ENERGY EFFICIENT AWARE ROUTING ALGORITHM BASED ON HIERARCHICAL PROTOCOL FOR IMPROVING NETWORK LIFETIME IN WSN

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ABSTRACT: Wireless Sensor Networks consists of very small nodes, which has the capabilities of sensing, computation power and wireless communication. In Wireless Sensor Network, the energy efficiency is the key design and scalability and energy efficiency as the same time is a big challenging task in Wireless Sensor Network. In order to increase the life time of the wireless sensors nodes many protocols have been designed. Several methods for transmitting data in randomly deployed sensors node have been proposed, which includes direct communication, flat and clustering protocols. But the mechanism of HEAAR for routing in Wireless Sensor Network have been described. It is very crucial to ensure that the system operates and consumes minimum energy meanwhile it should increase the scalability and lifetime of the network. By the introduction of heterogeneity in the sensor nodes, the life-time of the network could be increased. Routing of the sensed data is the one which consumes more energy, hence in order to minimize the energy consumption the routing protocols should be efficient. The design of the protocols should satisfy the requirements of sensor networks that each and every sensor transmits and receives the data depending on the requirements of the node and cluster head. The election of the cluster-head (CH) in each of the cluster depends upon the efficiency of each node and sensing area coverage. HEAAR algorithm which avoids both flooding and periodic updates of routing information but cluster head get information updates when any one of the node fails, and the modification takes place in the cluster. Simulation results and Analysis shows that the proposed HEAAR protocol which improves energy efficiency and increases the life-time for scalable network when these results are compared with the other routing protocols of Wireless Sensor Network.
Keywords: Wireless Sensor Network, Energy Efficiency, Hierarchy-based Anycast Routing, Clustering, Routing Protocol.

I. INTRODUCTION

Wireless Sensor Network are being used everywhere across the world. The wireless technology have been used by each and every person in the world, the wireless technology is now being used in the fields of military, agriculture, industry, navy, medical and many other fields. The wireless sensor technology which are equipped with n number of small-sized sensor nodes these sensor nodes will have the sensors and radio for wireless operation which have been used in several commercial and industrial areas. In wireless sensor network, the energy is the major part the energy of the sensor should be saved, so that the lifetime of the senor node could be increased which in turn increases the life time of the sensor network. In order to decrease the energy consumption of the sensor nodes, many protocols have been proposed like LEACH, PEGASIS, HEAAR and many more. Each of these protocol have their own routing strategy but achieving both routing and saving energy is a big challenging task in the wireless sensor network, and mean while scalability should also be achieved. The designing of the routing strategy is very challenging because sometimes the sensor nodes should be placed where there is no global identification, and with limited energy, memory and computational capacities for each sensor. As it is seen by the study of different protocols, instead of sending and data from the source node to the sink node directly using a single hop, it is better to send the sensed data by using multi-hop method, which in turn increases the reliability and fault tolerance of transmission of the sensed data, the only disadvantage with the multi-hop method is robustness are poor, which results in transmission delay, and energy consumption of each node and reliability of data transmission. When anyone of the sensor node among the family of the cluster fails due to low energy or some other reason, the remaining alive nodes should make sure that the routing should go on normally and it should not affect the ongoing operation, by creating the alternate path immediately, which helps in the routing operation go on normally. In order to routing stable, the user will deploy some new sensor nodes which replaces the failed sensor nodes to reconstruct the routing path by taking the advantage of newly deployed sensor nodes. The more energy is consumed in sending and receiving data in wireless sensor network. So research shows that energy consumption could be reduced efficiently by making use of hierarchical routing, because it uses the technique called as the data aggregation and fusion. Hence it is important to design the routing protocol based on the specific communication. ANYCAST is a technique which is used to deliver a packet to one of many hosts. Here the distributed hosts in the tree will respond to the same address which is known as ANYCAST address. A packet headed for an ANYCAST address will be sent to anyone of the host, with the address which is nearer to the source. Before sending the data packet to the nearest node it is first delivered to the ANYCAST address. Nowadays ANYCAST have been widely studied in wireless sensor network and in hierarchical routing too it plays a big role, the ANYCAST communication becomes quite important where a network which contains multiple sinks. The ANYCAST technique plays a very important role in wireless sensor network in terms of resource, achieving robustness and efficiency for replicated service applications, when the source and the sink nodes are distributed uniformly in the network. The source sending the data packet to the nearest sink around the area in which the sensing event happen can reduce the number of hops in packet transmission, which helps to save energy mean while it reduces the cost of router table maintenance which results in increasing the network lifetime, when a sensor node senses the data and that sensed data has to be sent to any available sink, the sink selection plan is to choose a sink node for each source, the cycle of selection of the sink is assumed to balance the energy consumption. Collection of many detection stations called sensor nodes is known as a sensor network, each node is small, lightweight and portable. Many disaster management applications require networks of sensors that can be easily deployed. In such applications wires or cabling is not practically possible. To overcome these drawbacks wireless sensor networks are used. Wireless sensor networks are fast, easy to install and maintain. [**1**] One of the major advantages of WSNs is that they can operate in dangerous environments in which human monitoring schemes is not possible or fails. Figure 1 involves various applications of WSNs like security, industrial, environmental and health care systems.

