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Designing Energy Aware Routing Protocol Distributed Ad - hoc Network.

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Abstract: The Cluster in Mobile Ad-hoc Network has paying attention in recent times and clustering defined in Mobile ad hoc network partitioning of mobile nodes into different groups, and each group contains ordinary node, cluster head and getaway .The basic need to create cluster is to save the energy consumption, simplicity of routing, extending capability and to improve the network efficiency .Each node is key element, when the energy of node is drained, the node become fails to sense the data or forward the data, So after we can reconstruct new cluster with remaining nodes, called as Re-clustering, but Re-clustering needs high energy consumption, but nodes have limited resource constraints, In order to overcome clustering problems we need design new energy clustering protocol, in this are proposing Intra-balanced LEACH protocol to achieve life span of WSNas, with Distrubuted Ad-hoc Network.

Keywords: Intra-balanced LEACH, Mobile Nodes different groups, Cluster.

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a distributed network and it comprises a large number of distributed, self-directed, and tiny, low powered devices called sensor nodes alias motes. WSN naturally encompasses a large number of spatially dispersed, petite, battery-operated, embedded devices that are networked to supportively collect, process, and convey data to the users, and it has restricted computing and processing capabilities. Motes are the small computers, which work collectively to form the networks. Motes are energy efficient, multi-functional wireless device. The necessities for motes in industrial applications are widespread. A group of motes collects the information from the environment to accomplish particular application objectives. They make links with each other in different configurations to get the maximum performance. Motes communicate with each other using transceivers. In WSN the number of sensor nodes can be in the order of hundreds or even thousands. In comparison with sensor networks, Ad Hoc networks will have less number of nodes without any infrastructure. The differences between WSN and Ad hoc Networks are presented in the Table 1.1. Now a day-‘s wireless network is the most popular services utilized in industrial and commercial applications, because of its technical advancement in processor, communication, and usage of low power embedded computing devices. Sensor nodes are used to monitor environmental conditions like temperature, pressure, humidity, sound, vibration, position etc. In many real time applications the sensor nodes are performing different tasks like neighbor node discovery, smart sensing, data storage and processing data aggregation, target tracking, control and monitoring, node localization, synchronization and efficient routing between nodes and base station.

Table 1.1: Wireless Sensor Networks Vs Ad hoc Networks.

Parameters	Wireless Sensor Networks	Ad Hoc Networks
Number of sensor nodes	Large	Medium
Deployment	Densely deployed	Scattered
Failure rate	Prone to failures	Very rare
Topology	Changes very frequently	Very rare
Communication paradigm	Broadcast communication	Point-to-Point communications
Battery	Not replaceable / Not rechargeable	Replaceable
Identifiers	No unique identifiers	Unique identifiers
Centric	Data centric	Address centric
Fusion / aggregation	Possible	Not suitable
Computational capacities, and memory	Limited	Not limited
Data rate	Low	High
Redundancy	High	Low

Wireless sensor nodes are equipped with sensing unit, a processing unit, communication unit and power unit. Each and every node is capable to perform data gathering, sensing, processing and communicating with other nodes. The sensing unit senses the environment, the processing unit computes the confined permutations of the sensed data, and the communication unit performs exchange of processed information among neighboring sensor nodes. The basic building block of a sensor node..

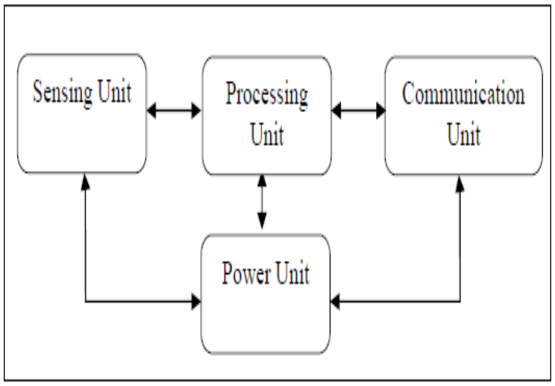

Fig1.1: Basic Building Blocks of Sensor Node

Wireless sensor networks usually are designed for harsh environment applications where human intervention is not possible such as forest fire, wild life monitoring, tunnels, bridges, coal mines etc. to name a few. Such data gathering applications require sensors to be deployed in large numbers and the data to be sensed from all locations. However, these sensor nodes are energy limited. In many applications the base station (BS) is usually placed far away from the sensing field and the data is gathered periodically by the BS. In order to address the energy constraint, large amount of research work has been carried out in the last decade. For such continuous monitoring networks, clustering with hierarchical topology is successful. It is exhibited that clustering the network offers greater lifespan with an increase of about 2-3 times than the network with direct data transmission.

