Multi-Level Hierarchical Routing Protocol for Wireless Sensor Networks

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Abstract-The wireless sensor networks is the decentralized and self configuring type of network in which senor nodes can sense information and pass it to base station. Due to decentralized nature and far deployment energy consumption is the major issues of wireless sensor networks. In this research work, WEMER protocol is implemented and improved to increase lifetime of wireless sensor networks. In the WEMER protocol, whole network is divided into clusters and cluster heads are selected in each cluster. The leader nodes are also selected in the network which take data from the cluster heads and pass it to base station. In the improvement of WEMER protocol, gateway nodes are deployed in network to increase lifetime of WSN. In the proposed improvement gateway nodes are deployed near to base station which takes data from the leader nodes. The leader nodes take data from the cluster head. The proposed WEMER protocol and WEMER protocol are implemented in MATLAB. The simulation results shows that proposed WEMER protocol has less number of dead nodes, high number of alive nodes, send more number of packets and more remaining energy consumption.

Keywords-*Cache;WEMER; Energy Efficient; LEACH.*

I. INTRODUCTION

The sensor nodes are deployed in the defined area to form the wireless sensor networks which can aggregate the information from the field and transmit it to the sink. The size of sensor node present in the network is very small. Thus, the processing capabilities it provides and the battery available in it is very constraint. According to the changes, the information is collected from the surroundings and then forwarded further by the network. This network has huge computational and processing constraints. Motes are referred to as the small sized computers with the help of which information is collected from all across the region. Motes are deployed today within various industrial applications. Using a group of motes, certain objectives within an application are accomplished by collecting all the information related to the activities being performed in the surroundings [1]. Depending on variety of configurations, motes are connected with each other through inks such that the best performance results can be achieved. In order to perform communication amongst each other, transceivers are used by motes. The deployment of sensor network within an application can include around hundreds to thousands of sensor nodes. However, there are comparatively less numbers of sensor nodes present within the ad hoc networks which do not include any infrastructure. There are several sensor nodes deployed in the region of interest when a WSN is deployed. The sensor nodes are less costly, small in size and also perform multi-functioning. Even when the size of sensor nodes is small, the processing capabilities are performed [2]. Short distance communications are provided by the wireless medium and nodes are gathered together such that a common task can be accomplished. WSNs have few unique characteristics such that they are different from other networks. The sensors deployed within these networks make it possible to monitor or recognize the physical conditions in WSNs. These networks have more benefits in comparison to the conventional wired networks. It is not possible to reduce all the costs and delays occurring within these networks. The deployment of WSNs is done within several regions ranging from military applications to other small range of applications as well [3]. Since the sensor nodes involved within these networks are very less costly and they provide ease of communication, WSNs can be easily deployed within several applications such as in military and civil regions. The WSNs consist of un-attended and un-tethered sensor nodes within them which help in monitoring the surroundings. Within the area of interest, the distribution of these sensor nodes is done and multi-hops are used to transfer such information further. With the help of such deployments, an ad hoc network is created in this manner. The sensor nodes include within them the battery powers which are small in size and irreplaceable or rechargeable. The nodes collect important information which is processed and stored within the sink node or the gateway node which is usually one within the region. An important component of sensor nodes is battery which helps in

performing data acquisition [4]. It is however, not possible to recharge these batteries. The batteries include few energy generating units which are known as photo-voltaic cells within them. Due to the node acquisition the energy of order 1 to 2 J is provided as there are very small sized sensors nodes present in the networks. Thus, there is limited lifetime of a sensor and because of this; the overall performance of network also gets affected. It is very different to perform routing within WSNs as compared to the conventional routing that is performed in fixed networks [5]. As the network does not include any infrastructure, the wireless links provided are unreliable. The routing protocols provide node failures here due to which it is important to save energy in the networks. Several researchers have introduced various routing protocols which have been categorized into various categories. The location-based protocols mainly focus on the information related to the location of sensor nodes. The location of sensor nodes is important to be known by most of the routing protocols such that the distance amongst two particular nodes can be calculated. This mechanism also helps in calculating an estimate of amount of energy that is being consumed by the networks. These types of routing protocols are very different from others as from source to the sink the data is transmitted here. Each source sends the data to the sink in an independent form such that these address-centric protocols can process it [6]. The data that originates from multiple source sensors is aggregated using the data-centric protocols when the transmission is to be performed amongst the source and sink of the network. The amount of energy being saved here is higher as very less amount of transmission from source to sink is needed here. Different researchers have proposed several viewpoints on the basis of which hierarchical clustering in WSN has been evaluated and developed. Clustering is the effective communication protocol used to transmit the sensed data towards sink. This study presents a view over the sample of layered protocols involved within various clusters of sensors. Each cluster includes within it a special node known as cluster head. There are few special activities performed by this cluster head for other nodes of the cluster.

