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ENERGY EFFICIENT LAYERED MULTIHOP CLUSTER ROUTING SCHEME FOR WIRELESS SENSOR NETWORK

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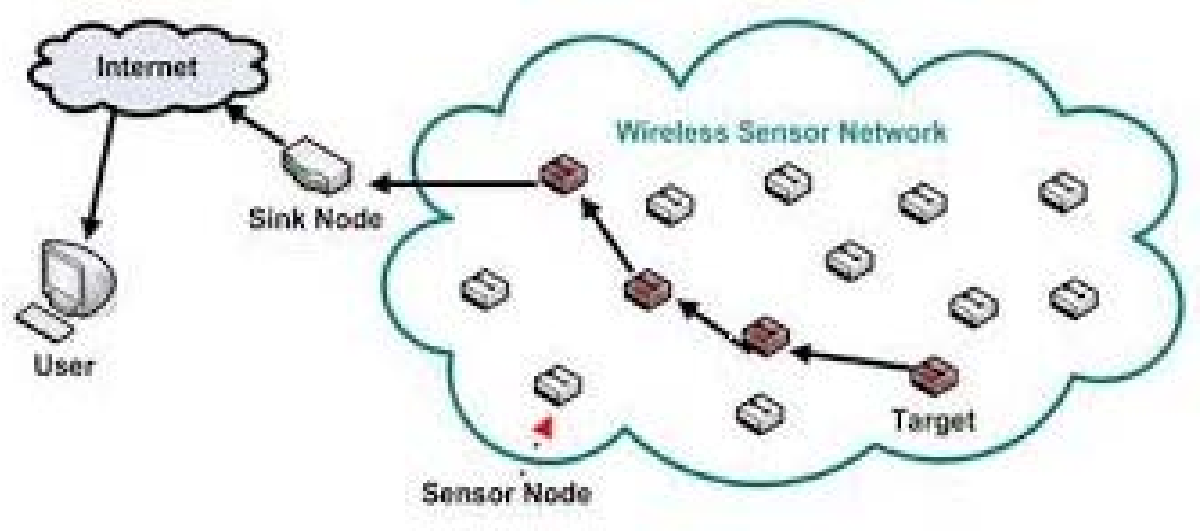
ABSTRACT: A cluster-based routing protocol with low energy consumption for wireless sensor networks. The protocol is based on a strategy which aims to provide a more reasonable exploitation of the selected nodes (cluster-heads). The network is framed by using layered concept which uses heterogeneous nodes that the node having different functionalities. The performance of the protocol is evaluate and the result produced is compare with Low Energy Adaptive Clustering Hierarchy (LEACH) and the results shows that the Energy Efficient Layered Multi-hop Cluster based routing protocol outperformed LEACH in terms of energy efficient and Lifetime.

Keywords: Sensor Network, LEACH, Layered Multi-hop Cluster, Heterogeneous node.

1. INTRODUCTION TO WIRELESS SENSOR NETWORK

A wireless sensor network is a collection of sensor nodes organized into a cooperative network. Wireless sensor network are used to collect data from the environment. A sensor network consists of multiple detection stations called sensor nodes, each of which is small, light weighted and portable. The nodes in the network are connected via Wireless communication channels. Each node has capability to sense data, process the data and send it to rest of the nodes or to base station. These networks are limited by the node battery lifetime.



The wireless sensor networks of the near future are envisioned to consist of hundreds to thousands of inexpensive wireless nodes, each with some computational power and sensing capability, operating in an unattended mode. They are intended for a broad range of environmental sensing applications from vehicle tracking to habitat monitoring.

The hardware technologies for these networks – low cost processors, miniature sensing and radio modules are available today, with further improvements in cost and capabilities expected within the next decade.

The applications, networking principles and protocols for these systems are just beginning to be developed. Sensor networks are quintessentially event-based systems. A sensor network consists of one or more “sinks” which subscribe to specific data streams by expressing interests or queries. The sensors in the network act as “sources” which detect environmental events and push relevant data to the appropriate subscriber sinks.