II. LITERATURE SURVEY

A. LEACH

Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the most popular clustering algorithms with distributed cluster formation for WSNs [2,3]. This algorithm will select the cluster head randomly, and rotates the role to distribute the consumption of energy. The LEACH will make use of the TDMA/CDMA MAC in order to reduce the collision like inter-cluster and intra-cluster collision, and with the defined period the data collections are centralized. The clusters are formed based on the received signal strength and the cluster head (CH) node will act as a router to the base-station. The LEACH has two main phases, first is Set-up phase and second is Steady-state phase. In set-up phase all the nodes in cluster decides to become CH or not for that round. The decision of CHs is determine by percentage of CHs in the network and how many times the node become a CH. If the value of that node is less than the threshold then the node become a CH. The threshold is determined by following formula:

$$\mathrm{T(n)} = \mathrm{P}/1 - \mathrm{P}(\mathrm{r} \bmod 1/\mathrm{P}), \text{if } \mathrm{n} \in \mathrm{G}$$
$$\mathrm{T(n)} = 0, \text{otherwise}$$

Where: desired percentage of CHs is denoted by P, Current round is denoted by r, the nodes which are not elected as CHs for last 1/P rounds is denoted by the set G.

B. PEGASIS

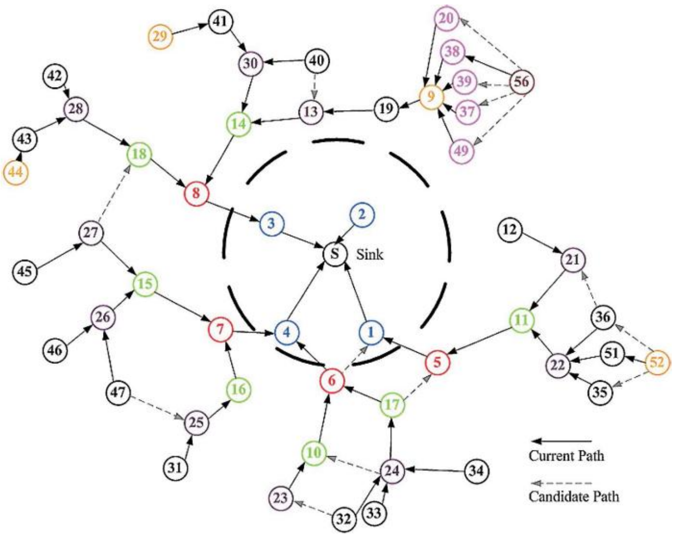
Lindsey proposed Power-Efficient Gathering in Sensor Information Systems (PEGASIS) [4]. It is an improvement of LEACH. Each node communicates with its neighbors and become a leader for the transmission to the sink node. In PEGASIS, nodes are located randomly. Wireless communication, data fusion, positioning and data detection are the abilities of sensor nodes. Node forms the chain, which is assigned by the sink and transmission to all nodes by greedy algorithm. During the procedure of chain establishment it is expected that all nodes have the universal information of network and greedy method is employed. The chain building is initiated from furthermost node commencing the sink node and the closest node to this node is the next node for the chain. Dead node is eliminated by reconstruction of chain by passing it. Each node receives data from its neighbor node and fuses this data with its own data and then node passes this fused data to the leader node and leader node passes this data to sink node in the chain network.