The sensing unit of sensor nodes unites various types of sensors like thermal sensors, magnetic sensors, vibration sensors, chemical sensors, biosensors, and light sensors. The measured parameters from the external environment by sensing unit of sensor node are fed into the processing unit. The analog signal generated by the sensors are digitized by using Analog to Digital converter (ADC) and sent to controller for further processing. The processing unit is the important core unit of the sensor node. The processor executes different tasks and controls the functionality of other components. The required services for the processing unit are pre-programmed and loaded into the processor of sensor nodes. The energy utilization rate of the processor varies depending upon the functionality of the nodes. The variation in the performance of the processor is identified by evaluating factors like processing speed, data rate, memory and peripherals supported by the processors.

II. NODE DEPLOYMENT IN WSNS

Node deployment has significant impact on the lifetime and coverage of the network. In WSNs the node deployment strategies are mainly classified into two **static node deployment and dynamic node deployment**. The mode of deployment can be random or deterministic. In static node deployment the nodes remain static throughout their lifetime. Because of this, the positioning of the sensor node has to be determined taking into consideration the factors like maximum coverage, less energy consumption etc. and choosing the best optimization strategy. Based on the application scenario, the node deployment will be random or deterministic. The deterministic approach is used when the requirement and the nature of the deployment region is known prior and is manageable. The random deployment will be needed in situations of emergency like environment hazards and rescue operations. In such case, the sensor nodes will be randomly thrown over the area under monitoring, and later they self-organize. For dynamic node deployment, backing of additional resources like robots is a must in order to place the sensor nodes in adequate positions to have optimum coverage. Dynamic node deployment is usually employed if the area under deployment is quite risky to have human interventions. Compared to static node deployment, dynamic node deployment has more overheads.

SECURITY IN WSN

Sensor networks have many challenges, so conventional security techniques used in traditional networks cannot be applied directly for WSN. The sensor devices are inadequate in their energy, computation, and communication capabilities. When sensor networks are deployed in a hostile environment, security becomes extremely important, as they are prone to different types of malicious attacks. For example, an adversary can easily listen to the traffic, impersonate one of the network nodes, or intentionally provide misleading information to other nodes. WSN works together closely with their corporal environments, posing new security troubles. As a result, existing security mechanisms are insufficient, and novel ideas are needed.

Sensor nodes are randomly deployed in an open and unattended environment, so security is critical for such networks. WSN uses wireless communication, which is predominantly easy to eavesdrop on.

An attacker can easily inject malicious node in the network. WSN involves a large number of nodes in the network. Enforcing security in all the levels is important and also too complex.

Sensor nodes are resource constraints regarding memory, energy, transmission range, processing power. Hence asymmetric cryptography is too expensive and symmetric cryptography is used as alternatives. Cost of implementing tamper resistant software is very high. WSN's general security goals [12] are confidentiality, integrity, authentication, availability, survivability, efficiency, freshness and scalability. WSN is susceptible to many attacks because of its transmission nature, resource restriction on sensor nodes and deployment in uncontrolled environments. To ensure the security services in WSN many crypto mechanisms like symmetric and asymmetric methods are proposed. To achieve security in wireless sensor networks, it is important to be able to encrypt and authenticate messages sent between sensor nodes.