2. OVERVIEW OF EXISTING WORK

LEACH (Low Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster based station (cluster-heads) to evenly distribute the energy load among the sensors in the network [7]. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station [11] .

LEACH protocol is divided into rounds; each round consists of two phases (i) Set-up Phase (ii) Steady Phase LEACH forms clusters by using a distributed algorithm where nodes make autonomous decisions without any centralized control. [7]

In the Advertisement Phase, CHs inform their neighbourhood with an advertisement packet that they become CHs. Non-CH nodes pick the advertisement packet with the strongest received signal strength. Each node decides independent of other nodes if it will become a CH or not. [15], [9] This decision is made by looking into account when the node served as a CH for the last time (means the node that hasn't been a CH for long time is more likely to elect itself than nodes that have been a CH recently)

Steady phase is further divided into two parts (i) Schedule Creation (ii) Data Transmission.[7] Once the nodes have elected themselves to be cluster heads, The cluster head nodes must let all the other nodes in the network know that they have chosen this role for the current round. To do this each cluster head node broadcasts an advertisement message. This message is a small message containing the nodes ID and a header that distinguishes this message as an announcement message.

Each non cluster head node determines to which cluster it belongs by choosing the cluster head, [15] that requires the minimum communication energy based on the received signal strength of the advertisement from each cluster head.

3. PROPOSED SCHEME

The proposed research defines the new mechanism for grouping nodes into clusters. This mechanism ensures a distribution of the workload of sensor nodes by structuring them into clusters of unequal size (heterogeneous nodes). Then, cluster- heads communicate the collected data of the network to the base station. The cluster-heads are selected periodically according to the weight. This weight is calculated so that the number of cluster-heads increases while approaching the base station. Hence, clusters farther away from the base station will have smaller sizes.

The execution of Energy Efficient Layer Multi hop Cluster based routing protocol is established periodically over three phases. The first is the network configuration, while the second ensures the election of cluster-heads and cluster formation. Data transformation is the third phase of our protocol.

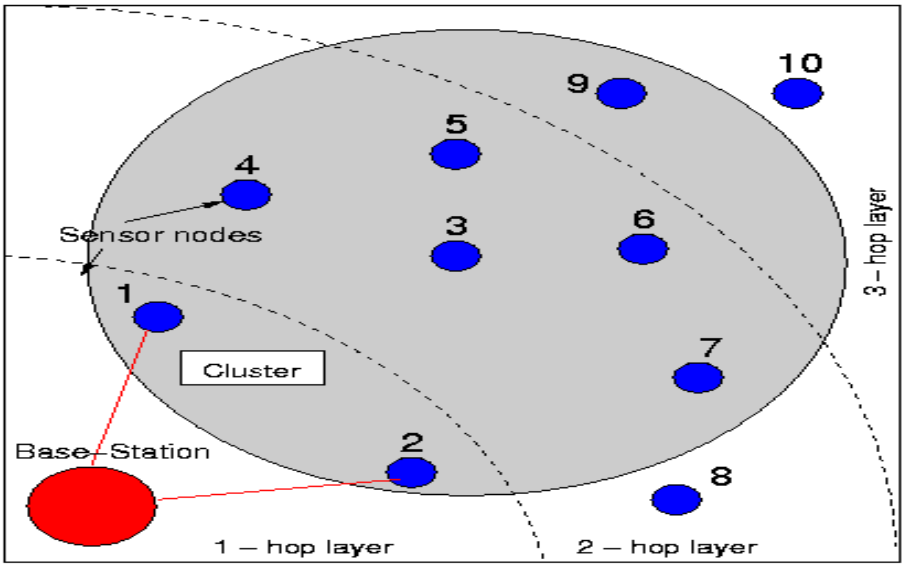


FIG 3.1 Layer Architecture

PHASE 1: NETWORK CONFIGURATION

The main aim of this phase is establish the network nodes in layer and discover their neighbors. The neighbor discovery is started by the base station using diffusion of hello message. The neighbor at one single-hope of the base station are said to be the first layer of the network hierarchy. Thereafter, the node in the first layer will act as a local base station for other neighbor nodes. Then the local base station diffuses the hello message to the other node within the range by using this each node knows it distance using number of hops.

