue in the WSNs. The clustering method is used in order to save the energy available within the sensor nodes. Each of the nodes present within the network can be divided into several smaller groups, which are known as clusters with the help of productive network organization. A cluster head is present within each cluster along with all other individual nodes [7]. A two-level order is provided within the clustering method. The cluster heads shape accommodates the higher level here. The second part involves the nodes of these networks. The nodes are grouped into clusters through the clustering process. The cluster head is chosen here periodically in such a manner that all the other nodes can communicate with it as per their requirement. The data that is gathered from the numerous nodes by the cluster head which is further passed to the base station by it [5]. The utilized cluster head and cluster formation are two principle criteria for classifications that have been utilized by different clustering algorithm to select cluster head in wireless sensor networks. Probabilistic (random or hybrid) clustering algorithms include Low Energy Adaptive Clustering Hierarchy (LEACH), Energy-Efficient Hierarchical Clustering (EEHC), Hybrid Energy-Efficient Distributed Clustering (HEED), etc. The radio frequency based contactless automatic identification expertise is known as Radio Frequency Identification (RFID). The active and passive RFID are the two sources of power in RFID and out of two uses of passive RFID gives more advantages than active RFID in terms of

size, battery management, tag cost, etc. To store or detect physical information for a long time RFID is produced that add fundamental function and enhance the nature of framework [6]. In order to cover the target area, the networks are organized with numerous nodes. A common task is to be accomplished by the nodes which are done with the help of communication amongst these nodes. MAC layer finds out the way in which access is controlled in the communication channel, an important function in case of WSN where the physical medium is accessed by several number of sensor nodes. In order to design the MAC protocols for WSN, there is an efficient usage of less amount of energy. There was an involvement of stable energy resources along with the robust hardware and software in order to design a system that can be deployed for many years which is a major challenge. This requires the energy of the nodes to be available in huge scale, which is usually not possible [7]. A channel access method that is involved within the shared-medium networks is known as the Time-Division Multiple Access (TDMA). Similar frequency channel partitioned the signal into various time slots, which can further be utilized by multiple users at similar time duration. This results in rapid transmission of data in continuous manner in which every user uses its own particular time slot. The same transmission medium shares multiple stations, which only utilizes a part of the complete capacity of the channel.

II. LITERATURE REVIEW

Yang Liu, et.al (2018) presented for the optimization of the throughput, power consumption and energy efficiency they consider the joint pre-coder design. They devolved algorithms which are based on both centralized and decentralized ways in order to increase the throughput. The formulation of the issue is done by the centralized algorithm as it provides a new second order cone programming (SOCP). This method is different from the existing methods and can be utilized to apply in more generic systems [8]. They proposed an optimal decentralized solution and analyses its union as all the existing solution in the previous methods are based upon the centralized system. They also provide the conditions, which are sufficient for the validation of the decentralized method.

Xu Lu, et al. (2018), proposed a new technique to minimize the energy consumed in wireless sensor networks. This technique is known as Square partition- based node scheduling algorithm. As WSN helps in solving the issues of nodes in IoT and scheduling of nodes is an important method to improve the energy efficiency in the network. In this, author has used a unused energy model to analyze the passive nodes' energy consumption [9]. A clustering technique proposed to consider the radii of sensing and communicating nodes. The proposed algorithm of the author is proved better than the previous one in terms of coverage and connectivity rates. Both are maximum than the previous techniques.

Abdelbari Ben Yagouta, et.al (2017) proposed a study for wireless sensor networks in which comparison between the sink at different locations and mobility patterns was performed. This examination was done to determine the impacts of mobility on energy consumption and QoS metrics. For this purpose they used the routing protocol which is based on the LEACH cluster having different scenarios and conditions. As per simulation result, it is demonstrated that energy consumption rate in the network is reduced due to mobility of sink that provide result similar to centered sink. In the application of WSN, it improves the throughput even in the condition of high density and high packet rate [10]. It also increase the latency time of the packets as well as improve reliability but it does not increase the nodes density or the application rate of packets.

