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DESIGNING A GATEWAY FOR ISOLATED NODES USING WIRELESS SENSOR NETWORK

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ABSTRACT

Data delivery is important in wireless sensor network applications. To reduce the probability of wireless sensor network disconnection from user a lower energy consumption gateway must be used, but data delivery speed should be maintained as high as possible. So this paper is to compare and analyze the common approach to build a gateway for isolated nodes using WSN.A new cluster based protocols EREAC-IN is used to maximize the network lifetime with less energy consumption.Isolated nodes are transferring the data to the cluster head while communicating with the CH it will lose some data's and also it consumes more energy. In clustering protocols, nodes will be isolated because of the improper designed algorithms. This is the main drawback for all clustering based protocols. So develop a gateway between the two different networks and transfer the data for isolated nodes from source to sink. More specifically, in simulation the resulting communication maximizes the data rate achieved by the network, reducing energy consumption, Minimizing delay, Load balancing, Stable, Secure and improving lifetime. Then it is also revealed in the performance of the different algorithms

Keywords: sensor networks, energy consumption, EREAC-IN, gateway, isolated nodes.

1. INTRODUCTION

In a distinctive wireless sensor network (WSN), sensor nodes consist of communicating, sensing and data processing components [1]. Sensor can be used in various applications such as military, industrial, and agricultural applications, such as environmental monitoring, smart offices, and battlefield scrutiny [2]. Here sensors are deployed in an ad-hoc manner. Energy consumption and lifetime is the most critical problem in the WSN. Several energy efficient relaying schemes have been designed for WSN [3]. Clustering is predominantly useful for relay based sensor networks and it requires hundreds of thousands of nodes. Actually a cluster comprises a cluster head (CH) with cluster members [4] in Figure-1. CH is responsible for coordinating the nodes inside their cluster and periodically transmits the data. During periodic re-clustering, nodes have high residual energy and it can served as a CHs. Lifetime of the network is expanded using the performance of data aggregation, and it involves combining the data from source nodes, and make data transmission to be more energy sufficient [5]. But, these clustering algorithms reveal disadvantages, such as additional overhead is takes place during CH selection and assignment [6]. Researchers proposed several cluster-based protocols in recent years which are intend to maximize the network lifetime [7]. Low Energy Adaptive Clustering Hierarchy (LEACH) is a self organizing adaptive protocol. It uses a distributed clustering structure algorithm. In LEACH, CHs are preferred based on a prearranged probability and other nodes are choosing a cluster to join by estimating which CHs is closest. In LEACH, CHs can be overloaded and causing the network load balance, thus it consuming more energy than other nodes [8]. The authors proposed Hybrid Energy-Efficient Distributed clustering (HEED). It uses a combined approach for energy and communication cost to generate the CHs [9]. It prevents two nodes within the same transmission range to CHs because energy is uniformly distributed to all the nodes. Additionally, the probability of CH selection is bendy, providing inter-CH connectivity within a transmission range [10]. In HEED, every node must communicate frequently with its neighboring nodes. Thus, extra communication costs are required. Therefore, HEED is inappropriate for large scale WSNs [11]. Distributed Energy Efficient Clustering (DEEC) is also a clustering-based algorithm in which the CHs are selected based on the possibility of the ratio of the residual energy to the normal energy of the network [12]. It estimates the ideal value of network lifetime. Therefore, each node is not required to have general knowledge of the network. The main drawback of DEEC is overhead involved in the network [13]. Moreover, the average energy of the network cannot exactly represent the state of the regional network [14]. Regional energy-aware clustering method (REAC) based on this concept of LEACH; REAC enables each node to consume energy uniformly by revolving the CH [15]. It selects the CHs based on the threshold concerning the residual energy of each sensor. The regional average energy of all sensors in each cluster to try to equally distribute the CHs [16].Improperly designed distributed clustering algorithms can cause the nodes to become isolated from the CHs. Such nodes will communicate with thesink by consuming a more amount of energy because the isolated node sent its data to a CH node with more energy and thus its lifetime is very less in the sink [17].