PHASE 2: CLUSTER FORMATION AND CLUSTER HEAD SELECTION

By using a weight function the cluster head will be elected by the sensor node. The weight function should help to choose the node with highest energy capacity, largest number of neighboring node, less frequently cluster head. The main aim of the function is that the degree of involvement of each parameter varies with the layer number of each node.

WEIGHT CALCULATION

Pi= (1/ α − Lnum(i) X deg(i) /N) + (1/ β + Lnum(i)X E(res)/ E(total)−(γ × 1 −1/1 + numCH)

- **E(res)**- Node's residual energy.
- **deg(i)**- number of it's neighbors.
- **numCH**-no.of times selected as cluster head.
- **N** – totalno.of sensors in the network.
- **α,β,γ**- weight parameters [0,1].
- **Lnum(i)**- layered no.of a node.

Once a node is elected as a cluster head, the node will inform its new role in the current cycle to the other node.

For that, it broadcasts an announcement message containing it's identifier as well as a weight (P C H) defined according to its residual energy, its degree and its layer's number.

$$P\ C\ H = \frac{E(res)}{deg(i)} \times Lnum(i)$$

Each cluster node determines the cluster head by using the P C H value. If the P C H weight value is greater, then the node is said to be as Cluster Head. It is possible to balance the load of the cluster head by producing the cluster with different size. The size of a cluster decreases accordingly to layer number of its cluster-head the farthest the cluster-head, the largest the cluster. The objective is to ensure a smaller number of nodes members and a smaller size to manage for cluster-heads of high layers close to the base station. Finally, each cluster head have a list of his adjacent cluster-heads, which is used to select a relay cluster-head.

PHASE 3: DATA TRANSMISSION

In this phase the sensed data is collected and transmitted in a multi-hop fashion to the base station. To ensure the intra cluster communication, TDMA technique is used. The cluster member nodes transmit their sensed data during the time slots allocated by their cluster-head. This data is then aggregated by the cluster-head and sent to the relay node. Then the relay node uses sleep awake protocol is used to avoid the traffic over network.

ALGORITHM

1. Node *S* broadcasts a wake-up signal to all its first-hop neighbours. The wake-up signal includes the identity of both the current sender (*S*), the next-hop (*n1*), and the previous-hop (empty for *S*).

2. Each neighbour of *S*, after being woken up, decides whether to stay awake or go back to sleep based on the role that it may play on the ongoing communication. If that neighbour is the next-hop (*n1*), it stays awake to forward the data and to monitor the next-hop from it(*n2*). If that neighbour is a guard for the next-hop *n1* over the link *n1*and *n2*, it stays awake to monitor the behaviour of *n1*. If the node is a guard of a forwarding node over the previous-hop, it stays awake to detect fabrication by the forwarding node. A node can independently make this determination based on first and second-hop neighbour information. If none of these cases hold, the node goes back to sleep immediately.

3. Node *S* sends the data packet to *n1* following the timing schedule presented

4. Nodesafter being woken up continue to stay awake for *Tw*. After that, it goes back to sleep.

5. *n1*does the same steps that *S* did to wake up the next hop(*n2*), *n2*'s guards and *n1*'s guards.

6. If *n1* fails to send the wakeup signal, the guard of *n1*with the lowest ID sends a two-hop broadcast of the Wake up signal through. If that guard fails, the guard with the next smallest ID sends the signal, and so on. This design ensures that if there is a chain of colluding malicious nodes then all the nodes will be suspected.

7. The process continues at each step till the destination.

4. RESULT AND DISCUSSION

This analysis shows that the performance of the Energy Efficient Layer Multi-hop Cluster based routing Scheme (EELMC) is better than the performance of LEACH in energy consumption and life time of the network. The below graph shows that the increasing number of nodes deployed in the network increases the energy consumption in both protocols.

