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Co-operative LEACH for efficient energy consumption in WSN

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Abstract – ***A Wireless Sensor network has been one of the most promising sensing technologies to comfort the human living as much as possible. Routing makes a major impact in making the network running for many years, so it comes into spotlight for bringing any scope of enhanced network lifetime into ground reality. Hierarchical cluster based routing protocols are considered to be one of the most prominent protocols due to their higher energy efficiency, low cost data transmission and much flexible topology. LEACH has been experiencing various advancement in its technique to send data to the Base Station. Traditional LEACH had poor energy balancing and single hop communication had put a heavy cost for the network. In this paper, we have discussed the Co-operative LEACH protocol in the prospective of rate of energy consumption, along with that various classification of routing protocols is also being discussed.***

Key Words: *Wireless Sensor Network, LEACH, Co-operative LEACH, Hierarchical Cluster Based Routing.*

1. INTRODUCTION

Due to rapid evolving of Micro-Electro-Mechanical Systems (MEMS), wireless sensor network came out to be one of the most significant technologies. Wireless Sensor Network is the network consisting of various nodes which are small in size, low in price and once rechargeable battery. These nodes have the battery which gets diminished when being communicated for a longer period. They are not replaceable. These nodes sense the environment and forward the data to the Base Station via wireless link. Thereafter from the Base Station it is being forwarded to the User via internet [1]. General architecture of sensor node can be shown like in the Fig.1. WSN is entirely based on application. Its topology is entirely dependent on the type of network used for the type of application.
Various components of sensor node is shown in Fig.2. With the development of sensor field various sensor nodes are available in the field, whether it is for sensing the temperature, moisture, vibration or any other. They are robust to the external environmental damage.

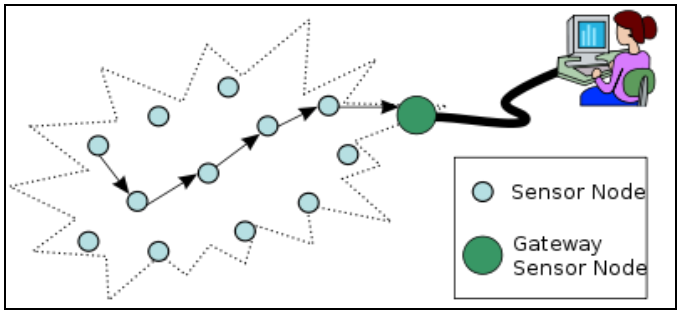

Fig-1 Architecture of Wireless Sensor Network [1]

Sensor Node has various components as shown in Fig-2. Mostly some of the components are found in almost every node but still few of them are application dependent.

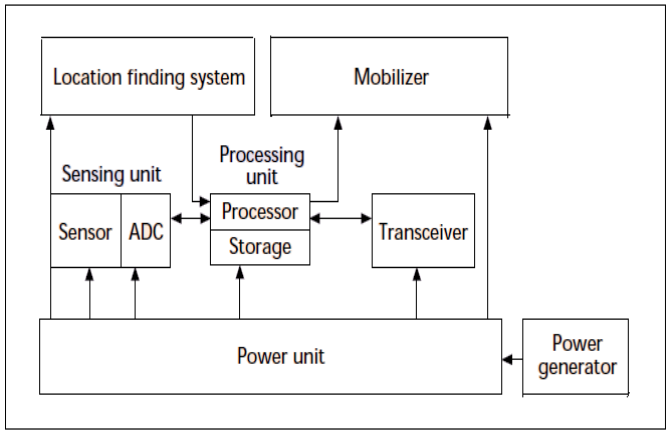

Fig-2 Components of Sensor Node [2]

Processing unit may have microprocessor or micro controller or it may even employ FPGA as well as ASIC. Employing microcontroller in place of microprocessor is always a benefit as it leads to the less energy consumption as compare to the microprocessor. Microcontroller handles the operation of individual components. Whether the node has to be turned on or to be turned off is also managed by microcontroller. Although FPGA gives the flexibility to reprogram the device but it adds so much procrastination in the task performance of sensor node. Sensors are used to sense the physical quantity from the surroundings and ADC being used for converting it to the format understandable by the processor or controller for further processing. They are operated at 1.2V and have limited power handling.

ADC is analog to digital converter is used for converting the attribute sensed by the sensor to the readable format.
Transceiver is for the transmission and reception of signals which becomes possible with use of IR (Infrared), RF (Radio Frequency) based communication. Generally RF based communication is the most effective one.
The most important component of sensor node is the power source. It is because it's limited one and power is mostly used in sensing, processing and mostly in communication. This is one of the reason the most concerning issue in the WSN field is minimizing the power consumption by making the communication as much effective as possible. Once the node is deployed in the area, its battery cannot be replaced.