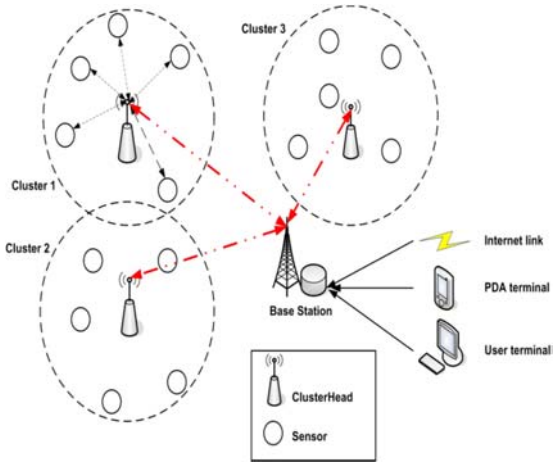


Figure-1. Cluster head formation.

In this paper a new energy aware clustering method is used called Enhanced regional energy aware clustering for isolated nodes (EREAC-IN) based on REAC approach [18].The rest of the paper is organized as follows. Section II presents clustering and its algorithms. Section III presents prelude information, including the problem explanation. Section IV describes the proposed method. Section V provides performance criteria used in EREAC-IN algorithm. Section VI provides simulations results by comparing EREAC-IN with existing schemes, and a concise conclusion in Section VII.

2. CLUSTERING

Wireless sensor network does not have ability for recharging the battery of node; it should find the technique by which this can prolong the life time of wsn [19]. Group of sensor nodes in a proper way is called clustering, in this different clustering algorithms has been used. By applying better clustering technique we can prolong the network life time of WSNs [20]. There are some algorithms for clustering in WSNs is used. Different algorithms have different and different scheme for making clusters and then it choosing cluster head [21]. It has minimal number of clusters and proper cluster heads in each cluster. A CH may be chosen by the sensors in a cluster or pre-assigned by the network. By applying clustering and selecting CH for communication with Base Station, energy of each member node of clusters require direct communication with BS [22]. Because energy dissipation will be more in case of long distance transmission [23]. Advantages of clustering in wireless sensor network are:

- Increase the life time of WSNs.
- Energy dissipation in the network will be minimum.
- Less number of nodes takes part in communication with BS.
- Large numbers of nodes are maintaining easily.
- Resource utilization is more efficient.

A. CLUSTERING ALGORITHIMS

a) Low Energy Adaptive Clustering Hierarchy (LEACH)

It is one of the most well-known clustering algorithms in WSNs is LEACH. It is energy based approach and it is a popular algorithm because of its clarity and efficiency [24]. LEACH protocols are used in WSN to increase the life time of a network and it performs self-organizing and re-clustering. Initially Cluster Head (CH) is selected, this will collects all the data of the cluster member and add own data. So, it suffered from the energy dissipation problem [25].

In LEACH algorithm, the lifetime can be divided into a number of rounds. Each round contains set-up and stable phases [26]. The CHs aggregate the collected data in order to decrease the amount of transmitting data and the consequent energy cost [27]. It provides a balancing of energy usage by random rotation of CH. This protocol makes the WSN to be scalable and robust and finally it reduces the energy dissipation [28].

b) Distributed Energy Efficient Clustering (DEEC)

In DEEC protocol all nodes use the initial and residual energy level to define the cluster heads. It estimates the ideal value of network lifetime to compute the reference energy [29]. DEEC does not require any global knowledge of energy at every election round. But sometimes it performs well in multi-level heterogeneous wireless network [30]. When compared to LEACH, it is having more lifetimes. The cluster head selection is based on the initial residual and average energy of the network [31].

c) Hybrid Energy-Efficient Distributed (HEED)

It is most commonly used clustering algorithm which offers uniform distribution of CH over the network and it considers sensors of residual energy [32]. In HEED two sensors are used as a neighbour sensor used within the power range. The main objectives of HEED is to

- Distribute the energy consumption to prolong the network lifetime.
- To minimize the energy during the cluster head selection phase.
- To Minimize the control overhead of the network.