Jie Huang, et.al (2017) has analyzed and researched a multi-cluster-head based clustering routing algorithm. They studied this algorithm so that energy consumption rate in the wireless sensor network balances its rate. This method is also useful in maximizing the lifetime of the network and stability [11]. This paper discussed the model of energy consumption rate in WSN. For the multi-cluster-head based clustering routing algorithm they studied the structure of network topological and method for realization. As per performed simulation and analysis, it is demonstrated that reduction on energy consumption by various nodes is obtained with the help of this proposed algorithm. This algorithm maximizes the network lifetime as well as provides the stability to the wireless sensor network.

H.Oudani, et.al (2017) presented the major issues faced by the wireless sensor network i.e. energy saving. Each node plays its own role in the transmission of periodic to the sink [12]. They also developed various hierarchical protocols so that present network traffic toward the sink is reduced to greater extent due to which lifetime of the network increases. They presented a new approach which is the advancement of clustering LEACH protocols. As per simulation results, it is demonstrated that the network lifetime of the network can be extended up to 45% as this proposed approach minimizes the rate of the energy consumption and improves the lifetime of the network. In future, this work can be improved so that increases all the aspects of the sensor networks.

M. Benaddy, et.al (2017) presented applications of wireless senor network in almost every field. Reliable data collection and attainment of results is the main requirement of this application. Various techniques so far are proposed by many researchers in this area for the reliability of WSN such as

retransmission or redundancy or multipath routing protocols. They proposed an algorithm in this paper for the reliability of transmitted data in the wireless network [13].The proposed algorithm has used multipath principle. It also focused on the energy consumption constraints based on which each node is separated from other node according to the distance between the nodes. The proposed algorithm is implemented and simulated for the evaluation purpose and the calculation of performance and also compared with other algorithms in order to check the efficiency of this method.

III. RESEARCH METHODOLOGY

The wireless sensor nodes are the part of the microelectronic device in which there is limited energy. It is not possible to replace energy resources all the time as its recharge and replacement procedure is not easy in some application area. Hence, the lifetime of the sensor node is solely dependent on the lifetime of battery. There is chance of network damage increases if the sensor node expires due to limited battery due to which it becomes impossible to collect the data of the particular area such as temperature, humidity etc. Clock timings of sensor nodes are not synchronized in the present work. The mismatching of timing occur the collision of packets. Due to which there is packet loss as packets are unable to reach their destination. The whole working of the sensor network without synchronous of sensor nodes is shown by the figure 1. This picture depicts the source by the two nodes and two destinations in which same path is followed for the transfer of data. The data is sent by the Cluster1'ssource tocluster4'sdestination and to the cluster2'sdestination data is send by cluster3'ssource. Therefore, between the clocks synchronous there is no sensor nodes present.

The data is send by the cluster 1's andcluster2'ssource to their respective cluster heads. On the basis of routes, the data to next cluster head is forwarded by their cluster head. Same route is followed by both sources in order to transfer their data. There is collision of data packets to each other when the data from both sources arrives to the cluster 2's head.

IV. EXPERIMENTAL RESULTS

The proposed work is implemented in NS2 and the results are evaluated by making comparisons against proposed and existing approaches in terms of several parameters.