II. LITERATURE REVIEW

RaminYarinezhada, et.al (2018)presented the relationship shared between the sensor nodes and sink node as it forwarded the more traffic loads in the wireless sensor network. To forward the data ahead, it is very important to have knowledge regarding the position of mobile sink [7]. It is possible that the energy being consumed and the delay of network are higher when the sink's position is clearly provided. A new routing algorithm is proposed here depending upon the virtual grid infrastructure as well as the mobile sink. This novel approach also helps in choosing the nodes that are appropriate from the network. It is also ensured that the sink's location is made static. They performed experiments and concluded results shows the effectiveness of the proposed method in terms of performance, energy efficient and compared delay as compared to the other methods.

Ram Murthy Garimella, et.al (2018)presented the wireless sensor network in this paper, in which essential role is played by the energy efficiency. A novel mechanism is proposed here such that any kind of research gaps identified previously can be overcome. In order to apply the energy efficient approaches such that the data can be collected and routing can be performed is done using the Hessian matrix [8]. The novel approach includes within it the multi-variable calculus which can be validated by applying the proposed technique. Several simulations were performed by using this proposed technique. The mathematical design was utilized to be applied in the clustering mechanism. It was seen through the results achieved, that the minimum energy communication design was achieved at the end.

Deepa PUNEETH, et.al (2018)reviewed the study related to some parameters that plays an essential role in the functionality of the wireless sensor network. In order to obtain the energy efficiency and data reliability, a novel approach is proposed [9]. The compromised node (CN) attack is the limitations of these approaches which occur when there are minimum numbers of nodes are compromised. Therefore, to overcome all the above mentioned issues, they proposed another method in this paper using which security against CN attacks is provided. It also provided the data reliability, efficient energy in the network. The split hop AES (SHAES) defined the integration of SRSS and a round-reduced AES cipher which was there main objective. In case when the CN attack is to be validated, this approach is applied such that it can be evaluated in a better way. After achieving the results, comparisons were made which clearly showed the improvement of results.

PeijunZhong, et.al, (2018) studied that increase in demand of WSNs is due to the vast development and emerging technology, it has been utilized it various different fields. They discussed the hot spot problem as the base station is closer to nodes of the network which tend to die earlier than other sensors. Therefore, they introduced the concept of mobile sink node, in order to remove this issue effectively [10]. The nodes of hot spot can be distributed evenly in all direction as the sink node can move along certain trajectories. In detailed, they studied the energy efficient routing method in which multiple mobile sinks was used. In the several clusters the whole network was divided in order to perform various experiments to show the effects of mobile sink on the network lifetime.

Hassan Oudani, et.al (2017)presented the study related to the wireless sensor network and faced issues in this paper in which consumption of more energy leads to decease in the network lifetime. They developed some hierarchical protocols

that lead to reduce in the network traffic toward the sink and also enhance the working capability of network. They utilized the hierarchical cluster-based approach named as LEACHES in order to perform the survey on the energy-efficient [11]. In order to minimize the issue of energy consumption and maximize the lifetime of network sensor, they proposed a new method in this paper. The novel approach designed in this paper is simulated here in MATLAB simulator. The experiments also evaluate the LEACH protocol to test its performance.

NukhetSazak, et.al (2017)presented the network in which sensor nodes are deployed randomly within the network where they can join and leave the network any time due to which significant design issues faced. There are some additional limitations faced by this network such as resource constraints, remote location, limited energy are the reasons due to which functionality of the network is degraded [12]. A novel approach commonly known as ANDM is designed here using which there is improvement in the energy efficiency. The integrated the ANDM with ETDMA and compared this combination with E-TDMA. The obtained results concluded the effectiveness of the proposed method which provides the usage up to 31 % approx. for the optimal energy.

III. RESEARCH METHODOLOGY

Wireless sensor network is the self-configuring and sensor nodes are small in size due to which the energy consumption is the major issue. LEACH is the effective protocol which can improve lifetime of the wireless sensor networks. LEACH works on the concept of clustering which can select the cluster head in each cluster based on distance and energy. This research work is also based on the LEACH protocol. The protocol proposed in this research has the 3-level hierarchy. In this hierarchy the cluster head, leader nodes and gateway nodes are involved for the data aggregation. Following are the 3-phases involved in the aggregation process:

Level 1: Choosing the Cluster head

In this phase, the network is divided into certain clusters and process of cluster head selection is initiated by the base station. The message is passed all across the network which states that an efficient cluster head can be chosen. The distance of one node from the base station is calculated mathematically. The sensor nodes also present their residual energy which play important role in being chosen as cluster head. The radius of each cluster is calculated and the sensor nodes which lie within the radius of the cluster represent that cluster. The number of nodes represent the cluster should be 3 or more than 3. The nodes which are within the cluster should select their cluster head on the basis of residual energy.