In this algorithm it consumes more energy and its life time is very less, so it is not suitable for WSN [33].

d) Regional Energy Aware Clustering

Regional energy-aware clustering method REAC is proposed recently. Based on the concept of LEACH, REAC enables its each node to consume more energy uniformly by rotating the CH [34]. It selects the CHs based on the threshold voltage involving in the regional average energy and the residual energy of all sensors [35]. Improperly designed algorithms can cause the nodes to become isolated from Cluster Head. Such nodes will

communicate with thesink by consuming more amount of energy. So this is the main drawback of the algorithm [36].

3. PROBLEM DEFINITION

A. Isolated nodes

Each sensor node in WSN consumes more energy to sense in the environment and it conveys or relay its sensed data to a sink node [37]. In a WSN formed by improperly designed distributed clustering algorithms, nodes may become isolated due to randomly selected CHs, as illustrated in Figure-2.

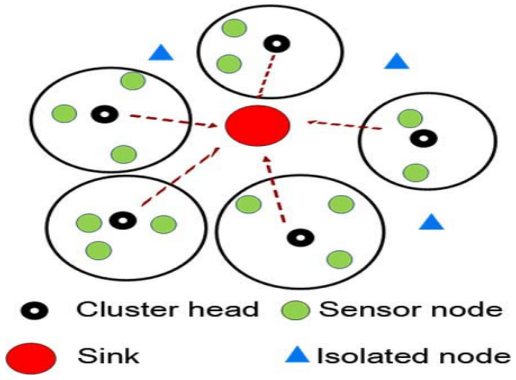


Figure-2.

The energy consumption problem of an isolated node communicating with the sink would become more obvious when the distance between them is fairly far [38]. Even worse, it is vulnerable to drain its energy, resulting in an incomplete sensing coverage. To prolong network lifetime, regional average energy and the distance between sensors and the sink were analyzed to determine whether the isolated node should send its data to a CHnode in the previous round or to the sink [39].

B. Data transmission node

The data transmission method used for isolated nodes canbe determined according to the condition of the cluster head [40]. In this entire transmission node it uses the First Order Radio Model (FORM) as the power consumption model between the transmitter and the receiver, because of this in some algorithms transmission of data is very less it does not reach the sink in proper transmission [41].

C. Global average energy and local average energy

The residual energy distribution of randomly deployed sensor nodes is placed and it is revealed with very uneven. For large-scale networks, the global energy of the network cannot exactly represent the state of the whole network [42]. The original scheme is not consider the regional average energy. A node should consider the energy level of nodes when selecting a CH to save more energy in all the clustering method [43]. Therefore, this study proposes the EREAC-IN scheme to extend the lifetime and energy of WSNs by considering re-electing clusterhead and the regional average energy of the WSN nodes [44].

4. PROPOSED SCHEME

This section presents details on the EREAC-IN protocol. In this protocol, the regional average energy and residual energy of all sensors in each cluster are used to select the Cluster Heads. To avoid the problem of eachnode isolation, the regional average energy and the distances between the sensors and the sink are calculated. To determine the isolated node it should send its data to a Residual energy of randomly deployed sensor nodes. Theproposed scheme is as follows.

A. Cluster head selection algorithm based on multihop-cluster scheme using authentication

Usually in LEACH, HEED, TEEN and in REAC, the cluster-head selection algorithmis divided into many rounds. At each round, each node decides it cluster-head based on the threshold. In each round, each node choose its random number between 0 and 1, if the number is less than a threshold, then the node becomes a cluster-head for the current round. In this multihop cluster scheme algorithm, it initially selects a node which is far away from the base station and near to the cluster nodes in a particular desired region. Then all the nodes are clustered due to the regional distance initially from the base station. Here it used Distance Based Clustering algorithm also to know the distance between the each nodes. Every cluster might have ‘k’ number of node and the total network has N number of nodes and m number of clusters n. The Weighted Based Clustering method is used initially to select any node as a Cluster Head because all the nodes having same weight and same energy level in the Base-Station. Due to data transmissions the nodes will lose its energy and weight because of this problem it use this algorithm. At each time the nodes will communicate with the neighbour nodes, so that every node in the network should be synchronized.

