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Design of an Energy Efficient Information Gathering Routing Algorithm in WSN

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***Abstract*-- In this paper, WSN proposes to design an energy-efficient routing protocol for the collection of data. One of the key tasks of the sensor nodes in the Wireless Sensor Network (WSN) is to collect data and forward the collected data to the base station (BS). We are creating an energy routing protocol in this paper that can be accessed by nodes with the full residual energy for energy-efficient routing. Hence, to forward the data to BS, the highest residual energy nodes are chosen. This helps to provide a higher packet distribution ratio for a lower use of resources. The LEACH protocol and fuzzy C-means routing protocol have been chosen here. We are implementing authentication methods for data collection here along with the leach protocol. The data from the authenticated nodes is stored at the head of the cluster. RSA is used here for authentication purposes.**

***Keywords*-- Base Station (BS), Wireless Sensor Network (WSN), Energy Efficient Routing Protocol, LEACH protocol, Fuzzy C-means (FCM), Authentication, RSA.**

I. Introduction

The features of wireless sensor networks involve more efficient data forwarding and processing techniques. The sensor nodes have a restricted transmission range in WSN and are also restricted in their processing and storage capacities as well as their energy resources. Wireless sensor network routing protocols are responsible for maintaining the routes on the network and must, under these circumstances, ensure effective multi-hop communication. In this paper, we give an overview of Wireless Sensor Network routing protocols and compare their strengths and limitations.

In WSNs, routing approaches have to cope with a range of difficulties and design problems. Sensor nodes in WSNs also have drawbacks, such as limited battery capacity, bandwidth limits, limited processing power and limited memory, despite advancements in technology. It generates the need to be highly flexible and resource conscious for routing protocols. Some of the routing protocol challenges are:

1. Node deployment in either random or pre-determined manner.
2. Data reporting method which can be a time-driven, event-driven, query-driven or a hybrid o of all of these methods.
3. Trade-off between energy consumption and accuracy of data gathered.
4. Node failure tolerance of the network. Scalability, where routing method should be able to work with large networks.
5. Routing method should be adaptive for mobile sensor nodes.
6. Should support data aggregation to reduce redundant data.

Routing protocols in WSNs have a common objective of efficiently utilizing the limited resources of sensor nodes in order to extend the lifetime of the network. Different routing techniques can be adopted for different applications based on their requirements. Applications can be time critical or requiring periodic updates, they may require accurate data or long lasting, less precise network, they may require continuous flow of data or event driven output. Routing methods can even be enhanced and adapted for specific application. Generally, the routing protocols in WSNs can be classified into data-centric, hierarchical, location based routing depending on the network structure as shown in figure 3. In data-centric, all the nodes are functionally equivalent and associate in routing a query received from the base station to the event. In hierarchical approach, some nodes have added responsibilities in order to reduce the load on other nodes in the network. In location based, the knowledge of positions of sensor nodes is exploited to route the query from the base station to the event.

Data gathering is an efficient method for conserving energy in sensor networks. The major purpose of data gathering is to remove the redundant data and save transmission energy. A data-gathering algorithm includes some aggregation methods to minimize the data traffic. It reduces the number of message exchange among the nodes and BS. The performance of data gathering in WSN can be characterized based on the rate at which the sensing information can be gathered and transmitted to the BS (or sink node). In particular, the speculative measure to capture the demerits of collection processing in WSN is the capacity for many-to-one data collection.

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Data-gathering capacity reflects how efficient the sink can gather sensing data from all sensors under the presence of interference. Performing the data- gathering function over CH still causes significant energy wastage. In case of homogenous sensor networks, CH will soon die and re-clustering needs to be initiated. It causes higher energy consumption.

II. RELATED WORK

Zhu et.al[1], proposed an energy-efficient algorithm for data collection to increase the lifespan of the network. To remove the mutual transmission and loop transmission between the nodes, a data gathering sequence (DGS) was used. A mathematical programming model was also used to measure among the nodes the minimum remaining energy and overall energy consumption. A genetic algorithm was later applied to determine the optimal solution to the problem of programming.

Dhilip et.al[12], for the heterogeneous WSN, suggested an energy-efficient clustering and data aggregation protocol. This protocol was built on the basis of data aggregation ideas on cluster-based energy-efficient routing. The cluster head election technique was used, and based on the amount of residual energy used for data transmission, the routing route was chosen.

Wei et.al[13], introduced an energy-efficient solution for WSN clustering. For the measurement of the required cluster size, a distributed clustering algorithm was used.