These sensor nodes find its various applications in the real time scenario today. If it is about environmental monitoring they are right up there for the temperature monitoring in the forest fire detection. As it is not easy for human to intervene into the remote areas or various hostile areas, there these sensor nodes play a crucial role. Military Battlefield is one another area where once sensor nodes are deployed they help in monitoring the activities of enemies.
Health applications include exploiting the sensor nodes in the monitoring of patients which are outside the territory of hospitals. They diagnose the internal organs of patient consistently and keep reporting to the medical supervisor of the patient.
Habitat monitoring helps in getting the information of various cattle that move randomly in their zone searching for food and their natural behavior is observed as well.
Vibration sensor when employed helps in exploring the lifetime of the building or any bridge. The measurement of the vibration above the threshold value gives the sign of replacement of the material or the appeals for the reconstruction of the bridges [3].

2. ROUTING IN WIRELESS SENSOR NETWORK

Routing is generally consists of flat based routing and hierarchical based routing. Flat based routing involves the flooding of message throughout the network. Nodes who matches the query respond accordingly other nodes they remain in the active state to hear any call of query. Node which matches the query sends the data to the Base Station via intermediate nodes. This makes the nodes burdened with the huge amount of data which are near to the Base Station. So they die early.
The disadvantage is overcome by hierarchical based routing. In this kind of routing data is aggregated and collected by different node and sensed by the different nodes. This method improves the scalability and energy balancing in the network. This hierarchical based routing balances the traffic load in the network [4].
The basic classification of routing protocols is shown in the Fig.3 [] .

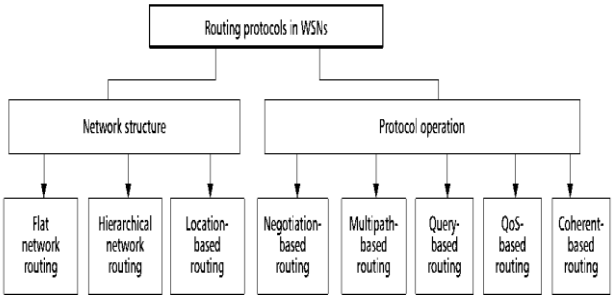

Fig-3 Classification of routing protocols

Various hierarchical based routing protocols are named as LEACH [5], PEGASIS [6], TEEN [7], APTEEN[8].

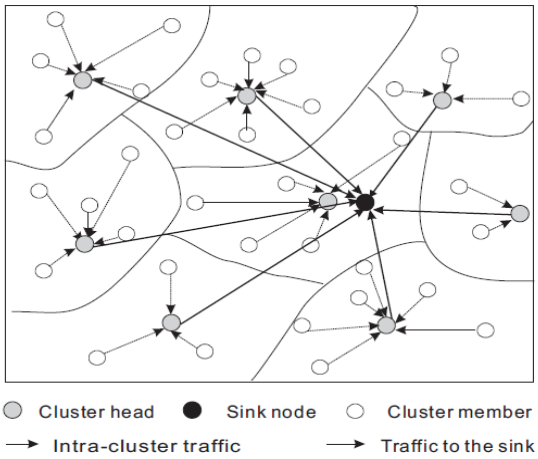

Fig-4 Hierarchical Based Data Collection

LEACH (Low Energy Adaptive Clustering Hierarchy) is first clustering protocol which gave the clustering concept by randomly selecting the cluster head. It operates into two phase, set up phase and steady state phase.
LEACH suffered from following drawbacks:

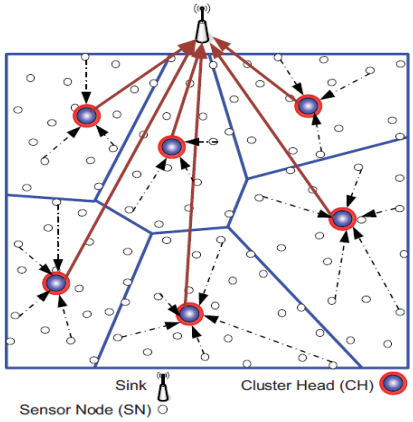

Fig-5 LEACH Protocol [5]

1. It performs the single hop communication when sink is outside the network, leading to the early diminishing of the CH.

2. Random selection of CH led to the selection of low energy nodes as CH.
3. Nodes are considered to be homogeneous but in the reality there is always a difference in energy.

