Clock Synchronization Technique for Wireless Sensor Networks

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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. In this work, further enhancement will be proposed in RFID protocol for clock synchronization. In the proposed improvement the clocks of the sensor nodes will be synchronized on the basis of time lay technique. When the time of the cluster head gets mismatched then the cluster head will adjust its clock according to the sink node timing and sensor nodes. The proposed technique has been implemented in simulated environmental conditions. The graphical results show that proposed technique performs better than previous protocol in terms of throughput, delay, overhead, energy consumption and packet loss in the network.*

Keywords- Clock Synchronization , WSN, Energy Efficiency.

I. INTRODUCTION

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. 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. It is not possible for a hub to communicate with the other hubs through any direct links [1]. The range is out of reach and the information thus to be transferred is passed with the help of various nodes that lie within the path in the network. This process is known as multi-hoping communication. For processing requests across the network, various nodes co-ordinate with each other and transfer the data to each other. There is a shared communication provided within the network and so they are not concentrated. One can add as well as remove the nodes within the network in the wireless sensor networks. This can also provide various changes to be made within the network topology. A hub within the network that gathers all the important information is known as sink [2]. Within the time constraints, the information can be utilized for certain purposes by exchanging the particular information with the outside world with the help of internet. 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. 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 [3]. 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. Thus, it is very important to address the energy conservation issue in the WSNs. The major issue that arises within the wireless sensor networks is the limited amount of lifetime of a battery of nodes present within the network. There are very limited constraints of size of battery, processors, and memory present within the sensor nodes of the network due to their small sizes [4]. Thus, the major concern here is to upgrade the amount of energy being consumed by these networks. In order to provide solution to this problem, regular time constraints are provided within the network such that the data that is gathered can be transmitted to the destination such that it can be utilized prior to any hazard. There is higher consumption of power due to the communication of data within these networks in comparison the processing occurring in these networks. Thus, there is a need to address such issue. Node failure can occur due to the absence of power within these networks. A reliable service is to be provided within this network by keeping in mind the objective, which is to be achieved. With the help of making adjustment, the network can act naturally as well here. From time to time, various adaptable properties are to be provided within this network [5]. Due to constrain provided in battery life, failure might occur within these nodes. In order to handle such failure and ensure that the operations are performed, the network protocols are to be provided within these networks. 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 [6]. 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 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. In this phase of LEACH protocol every node portrays without considering the current round need to wind up a cluster head. The decision is made by picking a random 0 or 1 number by every nodes present in a network. The node quality is compared with threshold that has been setup and if its quality is less than that of threshold quality then that node will be considered as cluster head.

II. LITERATURE REVIEW

Emad Alnawafa and Ion Marghescu (2017) Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is considered as one of the most important protocols that are frequently used in the Wireless Sensor Network (WSN). Many protocols were developed to modify and improve the LEACH protocol. The multi-hop technique (MHTLEACH) is one of these protocols, which appeared to improve the performance of the LEACH protocol. In this paper, an improved multi-hope technique (IMHT-LEACH) is proposed. Instead of distributing all the Cluster Heads (CHs) into two levels as in the MHT-LEACH, the IMHT-LEACH distributes all the CHs into a number of levels. It suggests a new technique to route the data to the Base Station (BS) through the levels. Simulation results indicate that the IMHT-LEACH improves the lifetime, stability and throughput of the WSN comparing with the conventional LEACH and the MHT-LEACH protocols.

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 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 affected the issues of the throughput maximization, consumption of power and EE problems. They also developed a decentralized algorithm whose main concept is based upon the dual-decomposition and block successive upper-bound method in order to optimize these two metrics. These two runs in parallel as it provides the semi analytical solutions and also have strong convergence. 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. A clustering technique proposed to consider the radii of sensing and communicating nodes. After this coverage of nodes is considered in this so that less coverage is used in node scheduling. 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. 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. It also increases 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. There is no significant difference in the gain of energy as energy consumed by the sink during communication is limited to 5% of the nodes mass. The growth in the density of nodes or packets rate leads to packet collision due to which there is decrease in packets latency time.

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. This network is divided into multiple clusters, where cluster is used as basic unit. Each divided part contain cluster head as main, node assistant of cluster head and node management cluster and various other nodes. 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.

