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A Technique To Improve MAC In WSN With Clock Synchronization

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Abstract— The wireless sensor network 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 sensor nodes various techniques has been applied so far. Among these, one is by using LEACH protocol used for clustering in which cluster heads are selected on the basis of distance and energy. Then various modes are applied on this protocol such as active, sleep and ready mode. Nodes will go into the sleep, active and ready based on the priority of request for the channel access. The main problem exists in this is of clock synchronization due to which packet loss happened in the network which reduce network performance. In this paper, further enhancement will be proposed in the existing protocol by synchronizing the clocks of sensor nodes based on time lay technique. Then the proposed technique will be implemented in simulated in NS2. The graphical result will show that proposed technique performs better than existing protocol in terms of throughput, packet loss, energy, overhead, delay.

Keywords—Wireless Sensor Network (WSN), Clock synchronization , energy consumption

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. Various methods have been analyzed till now for data aggregation, data compression and data routing. [1]

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 among the nodes present in the network, the sensor hub is present in the network, which consists of sensors, actuators, memory and processor. There is no wired connection present within the network. Data is transmitted through wireless channel or medium, which can be of radiofrequencies, infrared and so on. A random fashion is set across the nodes and the messages are transferred which thus provides an ad-hoc network environment.

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. 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.[3]

II. RELATED WORK

Yang Liu, et.al (2018) presented an algorithm for the optimization of the throughput, power consumption and energy efficiency in which they consider the joint pre-coder design. Multiple access channels are more coherent than the multi-antenna wireless sensor networks. 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 [38].

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 an unused energy model to analyze the passive nodes' energy consumption. [39]A clustering technique proposed to consider the radii of sensing and communicating nodes.

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 [41]. This paper discussed the model of energy consumption rate in WSN.

Sarath Pattahthil, et al. (2017) have considered the problem of optimal distributed scheduling for delay minimization. They did focus on static scheduling policies where the CSMA channel access rates are determined by the long- run traffic statistics, but not the instantaneous queue states. In case of heterogeneous traffic flow, such kind of static scheduling is preferable over the max- weight like dynamic scheduling. In this paper, the authors have formulated the problem of optimizing the channel access rates of different links subject to an upper bound on the access rate of each link. [44]

Bakhsh, et al. (2017) proposed a new technique which adjust the sleep time of nodes dynamically to increase the energy efficiency. It reduced the idle listening, increase the sleep time and reduced the collision. Author proposed a protocol which allots the time slots to the nodes according to the priority of request sent by the nodes. When a request is sent by the node or communication is going on between two nodes and any other intermediate node comes in between then it will wait till the transmission time of first nodes finishes. The value of transmission time is stores in a NAV field, and when the value of NAV reaches to 0, it assumes that the transmission time of node finishes. So after this nodes having highest priority in the request queue or waiting queue will immediately starts its communication.[45]

Dayong Y, et. Al (2017) presented a strategy to enhance the energy efficiency in the sensor network by using the sleep/wake approach. It is the most fundamental approach to save the energy of the nodes. As the sensor nodes have less battery lifetime and the battery of nodes are not rechargeable so there must be a mechanism to reduce the power consumption or to manage the power of the sensor nodes.[46] Duty cycling mechanisms causes tradeoffs between delay and energy consumption, throughput etc.

K. Praghash, et.al (2017) presented cluster head can be defined by which different functions can be performed in order to secure the sections of the networks using clusters. One node is helped by other node in transferring data, if nodes are unable to transfer the data to sink directly. It is possible to insert resource-rich nodes within the network. For instance, for the process of filtering they have more processing power in order to store or logs authenticated data or they can also use larger communication range for this purpose [47]. Better performance can be achieved by wireless sensor network with the help of sleeping nodes that increases network's lifetime, better latency, and reliability.

III. PROBLEM FORMULATION

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. Each node in the multi-hop ad hoc sensor network has played the dual role of data creator and data router. There are significant topological changes due to the malfunctioning of a few nodes and it also requires packets rerouting and the network reorganization.