3. The PROPOSED CO-OPERATIVE LEACH

In this paper we have discussed the improvement to the Reactive I-LEACH [9]. The CH selection is done through three different decision tree, 1st being the CH being the node enriched with maximum energy among all nodes, 2nd being the minimum distance from another cluster and 3rd being the threshold selection of CH.

Table 1: Simulation Parameter for the network

Parameter	Value
Network coverage	(100,100)m
BS location	(50,50)m
Node Number	100
Energy	0.5J
Eelec	50nJ/bit
Efs	10pJ/bit/m^2
Emp	0.0013pJ/bit/m^4
d_0	87m
Eda	5nJ/bit/signal
Data packet size	4000bits

In this co-operative LEACH is produced, which introduce the co-operative node inside each cluster along with the CH. Co-operative node collects data from the CH which collects data from all the nodes. Then Co-operative node transmit data to the Base Station or the node near to the Base Station.

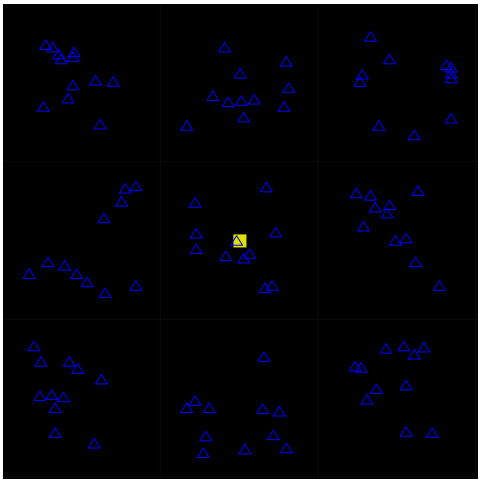

Fig-6 Network simulated in MATLAB

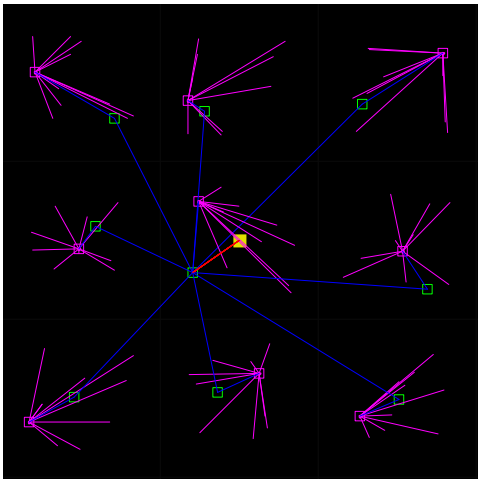

Fig-7 Co-Operative LEACH

Simulation parameter being shown in Table 1. It considers the area of 100 X 100 m^2 with 100 homogeneous nodes employed in the network. Fig-6 shows the network field with 100 sensor nodes deployed randomly and sinks deployed at the center. Blue color lines shows the data transmission from the co-operative nodes to the co-operative node nearest to the Base Station.

It is expected to enhance the network lifetime. This topology is found to be bringing a deduction in the energy consumption of the network.

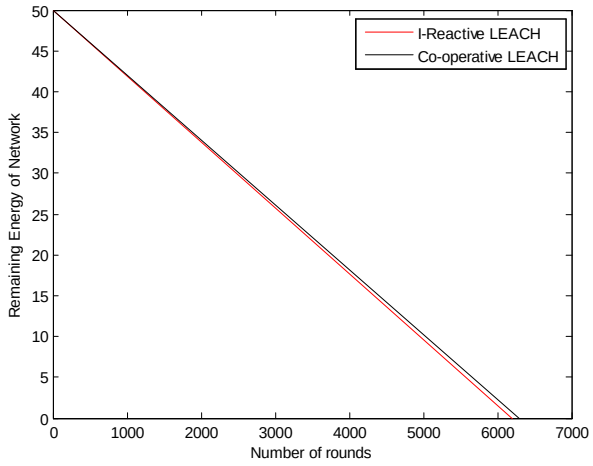

Fig-8 Rate of energy consumption of co-operative LEACH

In Fig-8 it is being shown that rate of energy consumption is reduced in the Co-operative LEACH as compare to the I-Reactive LEACH. This indicates the better applicability of Co-operative LEACH.

4. CONCLUSION

Wireless sensor network has revolutionized every technical field in today's world. The constraint to the power resources have led to the need of developing the various routing strategies in the network. Hierarchical based clustering has been very significant in lifetime enhancement of the sensor network. Co-operative LEACH has been one of the approaches which results in decreasing the energy consumption in the network as compare to the latest improved version of I-LEACH. This brings energy balancing in the network by sharing the load of Cluster Head. This approach is much favorite to the applications of large area network.

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