Saving of energy is very important in the networks so that rate of energy consumption is decreased. The major challenges faced by this network are the increase in the lifetime of the network and energy efficiency improvement. 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 such as medical applications, environmental monitoring, battlefield applications, transportation, emergency conditions, security applications and many more. 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. 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

In the infinite sensor nodes, the sensor network is deployed initially. In the clusters all the sensor nodes are grouped together. These clusters are formed on the basis of the sensor nodes. A cluster head is present within each cluster and for the selection of these cluster heads an election algorithm is used. The node with more resources and energy is selected within the cluster for cluster head. All these nodes transfer their data to cluster heads after which the data is further forwarded to their destinations by the cluster head. AODV routing protocol discovered the route for transmission and also establish the path between source and destination. The virtual paths mean dynamic paths have been discovered by the AODV routing protocol. The synchronization of sensor nodes is necessary with cluster head so that packet collision remains minimum in the network. There is a sink available at the network. After that, there are clusters having cluster head and node in it. First of all, the message is send by the one cluster head to the sink. After receiving message sink will minus transmission delay from the message and calculate its current time. At the end, to the same cluster head message is send by the sink. Now again this cluster head will minus transmission delay from the message and calculate its time. Now we have final delay that is transmission delay of sink– transmission delay of cluster head. Finally, cluster head will set its clock according to the current timing after deducting delay. This process will continue until all the cluster head gets the similar clock. Same process will be applicable to the clock synchronization between cluster head and node in a cluster. First, cluster head sends clock message to the sink for synchronization. Then, sink sends message to cluster head. After receiving message from sink cluster head will minus its delay from the message. For the final clock timing cluster head will calculate final delay and deduct it from the timing. The remaining time will the final time for clock setting. All the other nodes also set their clock by sending message to the cluster head first. Cluster head will calculate time by deducting transmission delay and send message back to node. Now node will calculate time by deducting transmission delay from the message. Again calculate final delay and minus it from the current time. The remaining time will be final time and node sets its clock according to it.

The synchronization of cluster head is done in the first step and the sensor nodes will be synchronized within the cluster in the second step. The RTS packets are transferred by the cluster head within the network to all cluster heads in the initial stage. The clocks are represented by the cluster heads when it receives the RTS packets. After which CTS packets to sink is transferred by the cluster head. The clocks are adjusted by the cluster head after sending CTS packets to sink node. On the basis of time it receive the RTS packet from SINK, the clocks are adjusted. The cluster heads when gets synchronized, then cluster head will send PING messages to all the sensor nodes which are in their cluster. After receiving, PING messages sensor nodes will adjust its clocks according to time when it receive PING messages from the cluster heads. The whole network is synchronized in this manner, no packet loss happens, and energy will be less consumed by this.

ALGORITHM

1.Base station :
2.broadcast (Sync_start, level=0)
3.if receive (Sync_req) then
4. send (Sync_ack , T1, T2, T3)
5.Neighbour cluster nodes :
6.receive (Sync_start , level)
7.if (level = null) then

8.level++;
9.wait a short random time ;
10.send (Sync_req, level, T1) ;
11.receive(Sync_ack);
12.1record (T1, T2, T3, T4);
13. 1d = ((T2 -T1) - (T4 -T3)) / 2;
14. calculate (d,)
15.Sync(d,)1
16.Broadcast(Sync_start,node=0)
17.If node(reciver Sync)
18.Clusterhead send(ping)
19.If(Node receive Ping)
20.Send(Ack)
21.Wait for random time2
22.Node record(d and d1)
23. IF(d1==d)
24.Node adjust its clock to d2
25.Else
26.Reply with Ok message

IV. EXPERIMENTAL RESULTS

The proposed technique has been implemented in NS2 and the results are evaluated by making comparisons of proposed approach with existing in terms of various parameters like throughput, delay, packet loss, energy consumption and overhead.

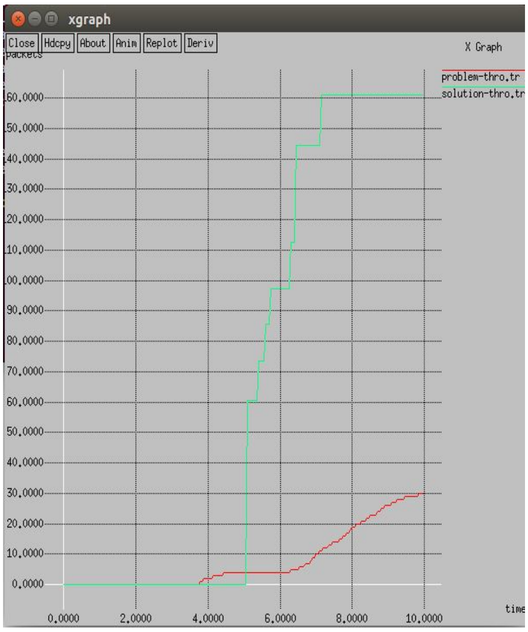

Figure 1:Comparison based on throughput

Figure1 shows the throughput graph. Comparison between new and previous technique is shown in the figure. Proposed work throughput is shown here by the red line and previous work is shown with the green 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.