Based on the hop distance from the source to sink, it was decided. To validate the cluster's effectiveness and measure the end-to - end delay, an energy-efficient multi hop data collection protocol was implemented.

To optimise the lifespan, Xiang et.al[14], proposed an energy-efficient clustering algorithm. To decrease the energy conservation among the nodes, the clustering algorithm with optimum parameters was used. One hop distance and clustering angle analytical clustering was used. Moreover, by reducing the energy consumption between the inter and intra clusters, the optimum one-hop distance and clustering angle were conveyed. The continuous process is repeated for each cluster until the optimum number of clusters has been obtained. It decreases the frequency of cluster head updates and greatly reduces the energy needed to set up a cluster head.

III. PROPOSED SYSTEM

This section explains the architecture of the proposed system. It mainly includes:

a. Network Initialization

Network initialization is to specify various network parameters before actually starting a network. The parameters include the working channel, the network identifier, and network address allocation.

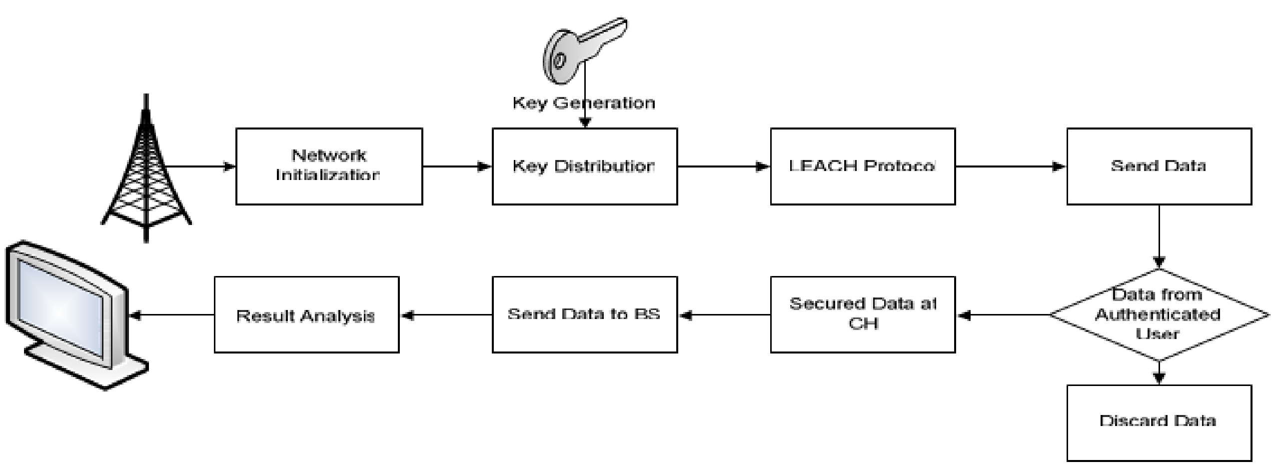

Figure 1: Proposed Architecture

b. Generation of RSA Key Pair

Each node which desires to participate in communication using encryption needs to generate a pair of keys, namely public key and private key. The process followed in the generation of keys is described below

1) Generate the RSA modulus (n)
   - Select two large primes, p and q.
   - Calculate n=p*q. For strong unbreakable encryption, let n be a large number
2) Find Derived Number (e)
   - Number e must be greater than 1 and less than (p − 1)(q − 1).
   - here must be no common factor for e and (p − 1)(q − 1) except for 1.
   - In other words two numbers e and (p – 1)(q – 1) are coprime.
3) Form the public key
   - The pair of numbers (n, e) forms the RSA public key and is made public.
   - Interestingly, though n is part of the public key, difficulty in factorizing a large prime number ensures that attacker cannot find in finite time the two primes (p & q) used to obtain n. This is strength of RSA.
4) Generate the private key
   - Private Key d is calculated from p, q, and e. For given n and e, there is unique number d.
   - Number d is the inverse of e modulo (p - 1)(q – 1). This means that d is the number less than (p - 1)(q - 1) such that when multiplied by e, it is equal to 1 modulo (p - 1)(q - 1).
   - This relationship is written mathematically as follows –

$$ed = 1 \bmod (p-1)(q-1) \quad (1)$$

c. LEACH Protocol

In Low Energy Adaptive Clustering Hierarchy (LEACH), a hierarchical protocol in which most nodes transmit to cluster heads is presented. The operation of LEACH consists of two phases:

The Setup Phase: In the setup phase, the clusters are organized and the cluster heads are selected. In every round, a stochastic algorithm is used by each node to determine whether it will become a cluster head. If a node becomes a cluster head once, it cannot become a cluster head again for P rounds, where P is the desired percentage of cluster heads.