III. CLUSTERING MODELS

Several WSN applications require only an aggregate value to be reported to the observer. In this case, sensors in different regions of the field can collaborate to aggregate their data and provide more accurate reports about their local regions. In order to support data aggregation through efficient network organization, nodes can be partitioned into a number of smaller groups called '**clusters**'. Each cluster has a coordinator, referred to as '**cluster head**', and a number of '**member nodes**' or non cluster head nodes. Clustering results in a two level hierarchy in which Cluster Heads (CHs) form the higher level while member nodes form the lower level. Figure1.2 illustrates clustering in WSN. Data moves from a lower clustered layer to a higher one. Data in this case as well, hops from one node to another node, but while it hops from one layer to the other, it covers longer distances and moves the data more rapidly to the base station as compared to the multi-hop model. The latency in this model is supposedly much lower than that in the multi-hop model. Clustering makes available inherent optimization capabilities at the cluster heads, which results in a more efficient and well structured network topology. This model is certainly more suitable than the one-hop and the multi-hop model.

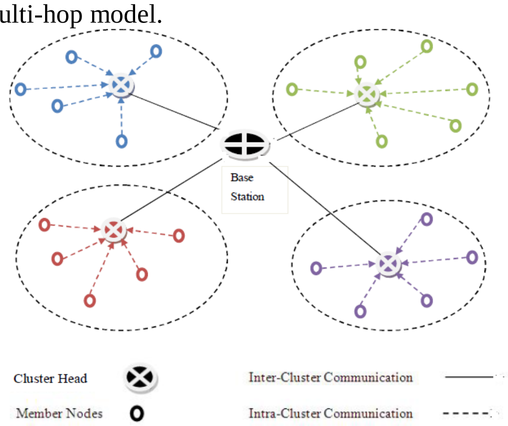

Fig 1.2: Example of Clustering Based Model.

The member nodes report their data to the respective CHs. As shown in Figure 1.2, the clusters are created where each CH aggregates the data and sends it to the central Base Station through other CHs. Because CHs often transmit data over longer distances, they lose more energy compared to member nodes. The network may be re-clustered periodically in order to select energy abundant nodes to serve as CHs, thus distributing the load uniformly on all the nodes. Besides achieving energy efficiency, clustering reduces channel contention and packet collisions, resulting in better network throughput under high load. Clustering has been shown to improve network lifetime, a primary metric for evaluating the performance of a sensor network. Although there is no unified definition of 'network lifetime', as this concept depends on the objective of an application, common definitions include the time until the first node in the network depletes its energy and the time until a node is disconnected from the base station. In studies where clustering techniques were primarily proposed for energy efficiency purposes where the network lifetime was significantly extends. Clustering has advantages and disadvantages. Clusters can decrease the power consumption of a WSN, thus boosting the lifetime of the network. Nodes inside a cluster are only required to broadcast to its CH, and this decreases each node's connection variety. This also permits the spatial reuse of communication channels while decreasing collisions. By aggregating data, the number of messages that flow through the network can be lowered. Another important feature of clustering is the rotation of cluster head role among the sensor nodes in order not to drain the battery of a single node (as the CH consumes the most energy among all nodes in a cluster).

IV. PROBLEM STATEMENT

There are many other advantages of using clustering protocols in data-gathering networks. As dense networks involve large volume of traffic among the sensors, it leads to interference problems. In such scenarios, grouping the sensors is extremely beneficial. Further, it minimizes the number of long distance transmissions and results into saving of the energy. In clustering, cluster heads (CHs) coordinate the activities of its member nodes and the normal sensor nodes (cluster members) remain in sleep mode, which further leads to energy saving . This is possible because CHs execute TDMA (Time-Division Multiple Access) schedule for its member nodes. Also clustering facilitates data aggregation at cluster head. Thereby the number of data transmissions further minimizes, and the network lifetime prolongs.

The data transmission in clustering protocols occurs in two steps, one is within the clusters i.e. intra-cluster and another is between the clusters and the BS i.e. inter-cluster. In addition, the communication in a wireless sensor network clustering protocol can be taken up either by employing direct transmission through single hop, or using multi-hop routing . For data transmissions within the cluster i.e. from member nodes to CH, most of the clustering protocols use single hop communication, as the transmission distance is relatively short e.g. LEACH , LEACH-DT , HEED etc. Multi-hop communication between the sensor nodes and the cluster head is promoted when the propagation loss exponent is high as in buildings, factories, or dense vegetation regions. Direct transmission also has its benefits in saving of energy as the radio dissipates energy in not only transmission but also in reception. But it is used only when the transmission distance is within certain threshold distance only. This is, because the energy expense increases according to the fourth power of the distance. There are number of clustering protocols developed which propose multi-hop communication for achieving more energy-efficient inter-cluster communication viz. The energy consumption among all the network nodes must be balanced. In clustered networks, therefore, there is inevitable problem of energy imbalance among sensor nodes.