Clustering is one of the techniques proposed specifically for energy saving. With the help of this clustering, the clusters are formed by taking various sensor nodes in a single cluster. The selection of the clusters is done periodically so that it becomes easy for clusters members to communicate with their cluster heads. The received data from its members is transferred by the clusters to the base station. For this purpose multi clustering can be utilized. In order to balance the energy, it is required to rotate the cluster head after which there will be equal load on every node. It also leads to reduction in the energy consumption.
Within the clusters, the whole network is distributed according to present work. The routing algorithm of the Ad- Hoc On Demand Distance Vector (AODV) is utilized in order to establish communication among the clusters heads. The data is transferred by the all the cluster members to the cluster head and after which it is forwarded to other clusters by cluster head until the data do not reach its destination. There is fixed path between the cluster head within the whole network. There is no change in the path until the battery of sensor nodes exhaust or die. Intermediate nodes die earlier than other nodes in some of cases due to which, there is breakdown of path between the source and destination. Hence, there is increase in the packet loss due to the breakdown of path, as packets do not

reach at the destination. The whole network becomes useless if there is increase of packet retransmission. Therefore, to complete the communication a new network is configured. In order to establish and configure the new network, it is required to have the cluster head and clusters which consume energy and time due to which sometime communication is not completed.

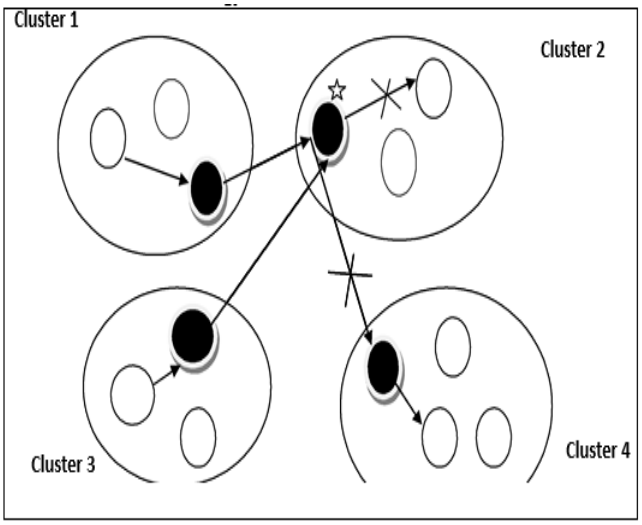

Fig 1. A network without synchronous nodes and packet collision

In the existing work , nodes are put into three different modes based on their requests sent by them to the cluster head or to the base station. In this a node has four states IDLE, GRANT, REQUEST and RELEASE. When a node A wants to transmit data to node B then it sends a Request to node B. If node B is free at that and not communicating with other nodes then it allocate the resources to the node A. If in between another node C also sends a request to node B then node B replies C with a WAIT message and then the node c will wait in the wait queue. Similarly, it works for all other nodes. In this way when the transmission time of node A will finish then the node in the waiting queue, which has the highest priority, will immediately slots its schedule. In this way, all other nodes that are not sending requests to the any other node, they are put into sleep mode and nodes that are transmitting data are in the ready mode and all other nodes are in active mode.

IV. PROPOSED WORK

Firstly we deploy the sensor network with infinite sensor nodes. All the sensor nodes are grouped into clusters. Each cluster has a cluster head. Cluster heads are chooses by election algorithm. A node in a cluster which has more resources and energy is selected as cluster head. For transmission, route is discovered by AODV routing protocol. All the sensor nodes are categorized as sleep and active nodes based on the priority of request sent by them. All nodes will be synchronized with cluster head by using a time lay technique to avoid the packet collision. Two steps will be taken to synchronize the clocks of the nodes. In the first step, only cluster head will be synchronized and in second step sensor nodes in the cluster are synchronized.