B. Re-electing cluster head

Dynamic selection of cluster head ultimately helps in distributing the load over a subset of nodes in a cluster. This subset of probable nodes can be regarded as nominees for cluster head.

C. Master and slave communication

If two nodes want to communicate, it must undergo some following process: First, the master sets it type of network and the frequency sets the message rate and the channel ID. Secondly, it establishes the channel by transmitting the channel ID with the data in a particular time interval, and the master will provide new data to the ANT protocol for continuous transmission. Thirdly, the slave opens its channel to search a specific master or to search a subset of masters, finally it receives the first message and it selects the type of network, operating frequency, and frame baud rate of the master.

D. Single hop communication using false data injection scheme

Every message is authenticated in a hop-by-hop fashion during its transmission. An unauthorized node cannot inject false data without it being detected. This scheme discusses the security of every node to know the authentic Ids of its upper association and its lower association. A compromised node can provide an authenticated pairwise MAC over any data to deceive its upper association node.

E. K-hop neighbour

The message is forwarded to all sensors that are no more than k-hops away from the cluster head which represents the cluster radius. This forwarding limitation is used to limit the flood of advertisement messages. If a node did not receive any advertisement message within reasonable time duration, it deduces it's any cluster head and hence elects itself as a cluster head node and starts sending advertisement message. After this round, clusters are formed and nodes start sensing data and send these data to the cluster head. The cluster head then sends the data to the base station. After a certain time, the energy of the cluster head node is consumed more than other nodes so we need to change the cluster head node through the short round.

Therefore to prolong the network lifetime, the regional average energy and the distance between sensors and the sink are used to determine whether the isolated node sends its data to a CH node in the previous round or to the sink. The simulation results of the current study exposed that EREAC-IN outperforms other clustering algorithms.

5. PERFORMANCE CRITERIA USED

The parameters or performance metrics is used to study and evaluate the clustering protocols are number of nodes alive, number of data packets received at base station and life time.

- **Number of alive nodes:** The directmeasure reflects the total number of nodes and becauseof that each type has not yet expended their energy.
- **Data Packets received at BS:** It istotal number of data packets or messages that are received by the base station. This measure varieslinearly for all protocols.
- **Life time of node:** By using this algorithm life time of the each node is more, when compared to the other clustering algorithm.
- **Network remaining energy:** The network measures the totalremaining and stable energy of the network. At each transmission round of the protocol, it is calculated.
- **Energy efficiency of a node:** In all the node energy consumption is very low to send the data by using thisalgorithm energy is more efficient.

These parameters used to allow us to conclude the stability period of the network which is the time interval to start the network, and unstable period of the network is used for the time interval from the death of the first node to the death of the last node, More stable in the network having more lifetime of the network and energy.

6. SIMULATION RESULTS

This section describes a performance evaluation of the EREAC-IN protocol using Network Simulator 2(NS2). The parameters used in the simulations are energy consumption, throughput, delay, loss, and source and destination protocol throughput. All schemes select CHs at the same period in the same topology. The performances of schemes proposed in several scheme. In the first scheme, LEACH, the selection of CHs is based on a predestined probability.