In wireless sensor networks, one of the primary concerns is maximization of network lifetime because after the network becomes dysfunctional, significant amount of energy should not remain in the nodes, otherwise it is wasted. In a clustering protocol, a Cluster heads (CH) is heavily burdened as it is responsible for execution of various tasks such as cluster formation, data aggregation, and data transmission and relaying. Cluster heads therefore consume more energy as compared to non-CH nodes. For single hop communication, cluster heads which are far away from BS drain out their energy primarily because of the long distance transmission. But when using multi-hop communication in clustering protocols, then, the cluster heads near the base station deplete their energy quickly because of the extra burden of traffic relaying. This unbalanced communication load results in energy hole or hot spot area. Due to this, data required from all corners may not be obtained and the network performance is ultimately affected. Thus, the energy consumption among all the network nodes must be balanced. In clustered networks, therefore, there is inevitable problem of energy imbalance among sensor nodes.

In this research work, It is aimed to improve network lifespan of an energy-aware distributed clustering protocol used in continuous monitoring applications. The EARP-DC employs uniform clustering algorithm to mitigate the energy imbalance.

IV.I ASSUMPTIONS FOR LEACH

The following assumptions are made for the sensor network. Sensor nodes are randomly dispersed within a sensing field. There is only one Base Station (BS). After deployment sensor nodes and the BS are stationary. The location of the BS is known by each node and they have the capability of communicating directly with the BS in their situations.

Sensor nodes can use power control to vary the amount of transmitted power depending on the distance to the receiver. For simplicity it is assumed that the power level is continuous. The process of sensing is also continuous.

Based on RSS(Received Signal Strength), sensor nodes can compute their relative distance to BS and communication is symmetric.

Sensor nodes are homogeneous.

V. RESULTS AND DISCUSSIONS

Simulation was carried out for different cases where the number of nodes and the area of deployment were changed. Three different scenarios were taken into consideration. The area is kept constant as 100m×100m and the number of nodes is varied like 50, 100 and 150 in each case. The transmitting and receiving energy is calculated based on the equations 1.2 and 1.4.

Simulation was also performed by randomly changing the area and the number of nodes and the simulation period as well, following the assumptions adopted by LEACH. The results represent only the simulation results until fifty percent of the nodes are alive in any of the protocols considered with respect to the number of rounds. MATLAB is used for simulation and the simulation parameters are shown in Table 1.2.

Table 1.2 Simulation Parameters for Modified LEACH Protocol

Parameters	Values
Number of nodes	50,100,150
Area of simulation (x, y)	100 m×100 m
Initial energy of sensors nodes	50 J
Transmission energy	0.5 J
Receiving energy	0.2 J
Number of static sink	1
Deployment model	Random

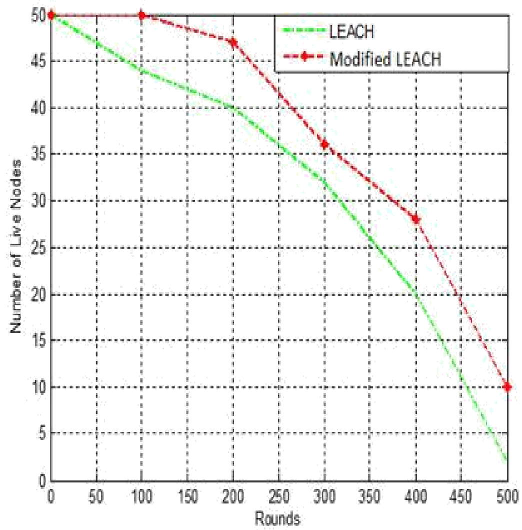

Fig 1.3: Simulation Parameters for Modified LEACH Protocol

Above Figure 1.3 represents the random deployment of 50 sensor nodes over an area of 100m×100m. The BS is located at the coordinate position (50, 80) for this scenario.