ALGORITHM:

1. Base station :
2. broadcast (Sync_start, level=0)
3. **If** receive (Sync_req) **then**
4. send (Sync_ack , T1, T2, T3)
5. **End if**
6. Neighbour cluster nodes :
7. receive (Sync_start , level)
8. **if** (level = null) **then**
9. level++;
10. wait a short random time ;
11. send (Sync_req, level, T1) ;
12. **if**receive(Sync_ack)**then**
13. record (T1, T2, T3, T4);
14. d = ((T2 -T1) - (T4 -T3)) / 2;
15. calculate (d)
16. Sync(d); **Endif; Endif;**
17. Broadcast(Sync_start,node=0)
18. **If** node(reciver Sync)**then**
19. Clusterhead send(ping)
20. **If**(Node receive Ping)**then**
21. Send(Ack)
22. Wait for random time
23. Node record(d and d1)
24. **if**(d1==d)**then**
25. Node adjust its clock to d
26. **Else**
27. Reply with Ok message; **endif; endif;**

V. RESULTS AND DISCUSSION

Table 4.1 Simulation Parameters used in the implementation

Parameter	Description
Channel	Wireless
Number of nodes	100
Area	200*200(m)
Initial Energy	100(joules)
Network Interface Type	Phy/WirelessPhy
Interface Queue type	Droptail/PriQueue
Routing Protocol	AODV
Antenna Type	Omni
Topology	Random

A. Throughput

Figure 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.

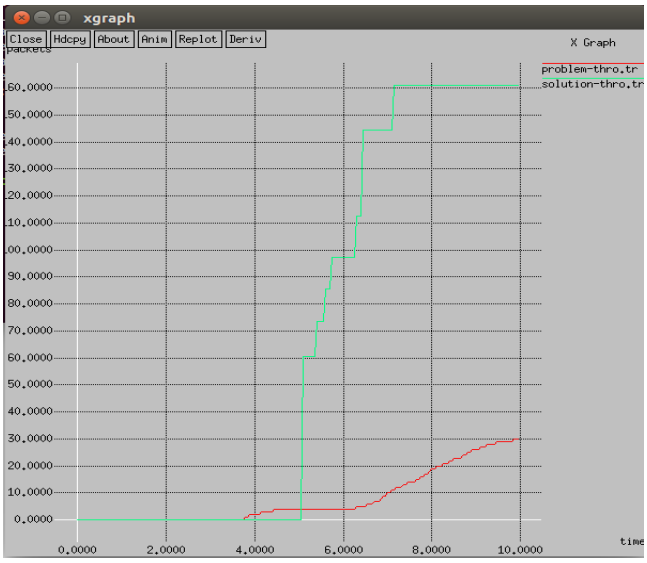

Fig 2.Comparison based on throughput

B. Packet loss

Figure 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 20000 to 4000.

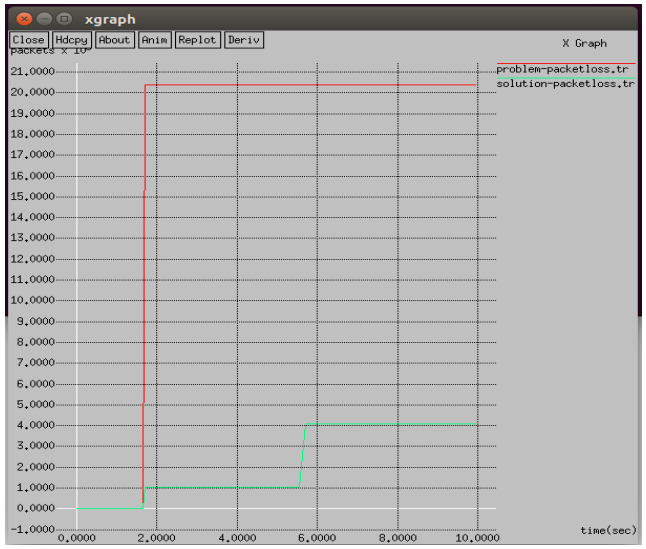

Fig 3. Comparison based on packet loss

C. Delay

Figure 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 550 to 140(approx.). It is because of synchronization. When there is clock synchronization between all the nodes in the network than packet loss is minimized. It reduces the overall energy consumption. Packets are not delayed because in case of packet loss, some packets needs to be retransmitted. Due to this, all other packets are delayed. Here delay factor is compare in terms of packets.