In the second scheme, DEEC, CH selection is based on the probability of the ratioof the residual energy to the average energy of the network. In the third scheme, HEED, CHs are selected periodically based on a combination of their residual energy. In the fourth scheme, REAC-IN, CHs are selected according to the regional average energy. In the final scheme,

EREAC-IN, CHsare selected according to the regional average energy, and by using K-hop neighbor, whether the isolated node sends its data to a CH node in the previous round or to the sink directly or not. This compared the proposed EREAC-IN with typical distributed clustering protocols LEACH, HEED,DEEC and REAC by using four performance metrics including the variance of energy level, the number of nodes alive over simulation time, lifetime, number of data received at the sink, and the average lifetime

a) The Figure-3. Shows the node allocation of the clustering protocols. Here it using some 30 nodes and in that it chose the node station from that it transmit the data to the sink because of some clustering problems node will be isolated.

b) The Figure-4 Shows the isolated nodes of the clustering protocols, here some of the nodes are isolated and they are not communicate with other node because of improper designed algorithms.

c) The amount of data received in the sink in Figure-5shows that the amount of data received at the sink is higher in the EREAC-IN protocol than in LEACH, HEED, DEEC and REAC protocols. The result indicates that EREAC-IN can help for data transmission from nodes to the sink (Base Station) in the entire network.

d) The lifetime in Figure-6 shows the average lifetime in simulations. It shows and proves that there is a significant improvement in lifetime by EREAC-IN. The network lifetime in EREAC-IN is longer than other protocols, and can prolong approximately up to 70% of the network lifetime. However, the isolated node problem is also solved so that it can prolong the whole network lifetime.

e) The delay in Figure-7 shows at each node the data can be delayed. In LEACH delay is more when

compared to our proposed method EREAC-IN. This is main thing for the data to be received in the sink.

f) The variance of energy level in Figure-8 shows the comparison between the variance of residual energy distribution produced by the LEACH, REAC protocol and our proposed EREAC-IN protocol. The variance of the energy levels of all the nodes is the measure of the residual energy with global or local average energy. The variance indicates the global average energy of the network and it cannot exactly represent the state of the complete network.

g) The packet loss in Figure-9 shows that the data of each node loss in each packet. When compared to our proposed algorithm LEACH having more loss in each packet. This can be represented by width; if width size is more, more amount of packet loss will happen.

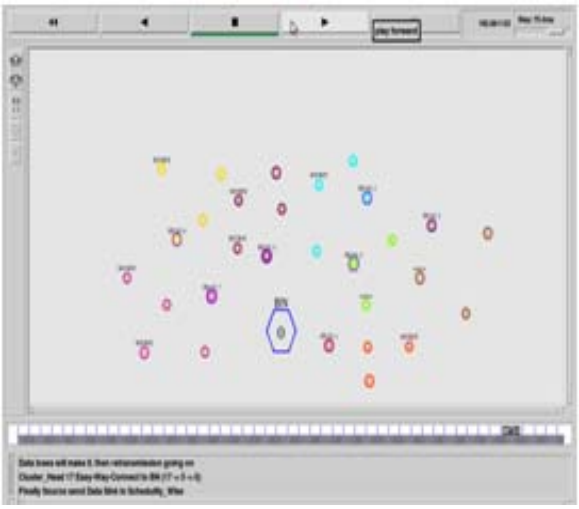
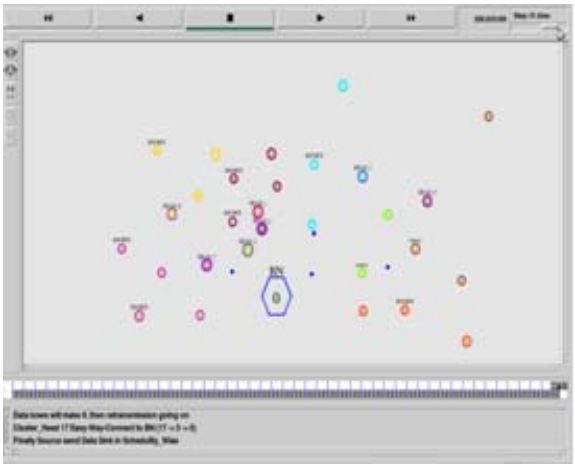


Figure-3. Nodes allocation.