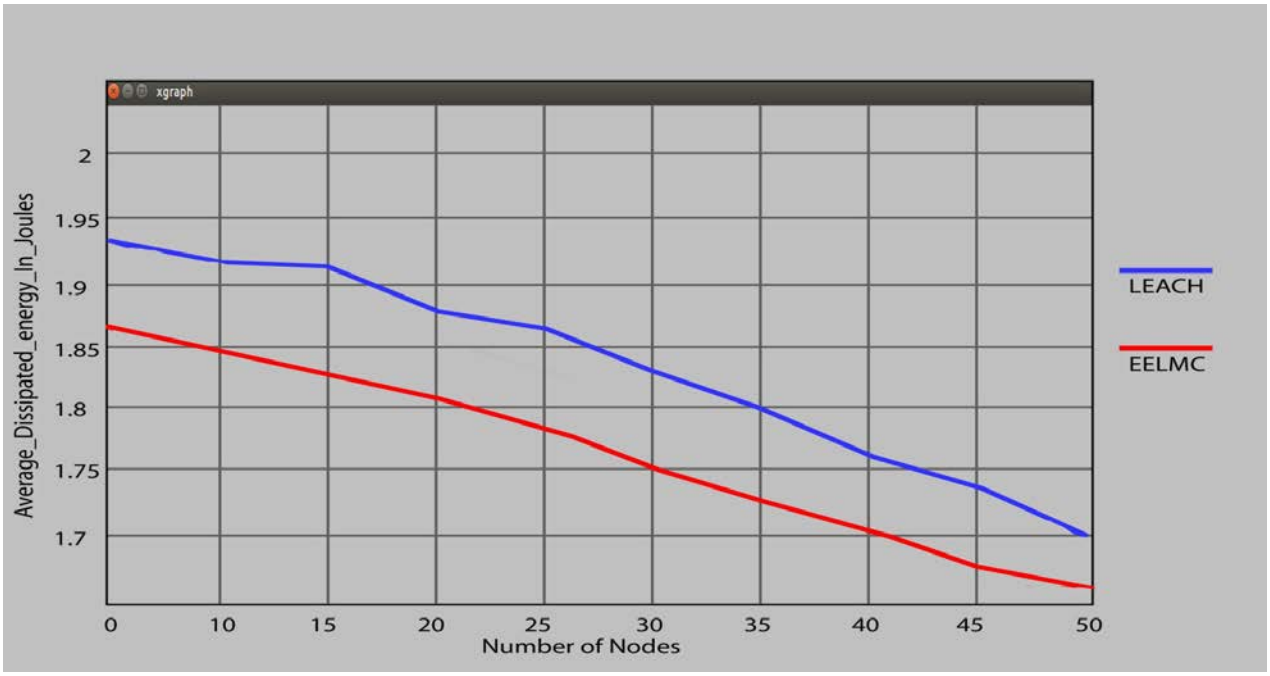


FIG 4.1 The Energy Dissipated ratio

Nevertheless, EELMC consumes less energy; less than 10% of the average consumed energy (for 50 nodes for example)compared to LEACH. This confirms the efficiency of load distribution policy adopted in EELMC, by taking into account the energy constraint in the selection of cluster-heads nodes and the clusters formation mechanisms the energy dissipated during data transmission is low in EELMC when compare to LEACH.

The below graph shows that the life time of the network increases when compare to LEACH. it's clear that the lifetime of the network decreases proportionally with theincrease of the number of nodes deployed in the network. These results are easily explained by the increasing number of interference between neighbouring nodes, when the number of nodes deployed in the network increases.