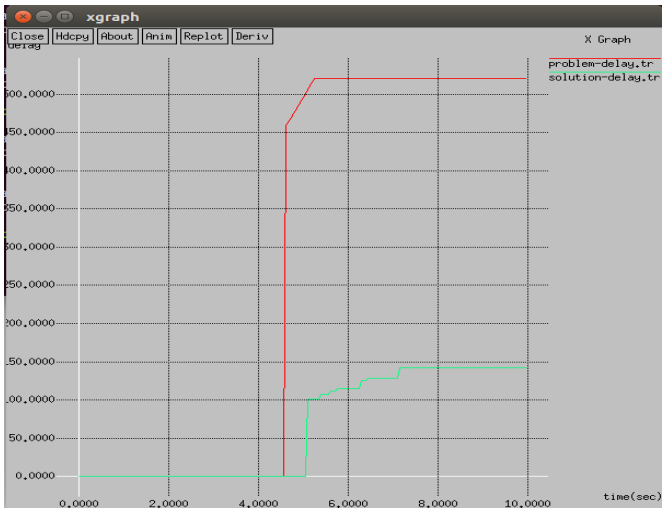

Fig 4.Comparison based on delay

D. Energy Consumption

Figure 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.

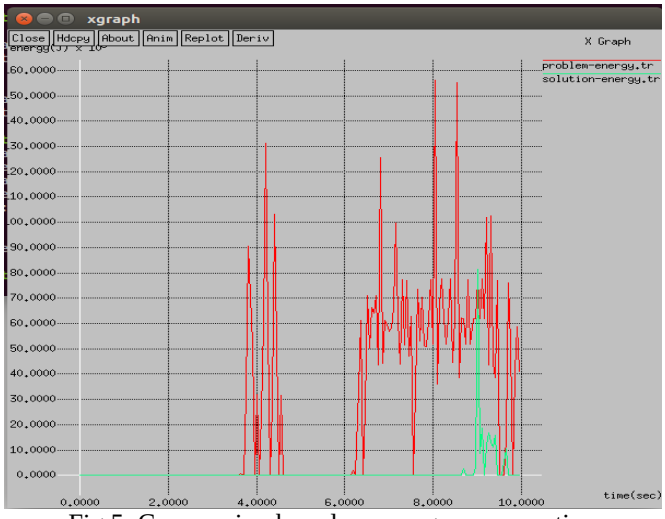

Fig 5. Comparsion based on energy consumption

E. Overhead

Figure 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. When there is synchronization between the nodes then packet loss decreases and it reduces the

energy consumption. Hence, overhead is also decreased because no need to transmit any extra packet when all nodes are synchronized with each other. Overhead in the existing algorithm is 45 and in the proposed algorithm is reduced to 12.

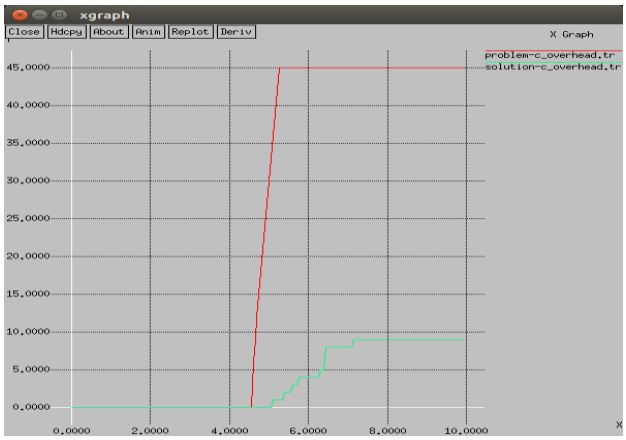

Fig 6. Comparison based on overhead

VI. CONCLUSION AND FUTURE SCOPE

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. These small devices have very low power. It will take more energy to in sensing the data in network and then transferring the data to base station leads to decrease in the lifetime of the network. Various methods have been developed till now to save the energy. One is clustering. But there is a problem in clustering method that is weak synchronization between the nodes. So, in proposed work , a clock synchronization technique is applied which match the timing of every node with each other. Cluster head match their timing with each other and to the base station. In this way, synchronization achieved. Results showed that proposed technique is better than existing technique in terms of packet loss, delay, energy consumption, throughput, overhead. The proposed can be compared with other techniques of clock synchronization in future and can show that they can achieve better result. The proposed technique can be enhanced to increase the security in the wireless sensor network.

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