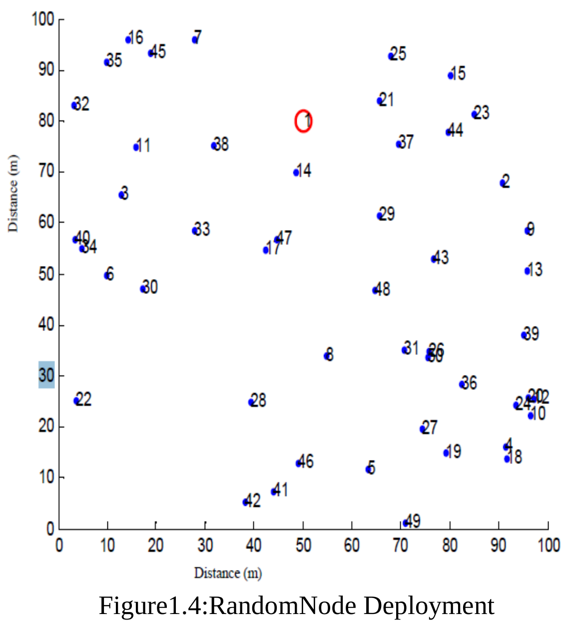

Figure1.4:RandomNode Deployment

Three different scenarios are represented below which are taken for the simulation of the Modified LEACH Algorithm; Scenario 1, A=100m×100m, N=50; Scenario 2, A=100m×100m, N=100 and Scenario 3, A=100m×100m, N=150, where A is the area of deployment and N is the number of nodes. A comparison based on the number of live nodes, energy consumed in each round and packet delivery ratio over a particular time period is done against the LEACH algorithm.

Based on different cases the performance evaluation of the Modified LEACH using various parameters are discussed below.

Number of Live Nodes

Live nodes are a factor which indicates the energy intake of a WSN. If the sensor nodes consume less energy their lifetime will be longer. The performance evaluation of the Modified LEACH with the LEACH protocol in terms of live nodes is mentioned below. The more number of live nodes indicates the efficient usage of energy.

Case i: A=100m×100m, N=50

Figure1. 4 gives performance analysis of the Modified LEACH and the LEACH protocol in terms the of live nodes over the simulation period of 500 rounds. It is evident that the Modified LEACH gives better life time compared to LEACH as the number of live nodes is more for the modified one throughout the simulation period.

Case ii: A=100m×100m, N=100

Figure 1.6 gives the performance analysis of the Modified LEACH and the LEACH protocol in terms of live nodes over the simulation period of 500 rounds.

Case iii: A=100m×100m, N=150

The performance analysis of the Modified LEACH and the LEACH protocol in terms of live nodes over the simulation period of 500 rounds is given in Figure 3.10.

From Figures 5 to 6, is observed that the Modified LEACH retains a higher number of live nodes for a longer time compared to that of LEACH.

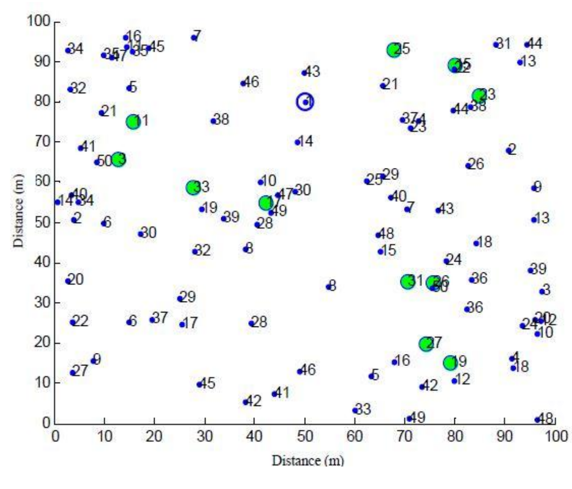

Figure 1.6: Number of Live Nodes Vs Rounds for Modified LEACH (N=50, A=100m×100m)