The Steady State Phase: In the steady state phase, the data is sent to the base station. The duration of the steady state phase is longer than the duration of the setup phase in order to minimize overhead.

d. fuzzy C-means-based routing protocols

The fuzzy C-means algorithm (FCM) has been used in cluster analysis, pattern recognition, image processing, and so forth. In the context of WSNs, this algorithm assigns each sensor node to a cluster with a degree of membership. Here we have proposed to overcome the issue of uneven distribution of sensor nodes of LEACH protocol. A uniform creation of clusters in randomly deployed sensor networks was performed where the total spatial distance among the sensor nodes within each cluster was minimized. However, these protocols are centralized hierarchical protocols where the cluster formation and CH election are carried out at the BS. This in turn adversely effects the network's energy consumption since the residual energy and the geographical location of all alive sensor nodes are delivered to the BS at the end of each round. Furthermore, the CH election mechanism is only based on the highest residual energy factor for the non-CH competitors within each cluster; this can lead to the election of an inappropriate CH where its distance is not optimal from the rest of the sensors in the same cluster and to its BS.

e. Send Data

In this phase data are gathered from all CH and passing it to authentication process.

f. Data from authenticated User

Data received from each node is checked for authentication using key generated from RSA. Data which are not from the authenticated uses those data packets are dropped.

As the next step, all the authenticated data are collected at every Cluster head (CH) and processed it to Base station (BS).

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IV. RESULTS

In this section explains the results of the proposed system. Figure 2 shows the initial network initialization, In figure 3 shows the key distribution from base station to all the other nodes.Figure4 shows the cluster formation.

As the next part of results we have computed some performance parameters for result analysis and plot the graphs for the values shown in graph1,2&3.the have plotted the values for the existing methods to our proposed methods.

i. Energy:

The Energy of the route is used find out the total energy consumed over the entire route. The Energy Consumption between two nodes is given by

$$E_{?} = 2E_{?} + E_{?}d^{?} \quad (2)$$

ii. Packet delivery ratio

It is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as:

$$\mathrm{PDR} = \mathrm{S1} \div \mathrm{S2} \quad (3)$$

Where, S1 is the sum of data packets received by the each destination and S2 is the sum of data packets generated by the each source. Graphs show the fraction of data packets that are successfully delivered during simulations time versus the number of nodes.

iii. End-to-end Delay:

The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and data packet transmission. Only the data packets that successfully delivered to destinations that counted. The lower value of end to end delay means the better performance of the protocol. Graph 2 describes end-to- end delay our proposed system .It is calculated using:

?(arrive time − send time)/ ? Number of connections. (4)

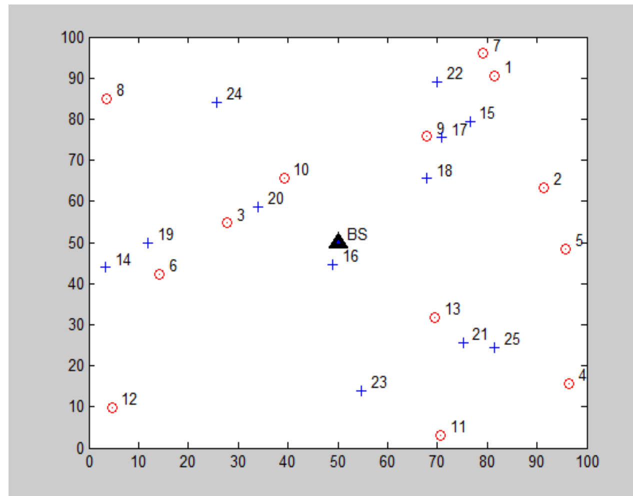

Figure 2: Network Initialization.