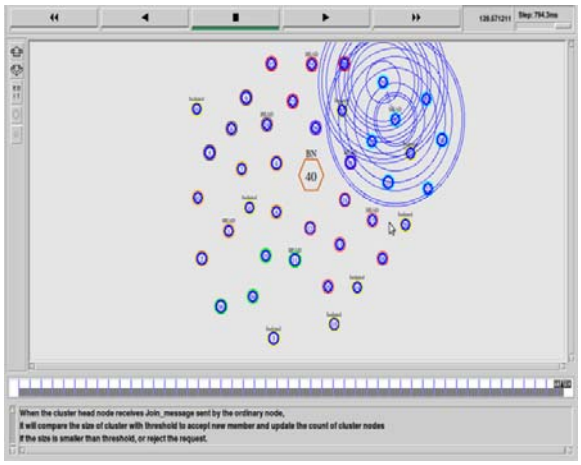


Figure-4. Isolated nodes.

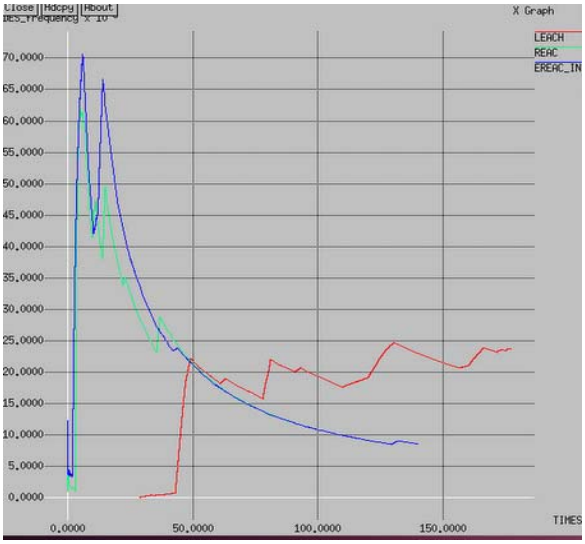


Figure-5. Total number of data received at the sink.

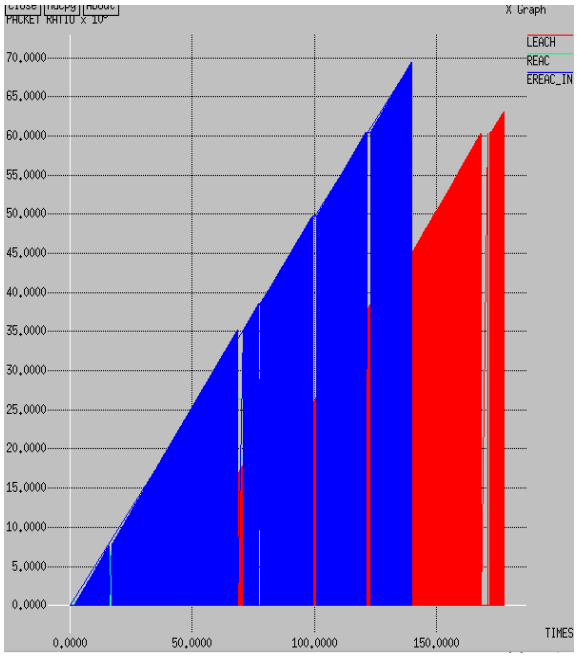


Figure-6. The average lifetime of 40 nodes simulations.

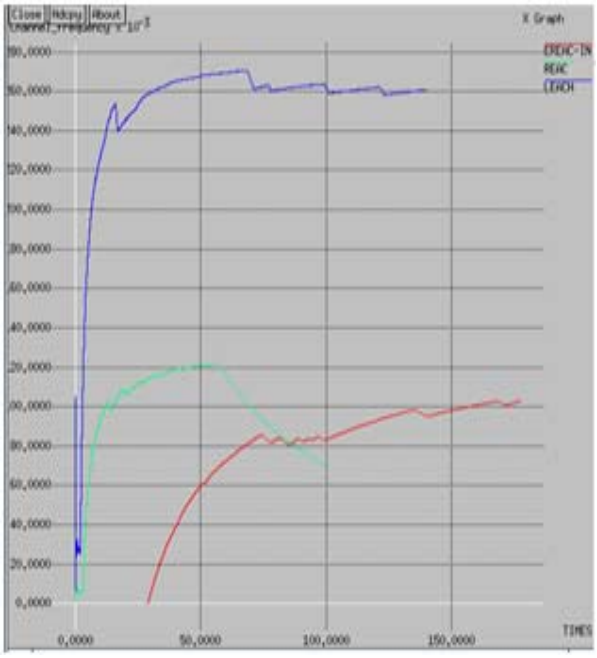


Figure-8. The variance of energy.