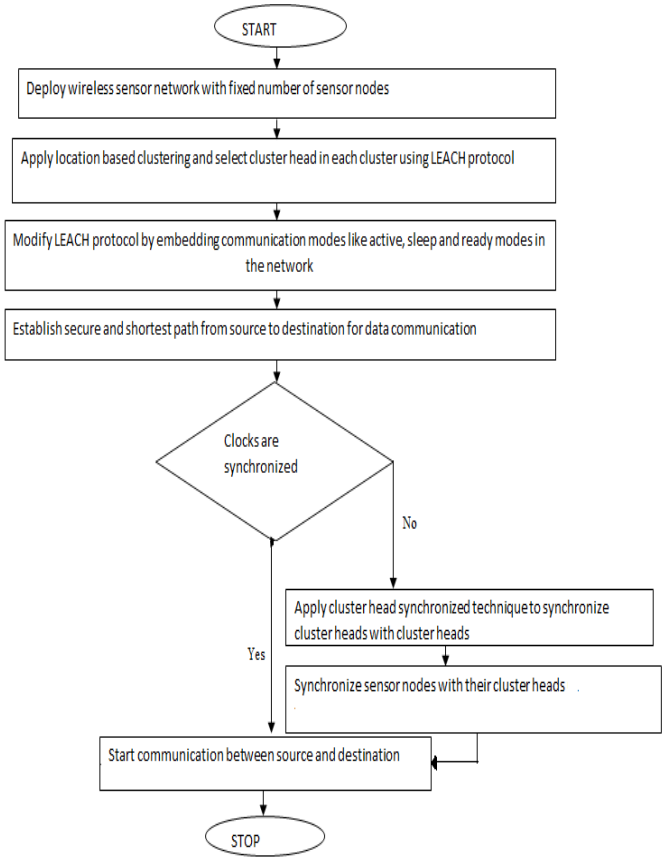


Fig.1: Proposed Flowchart

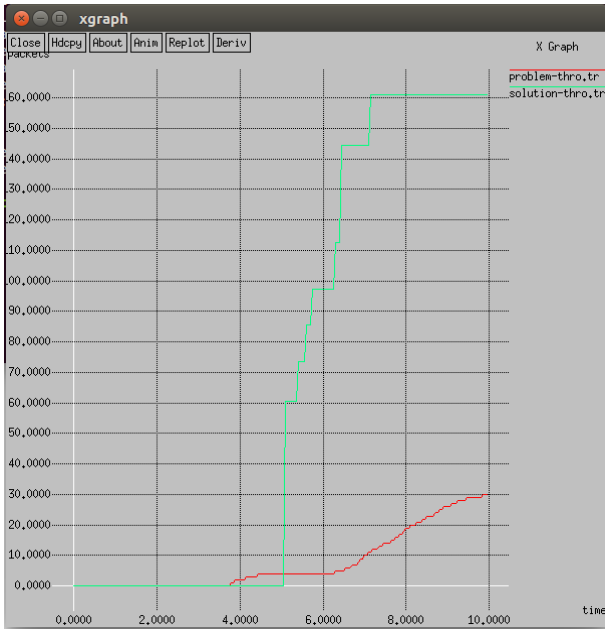
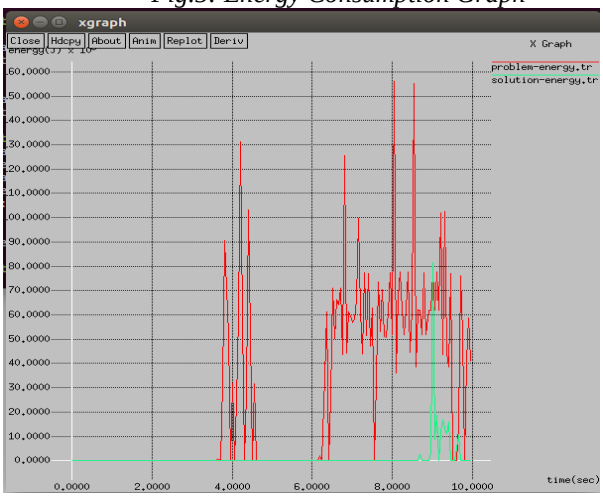


Fig.2: Comparison based on throughput

Figure 2 shows the throughput graph. Comparison between new and previous technique is shown in the figure. Proposed work throughput is shown here by the green line and previous work is shown with the red line. Throughput in the modified work is more as there is synchronization between nodes and no packet loss. Throughput is measured in terms of packet sent per second.

Fig.5: Energy Consumption Graph



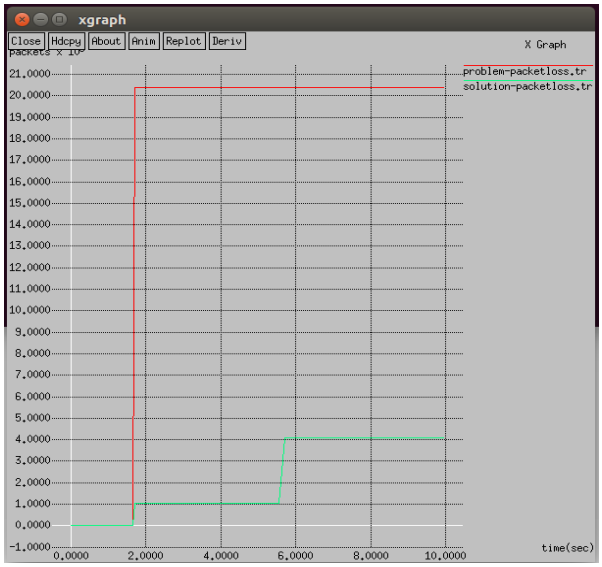


Fig.3:Comparison based on packet loss

Figure 3 is for the packet loss in the system. Green line is for the packet loss in the proposed work and red line shows the packet loss in the existing technique. Packet loss decreases because in the modified technique, clock synchronization technique is implied which reduces the collision and hence packet loss. Packet loss decreases from 19000 to 4000.