III. HIERARCHICAL ENERGY AWARE

A. ANYCAST ROUTING

Let us consider a network which is composed of many number of wireless sensors, which are randomly deployed and a small number of base stations. In the first phase the formation of the cluster head (CH) is carried out and the first phase is responsible for the formation of the clusters with cluster head and other nodes. The base stations are elected as cluster-head initially ad it initiates the tree construction by broadcasting a child request (CREQ) to discover the child node. The child nodes send a child reply (CREP) to the required cluster-head for joining the cluster and become the member of the tree. Upon receiving CREP packet, the parent node replies with a child acceptance (CACP) packet. So, finally the ACK packet from child to parent in reply to the CACP packet completes the binding in the cluster. In this network all sensor nodes have limited processing power, storage, bandwidth and energy but base stations have powerful resources and hence required to initiate the process to perform any task or communicate with the sensors [5]. Let BS and N be the set of base stations and number of sensor nodes respectively. Accordingly to area coverage of base stations, clusters are formed but simultaneously some nodes in each region are also elected as cluster-head depends upon the decision made by the election process and the nodes which are static in nature with better area coverage and resources. The election algorithm selects the node on the value generated by the performance of the node as the overhead of cluster-head is higher than other nodes. Then each elected cluster-head broadcasts an advertisement message to the rest of the nodes in the network to join their clusters. Based upon the strength of the CREQ signal, nodes send CREP packet to join the cluster. Whenever any node moves from one region to another region it will join the cluster accordingly and send information to the respective cluster-head. In this protocol the tree formation is hierarchical where base stations (BS) are connected to cluster-heads (CH) and each cluster-head connects to nodes in the cluster for the formation of the tree structure. These procedures are performed by every node throughout the network to complete the tree formation. [5] The rules which has to be considered while building routing tree are:

1. Collaborator node: It is the node which detects an event and reports the collected to the co-ordinator node.
2. Co-ordinator node: Even the co-ordinator node is the collaborator node which detects an event but after using election algorithm it becomes a co-ordinator node, this coordinator node which is responsible for aggregating the collected data received from other collaborator node and send results to the sink node.
3. Relay node: This node which is in route between co-ordinator node and sink node and forwards the data to the link.
4. Sink node: This sink node sometimes which is also called as the destination node, which is interesting in receiving the data from set of co-ordinator node and collaborator node



IV. HEAAR ALGORITHM

The algorithm is explained in the following steps:

Step 1: Initialization

Set number of CREP = 0 and status of parent node, CREP send and received, CREQ send and receive as NULL. Choose BS as parent (node), BS broadcasts CREQ packets; Sensor broadcasts PREQ packets, call election algorithm to select cluster-head (CH).

Step 2: Formation of tree

Select cluster-head (CH) near the sink (BS) and if node elected as CH connect to BS and send request to nodes else node will join CH as leaf in the tree as source node.

Step 3: Topology model

- All sensor nodes are started with same initial
- energy with transmission distance d0.
- Each sensor node can compute the distance d of the source based on the received location information.
- Transmitting power of a sensor node is controllable, i.e., transmitting power of a sensor
- node can be modulated according to the transmitting distance.
- Change the flag values accordingly as per transmission and buffer the packets for transmission.

Step 4: Update energy of each sensor node

Step 5: Each node transmit data during their allocated time slot t and finally data will be transmitted to BS via CH.