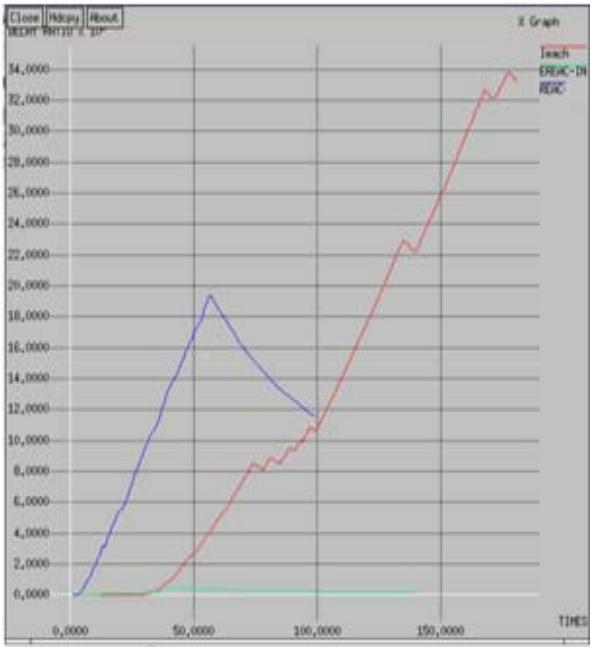


Figure-7. Delay of each node.

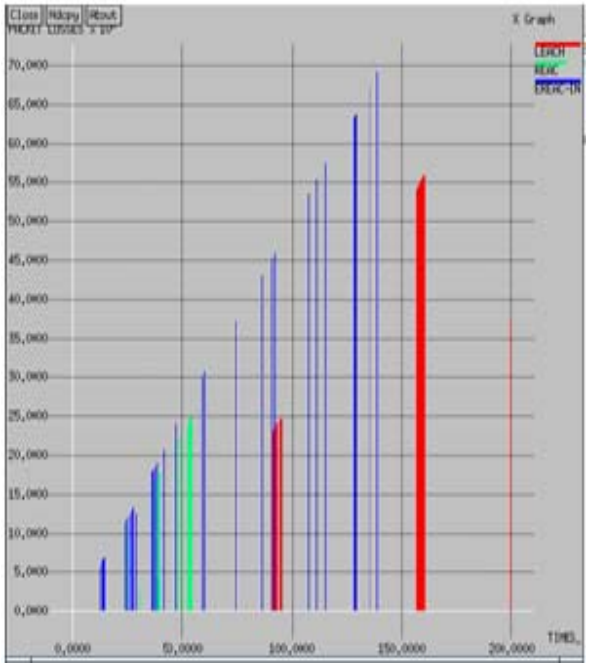


Figure-9. Packet loss.

8. CONCLUSIONS

A WSN is a combination of wireless communication and wireless sensor nodes. The network should be efficient, stable, and have a prolonging lifetime while transferring the data's. The EREAC-IN protocol presented in this paper, it improves the cluster head selection process and solves the problem of node isolation. So for designing a gateway in wsn we can use this EREAC-IN algorithm to solve the isolate node problems.

When compared to all clustering algorithm EREAC-IN have more lifetime of 70%, less delay, more throughput and energy efficient. The simulation results revealed in the performance of the algorithms used in EREAC-IN to improve the lifetime and stability of a network and it is more favorable than that of the other algorithms used in other protocols.

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