Level 2: Choosing the Leader Nodes

In the level 1, the cluster heads are selected in the network to aggregate the data to the base station. Some nodes have least distance to the base station but do not have maximum residual energy. Those nodes have the probability to be selected as leader nodes. The nodes which are not selected as cluster head are the volunteer nodes to be selected as leader nodes. The calculation is performed in the network which defines maximum number of leader nodes in the network and the leader nodes will generate a random number between 0 and 1 and nodes which satisfy the defined condition are selection as leader nodes.

Level 3: Choosing the Gateway node

The gateway selection is the last phase of proposed protocol. Gateway nodes are the extra nodes which are deployed in the network to improve network lifetime. The number of gateway nodes depends upon the size of network. The cluster heads transmit the data to leader nodes. The leader nodes transmit data to gateway nodes. The gateway node forwards this data to the base station. The base station takes data from the nearest gateway node and leader node transmits the data to the nearest gateway node. The distance between the nodes is calculated with the Euclidean distance.

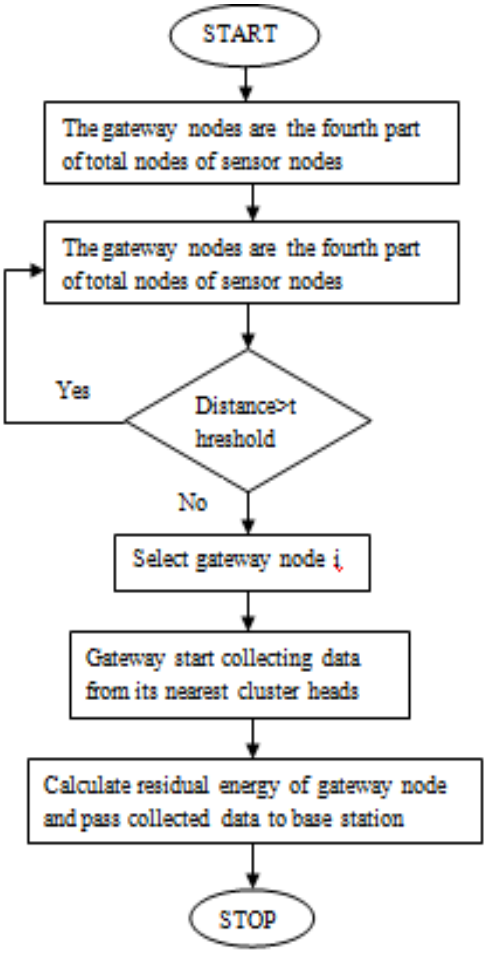

Fig.1: Selection of gateway nodes

IV. EXPERIMENTAL RESULTS

The proposed work is implemented in NS2 and the results are evaluated by making certain comparisons as shown below.

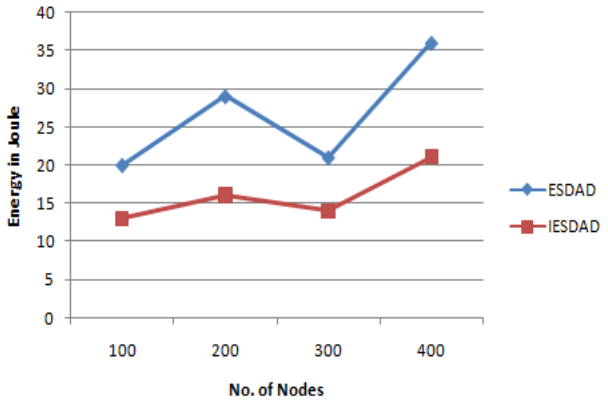

Fig.2 Energy Consumption Comparison

As shown in figure 2, the performance of ESDAD and IESDAD protocol is compared in terms of energy consumption. It is analyzed that energy consumption of IESDAD protocol is low as compared to ESDAD protocol

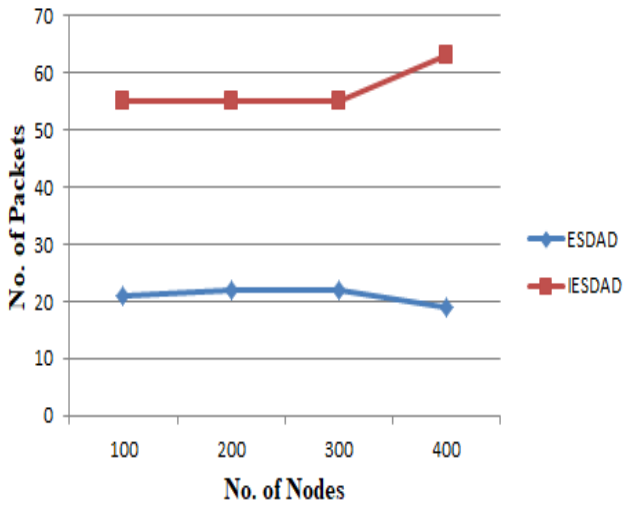

Fig 3 Throughput Comparison

As shown in figure 3, the ESDAD and IESDAD protocols are compared in terms of number of throughput. The throughput of the IESDAD protocol is high as compared to the ESDAD protocol.