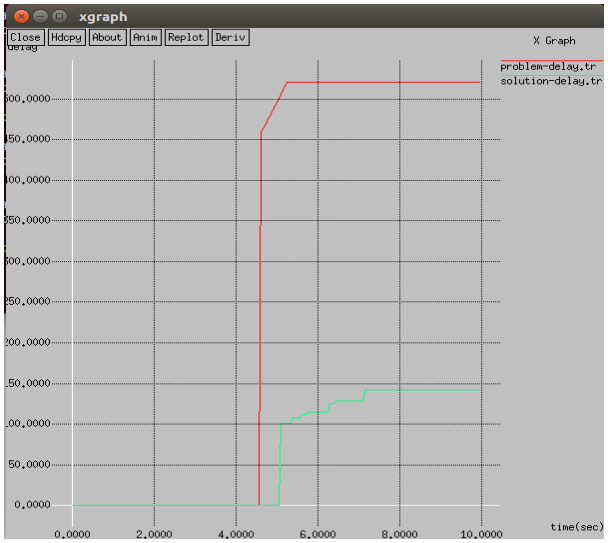


Fig.4: Delay Graph

Figure 4 shows the results in the delay. Green line shows the delay in the proposed work and red line shows the delay in existing method. Delay in proposed work decreases from 525 to 125(approx.). It is because of synchronization.

Figure 5 shows the energy consumption in the system. Red line shows the energy consumption in the existing work and green line shows the energy consumption in the modified or proposed work. The energy consumption in the modified method is reduced, because synchronization is done with time lay technique.

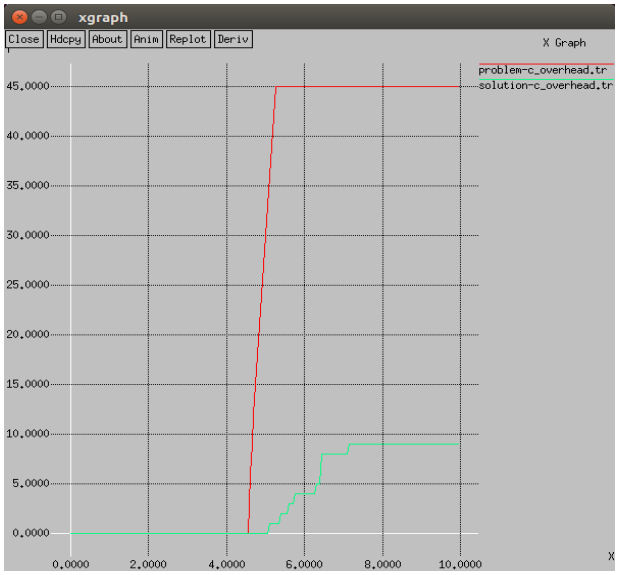


Fig.6: Overhead Graph

Figure 6 show the overhead results. Green line denotes the overhead in the proposed work which is less as compared to the existing methodology which is due to synchronization between the nodes. Packet loss decreases and hence message overhead.

V. CONCLUSION

Wireless sensor network is collection of many small power devices named as sensor nodes that are randomly deployed in the sensor network at various locations or sometimes at remote locations. Then there comes a problem in this method. There is weak synchronization between the nodes in the network. Due to which nodes timing mismatch and packet loss occurs in the system. So, in proposed work, a clock synchronization technique is applied which match the timing of every node with each other. Cluster head match their timings with each other and to the base station. In this way, synchronization achieved. Then, process is implemented in NS2 and results are compared based on the factors such as throughput, packet loss, delay, and energy consumption, overhead. Results showed that proposed techniques are better than the existing technique in terms of above given factors. Hence, energy consumption is reduced and network lifetime is increased.

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