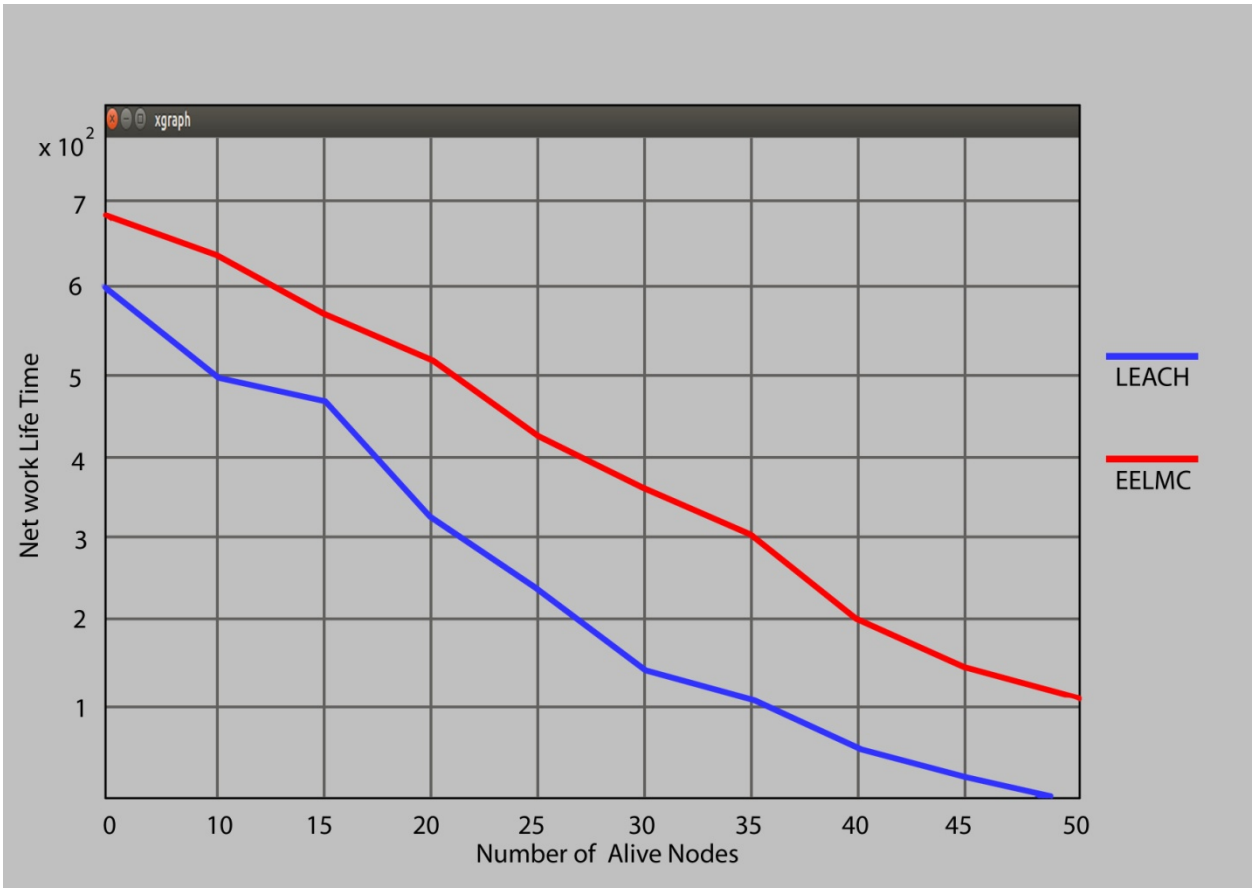


FIG 4.2 Life Time of the Network

5. CONCLUSION

To evaluate the performance of the proposed protocol NS2 is used an open source simulator. The reference comparison is the leach protocol. The results vary the number of sensor node up to 50. The heterogeneous nodes are deployed, randomly within a square area of 100 x100. In each test, the simulation time is set to 700s. The data packets are generated every 0.2 s. Compared to the result obtain with LEACH, The increasing number of nodes deployed in the network increases the energy consumption in both protocols. Nevertheless energy efficient layer multi-hop cluster protocol consumes less than 10% of average energy compare to LEACH by taking into an account the energy constraint in the selection of cluster head nodes and the cluster formation mechanism. It's clear that the lifetime of the nodes decreases proportionally with the increased number of nodes deployed in the network.

6. FUTURE SCOPE

The simulation result shows that Energy Efficient Layer Multi-hop Cluster protocol outperformed LEACH, in terms of energy efficiency and network lifetime. As future work, the protocol may applicable to extend the node and study the performance of Energy Efficient Layer Multi-hop Cluster protocol in the presence of mobility.

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