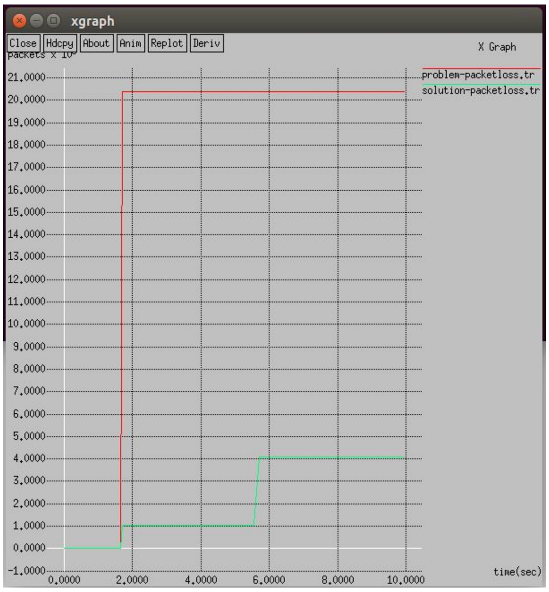

Figure 2: Comparison based on packet loss

Figure 2 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 decrease from 19000 to 4000.

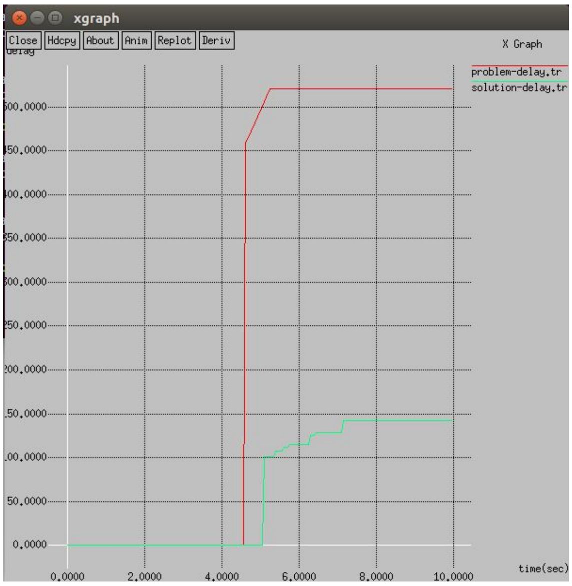

Figure 3: Delay Graph

Figure 3 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.

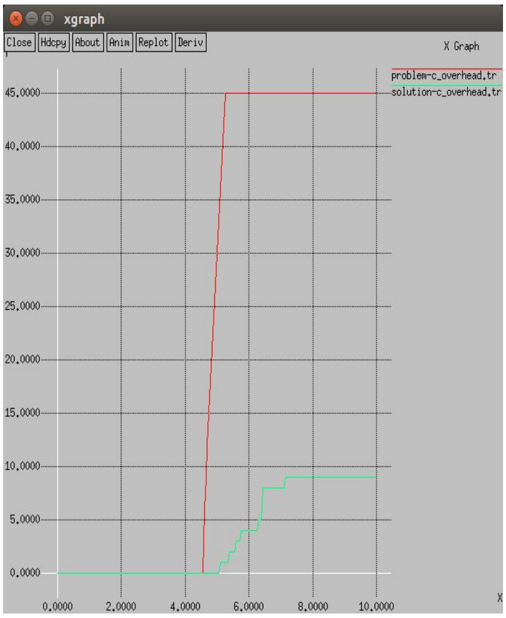

Figure 4: Overhead Graph

Figure 4 shows 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.

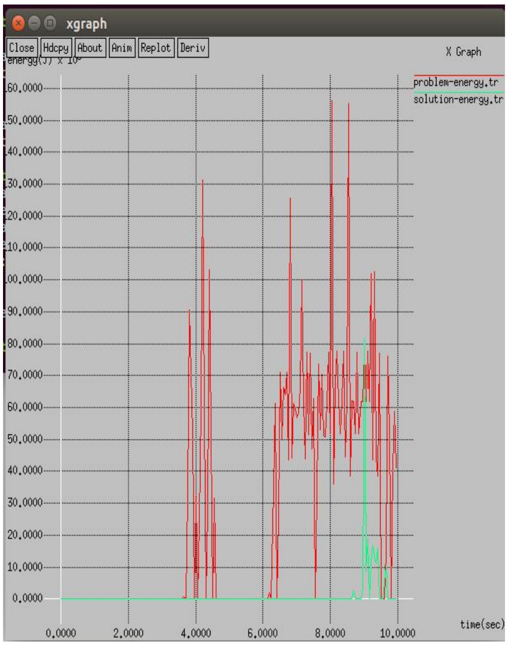

Figure 5: Energy Consumption Graph

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.

V. CONCLUSION

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, energy consumption, overhead .Results showed that proposed techniques is 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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