Step 6: After completion of one round repeat step 2 to 5

Step 7: Stop.

Each time after selection of cluster-heads (CH) the information will broadcast in the cluster so that each node can send PREQ to establish connection with CH but in HEAAR the broadcast process will be once to minimize the overhead and utilize less energy. HEAAR also reduce the overhead by minimizing the hop in routing and avoid periodic update to reduce the traffic in the network.

V. SIMULATION RESULTS

We evaluated these protocols over a set of networks with the number of nodes ranging from 100 to 500. The aim of the experiment was to measure system lifetime, energy consumption ration, packet delivery ration and latency of each protocol. For the same number of nodes, we randomly generate ten network topologies to obtain the average results. In each network the sensor nodes are distributed in the area of 300m X 300m with maximum transmission distance of node set to 10m and initial energy of 10J,

Table 1. The parameters used in the simulation

Parameter	Value
E_{Tx}	50 nJ/bit
E_{Rx}	50 nJ/bit
ε_{fs}	10 pJ/b/m^2
E_{elec}	50nJ/bit
E_{amp}	100pJ/bit/m^2
E_{elec}	50nJ/bit
E_{amp}	100pJ/bit/m^2
Packet size	512 bytes
broadcast packet size	20 bytes
the coordinate of sink	(0, 300)
Initial Energy	10J

VI. PERFORMANCE METRICS

Various performance metrics are used for comparing different routing strategies in wireless sensor networks, they are:

1. Average Energy: The metric gives the average of energy of all nodes at the end of simulation.

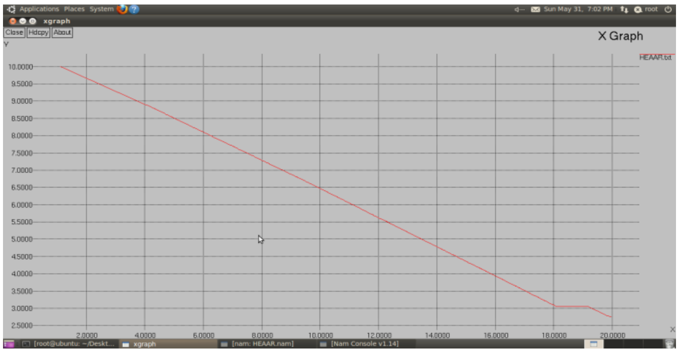


Fig 1: Average Energy

2. Packet Delivery Ratio (PDR): It is the ratio between the number of data packets received and sent.

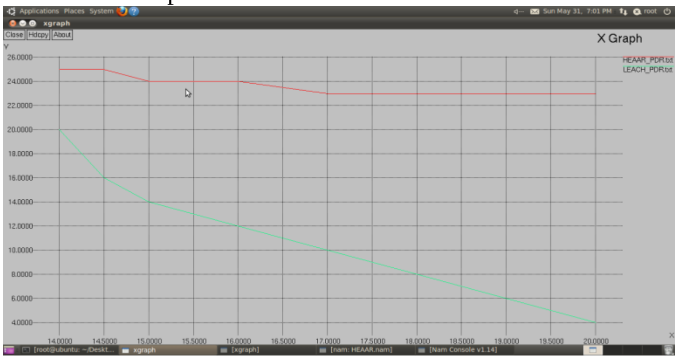


Fig 2: Packet Delivery Ratio.

3. Energy consumption: The metric gives the energy consumption of nodes in the event area for transmitting a data packet to sink.

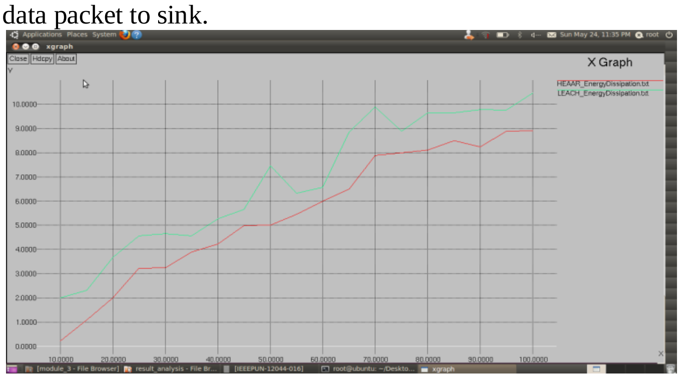


Fig 3: Energy Consumption

4. Average Latency: The average end-to-end delay observed between transmitting a data packet and receiving it at the destination.

