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Design of Energy Efficient Routing Protocol for Data Gathering in WSN

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ABSTRACT: in this paper proposes for design of energy efficient routing protocol for data gathering in WSN. One of the major tasks of the sensor nodes is the collection of data and forwarding the gathered data to the base station (BS) in Wireless Sensor Network (WSN). In this paper we are designing an energy routing protocol, the energy-efficient routing can be obtained by nodes which have the maximum residual energy. Hence, the highest residual energy nodes are selected to forward the data to BS. It helps to provide better packet delivery ratio with lesser energy utilization. Here we have selected LEACH protocol and fuzzy C-means routing protocol. Here along with leach protocol we are adding authentication method for data collection. Data from the nodes that are authenticated are collected at the cluster head. Here for authentication purpose the RSA is being used.

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

I. INTRODUCTION

The characteristics of wireless sensor networks require more effective methods for data forwarding and processing. In WSN, the sensor nodes have a limited transmission range, and their processing and storage capabilities as well as their energy resources are also limited. Routing protocols for wireless sensor networks are responsible for maintaining the routes in the network and have to ensure reliable multi-hop communication under these conditions. In this paper, we give a survey of routing protocols for Wireless Sensor Network and compare their strengths and limitations.

Routing methods in WSNs have to deal with a number of challenges and design issues. Despite advancement in technology, sensor nodes in WSNs still have restrictions such as limited battery power, bandwidth constraint, limited computing power and limited memory. It creates the need for routing protocols to be highly adaptive and resource aware. Some of the challenges of routing protocol 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. 6. Routing method should be adaptive for mobile sensor nodes. 7. 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

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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. 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], presented an energy-efficient data-gathering algorithm to improve the network lifetime. A data gathering sequence (DGS) was used to eliminate the mutual transmission and loop transmission between the nodes. Also, a mathematical programming model was used to compute the minimal remaining energy and total consumption of energy among the nodes. Later, a genetic algorithm was applied to identify the optimal solution for the programming problem.

Dhilip et.al [12], proposed an energy-efficient clustering and data aggregation protocol for the heterogeneous WSN. This protocol was designed based on the ideas of data aggregation on energy-efficient cluster-based routing. The cluster head election technique was used, and the routing path was selected based upon the sum of residual energy used for data transmission.

Wei et.al [13], introduced an energy-efficient clustering solution for WSN. A distributed clustering algorithm was used to calculate the appropriate cluster size. It was determined based on the hop distance from the source to sink. An energy-efficient multi hop data-gathering protocol was applied to validate the effectiveness of the cluster and calculate the end-to-end delay.

Xiang et.al[14], proposed an energy-efficient clustering algorithm to maximize the lifetime. The clustering algorithm with optimum parameters was used to reduce the energy conservation among the nodes. An analytical clustering with one hop distance and clustering angle was used. Moreover, the optimal one hop distance and clustering angle were conveyed by reducing the energy consumption between inter and intra cluster. For each cluster, the continuous procedure gets repeated until the optimum number of clusters was obtained. It reduces the frequency of updating the cluster head and significantly reduces energy to establish 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.

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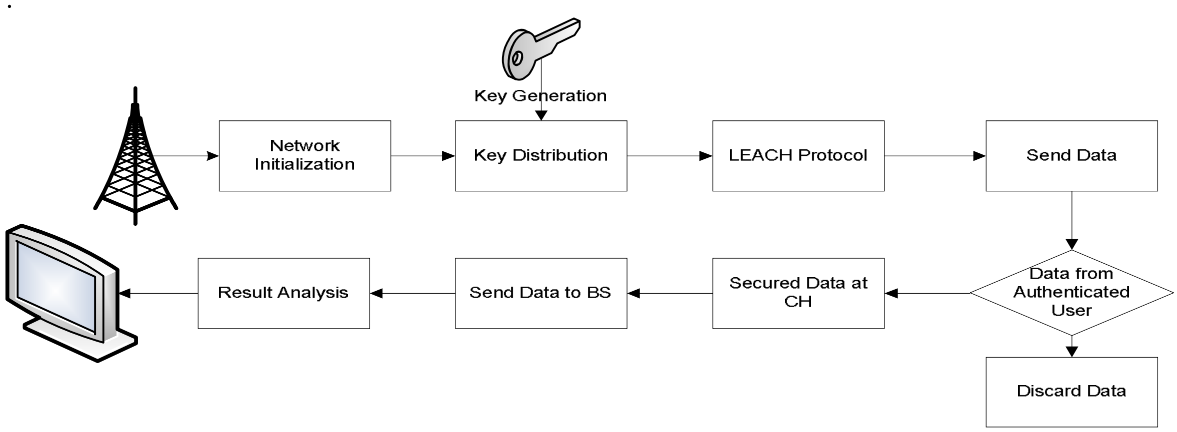

Figure 1: Proposed Architecture

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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 –

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

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.

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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).