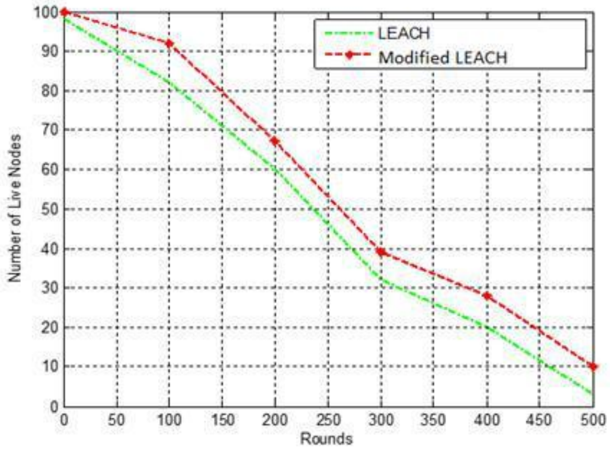

Figure 1.5: Number of Live Nodes Vs Rounds for Modified LEACH (N=100, A=100m×100m)

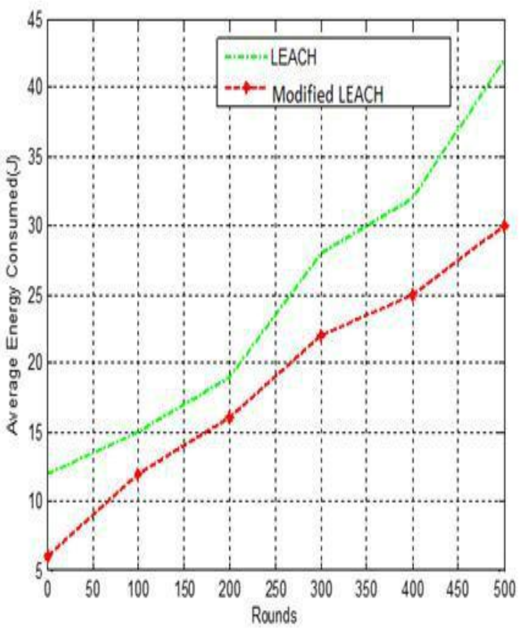

Figure 1. 6: Number of Live Nodes Vs Rounds for Modified LEACH (N=150, A=100m×100m)

Energy Consumed

For comparing the performance of modified approach, another metric used is the energy consumed. Total energy consumed is the energy devoured by the system for all its exchanges. The energy consumption includes the energy consumed for receiving packet (Er), transmitting a packet (Et) and forwarding a packet (Efw). The energy required to forward a packet is represented by Efw = Er + Et.

Less energy consumed indicates the energy efficiency of the protocol compared. The lesser the energy consumption the greater will be the network lifetime. Consider the cases given below.

Case i: A=100m×100m, N=50

Figure 6 gives the comparison of the Modified LEACH with the LEACH protocol based on the average energy consumed over the simulation period of 500 rounds.

Case ii: A=100m×100m, N=100

Case iii: A=100m×100m, N=150

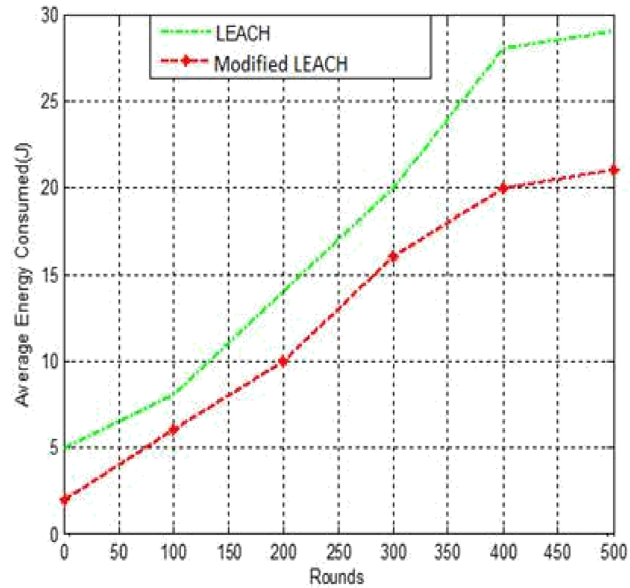

Figure 1.7: compares the Modified LEACH with the LEACH protocol based on the average energy consumed over the simulation period of 500 rounds.

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