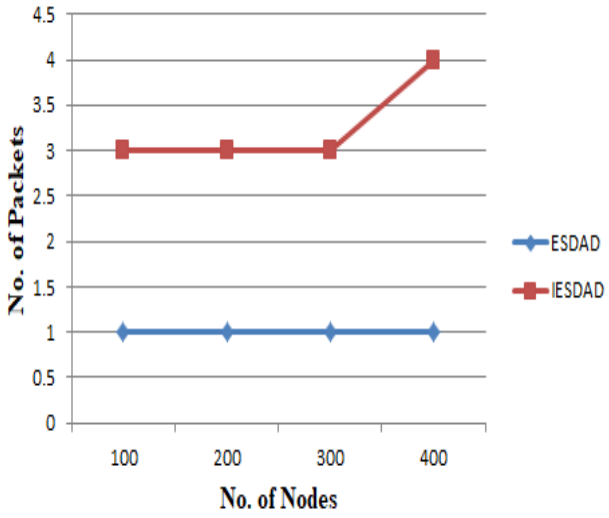

Fig.4 Lifetime comparison

As shown in figure 4, the ESDAD and IESDAD are compared in terms of network lifetime. It is analyzed that IESDAD protocol has higher lifetime as compared to ESDAD.

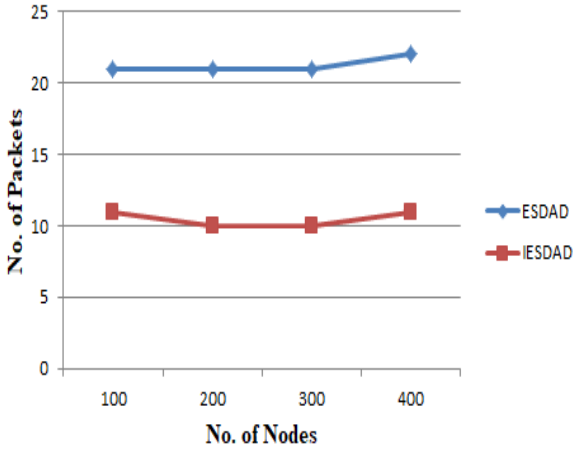

Fig. 5 Packet loss comparison

As shown in figure 5, the packet loss of the ESDAD and IESDAD protocol is compared and it is analyzed that delay of IESDAD protocol is less as compared to ESDAD protocol.

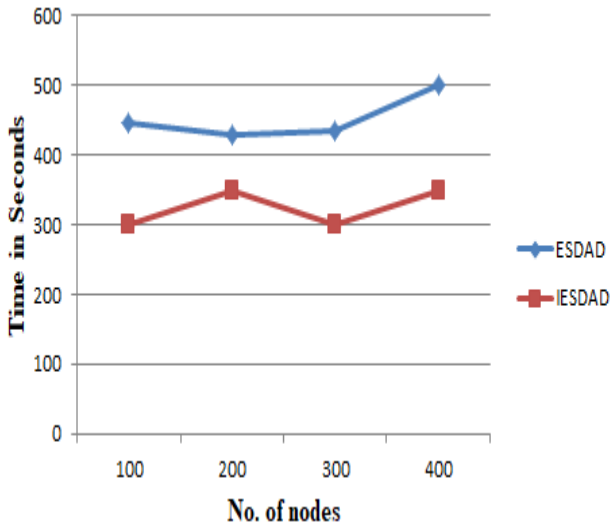

Fig. 6 Delay comparison

As shown in figure 6, the delay of the ESDAD and IESDAD protocol is compared and it is analyzed that delay of IESDAD protocol is less as compared to ESDAD protocol.

V. CONCLUSION

The sensor nodes are used to setup the wireless sensor network which is the decentralized type of network. The energy consumption is the major challenge of wireless sensor network due to its far deployment. The 2-level hierarchical routing protocol is proposed previously to improve lifetime of WSNs. In the 2-level hierarchical routing protocol the cluster heads and leader nodes play important role for data aggregation. In this research work, the WEMER protocol is improved using the gateway nodes. The cluster head send information to leader node which forward information to leader node. The leader node then forward information to gateway node. The proposed protocol is implemented in MATLAB and simulations show up to 20 percent improvement in the results.

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