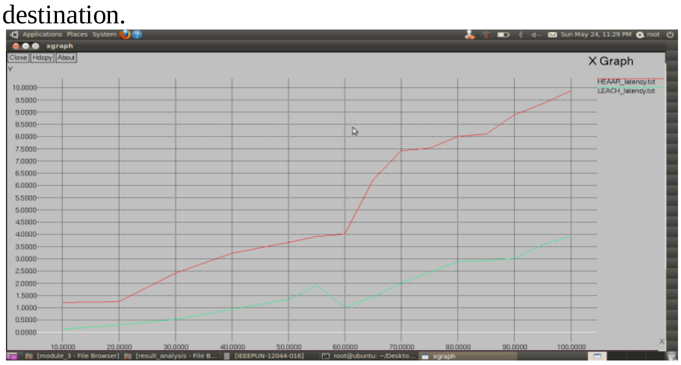


Fig .4: Average Latency

5. Network lifetime: This metric gives the time of the first node running out of its energy.

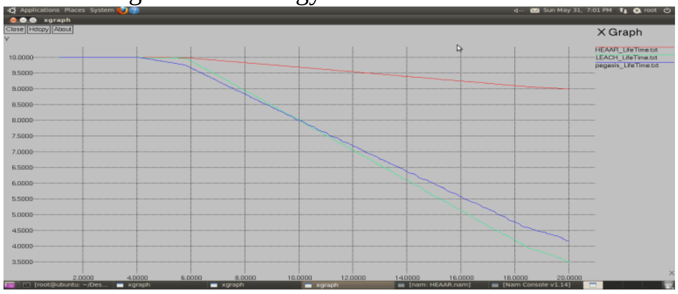


Fig 5: Network Lifetime

VII. CONCLUSION

Energy is one of the major parameter in Wireless Sensor Networks. Routing consumes the largest amount of energy in WSN for routing and in terms of achieving efficient routing mechanism for collecting data packets. Lots of redundant information is available in WSN due to widely deployed nodes but ANYCAST mechanism is limited to clusters and the approaches are different for both inter-cluster and intra-cluster communication due to the pre-defined role of cluster head. This paper has demonstrated the routing strategy of HEAAR protocol and showed how it provides the solution against the dynamic natures of WSN. It also tries to overcome the shortcoming of other protocols in terms of scalability for enhancing network life-time. However, we have not explored all required performance matrices which is one of our future work.

REFERENCES

[1] Suhas K.Pawar, Abhishek R.Tawde, Archana Pokharkar: "A Survey of Cluster formation Protocols in Wireless Sensor Networks" Multidisciplinary Journal of Research in Engineering and Technology, Volume 1, Issue 1 (April 2014) Pg. 40-49.

[2] W.Heinzelman, A.Chandrakasanand and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Maui, HI, 2000, pp. 3005-3014.

[3] W.B. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "Application specific protocol architecture for wireless microsensor networks," Wireless Communications,IEEE, vol. 1, pp. 660-670, oct 2002.

[4] Lindsey, S.Raghavendra, C.Sivalingam, K.M. Data gathering algorithms in sensor networks using energy metrics. IEEE Trans. Parallel Distrib.Syst. 2002, 13, 924±935.

[5] Subhrendu Guha Neogi, Anand A. Bhaskar, " Hierarchical Anycast Routing Protocol For Wireless Sensor Networks": International Journal of Industrial Electronics and Electrical Engineering, ISSN: 2347-6982 Volume-2, Issue-6, June-2014