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

$$E_c = 2E_{TX} + E_{gen}d^{\gamma} \quad (2)$$

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:

$$PDR = S1 \div S2 \quad (3)$$

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:

$$\sum(\text{arrive time} - \text{send time}) / \sum \text{Number of connections.} \quad (4)$$

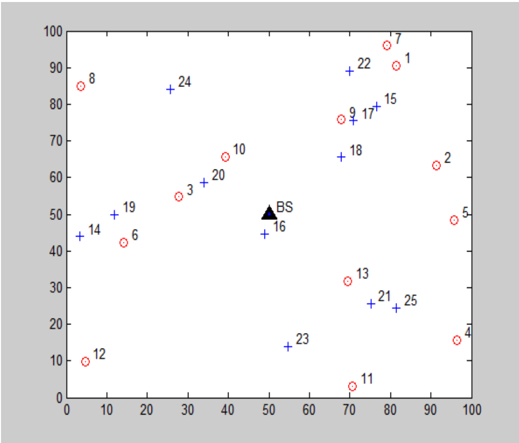

Figure 2: Network Initialization.

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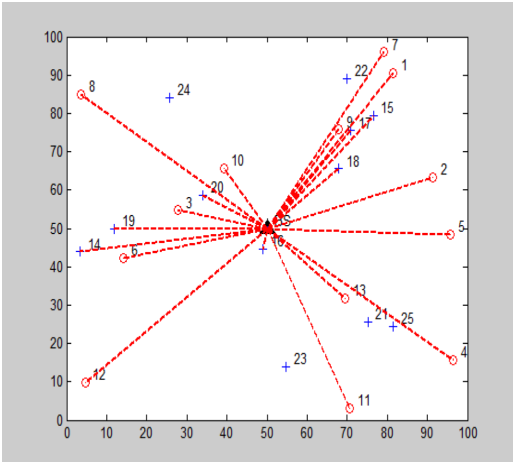

Figure 3: Key distribution

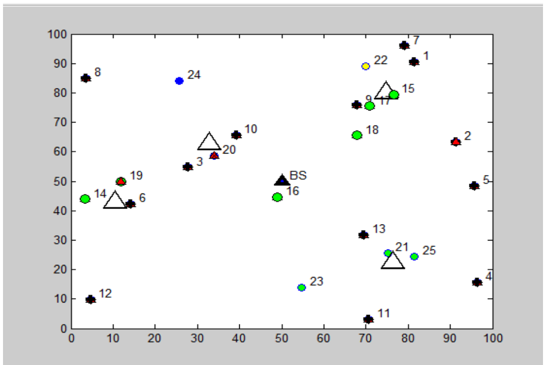

Figure 3: Cluster Formation

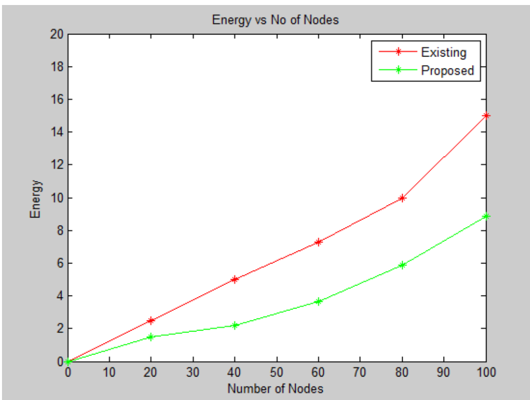

Figure 4: Graph of Comparison of Energy vs. No. of. Nodes.

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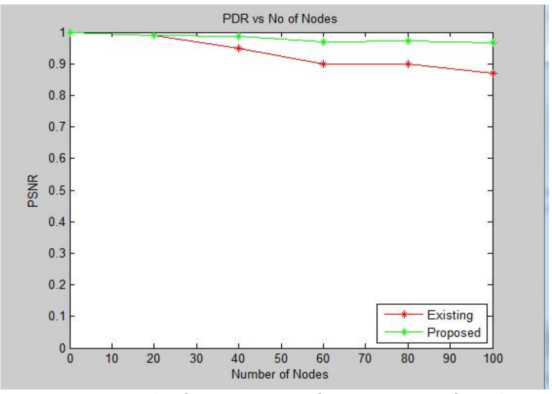

Figure 5: Graph of Comparison of PDR vs. No. of. Nodes

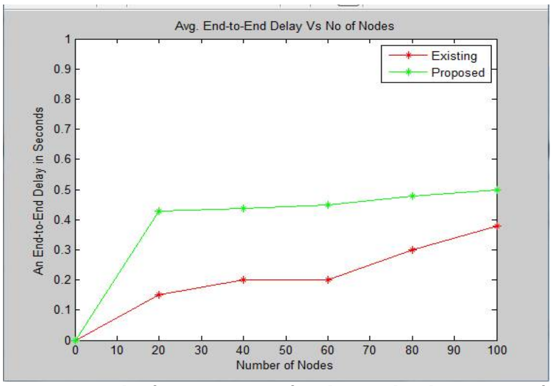

Figure 6:Graph of Comparison of End-to-End Delay vs. No. of. Nodes

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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