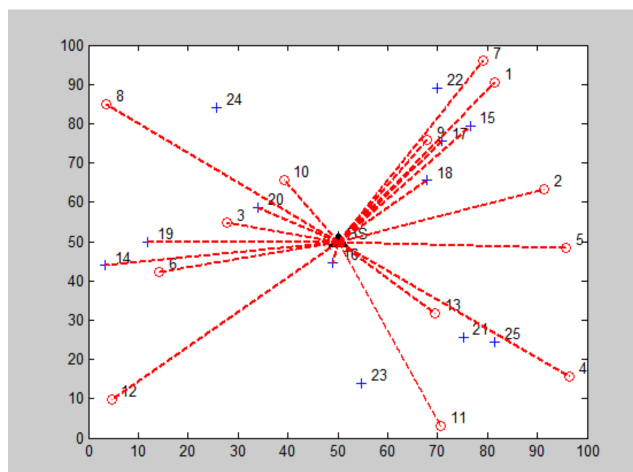

Figure 3: Key distribution

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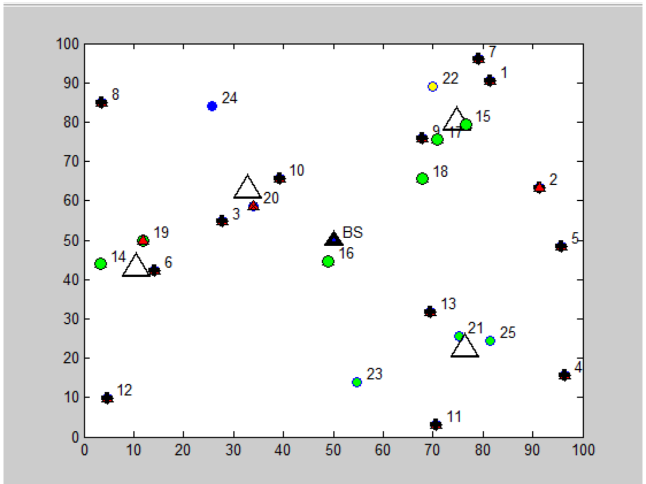

Figure 3: Cluster Formation

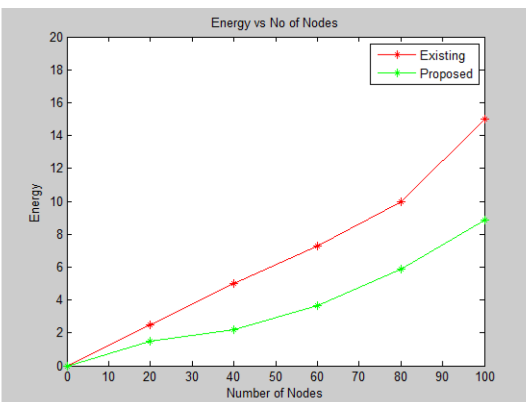

Figure 4: Graph of Comparison of Energy vs. No. of. Nodes.

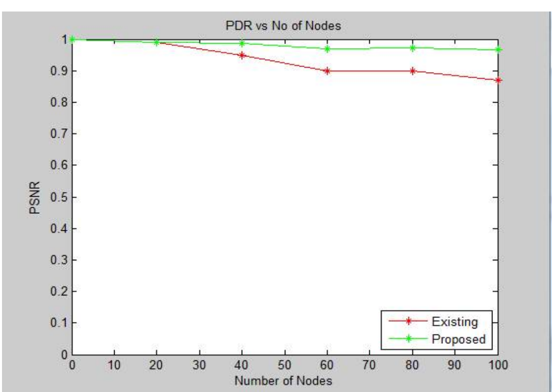

Figure 5: Graph of Comparison of PDR vs. No. of. Nodes

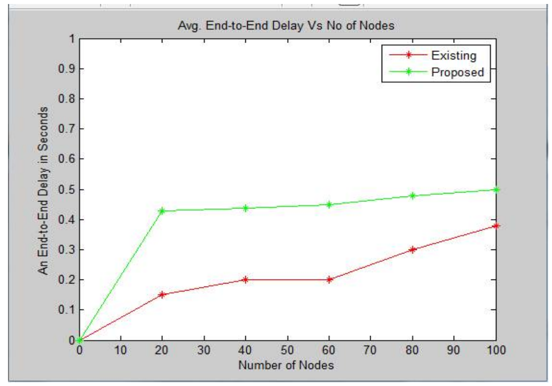

Figure 6:Graph of Comparison of End-to-End Delay vs. No. of. Nodes

V. CONCLUSION

Routing protocols in WSNs have a common objective of efficiently utilizing the limited resources of sensor nodes in order to extend the lifetime of the network and Data gathering is an efficient method for conserving energy in sensor networks. In this paper our proposed method for designing energy efficient routing protocol is archived using LEACH is used as energy efficient protocol and Fuzzy C-means-based routing protocol are considered good solutions to improve the network lifetime to optimize the cluster structure.RSA based authentication check provides us a secured data gathering in WSN.

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