WIRELESS SENSOR BASED ENERGY EFFICIENT NETWORKS USING LEACH PROTOCOLS

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ABSTRACT

A wireless sensor network (WSN) consists of a huge number of sensor nodes that are inadequate in energy, storage and processing power. One of the major tasks of the sensor nodes is the collection of data and forwarding the gathered data to the base station (BS). Hence, the network lifetime becomes the major criteria for effective design of the data gathering schemes in WSN. In this paper, an energy-efficient LEACH (EE-LEACH) Protocol for data gathering is introduced. It offers an energy-efficient routing in WSN based on the effective data ensemble and optimal clustering. In this system, a cluster head is elected for each cluster to minimize the energy dissipation of the sensor nodes and to optimize the resource utilization. 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. The experimental results shows that the proposed EE-LEACH yields better performance than the existing energy-balanced routing protocol (EBRP) and LEACH Protocol in terms of better packet delivery ratio, lesser end-to-end delay and energy consumption. It is obviously proves that the proposed EE-LEACH can improve the network lifetime.

Keywords: Leach, WSN, V-Leach, I-Leach, Leach-C.

I. INTRODUCTION

Wireless sensor networks (WSNs) are composed of nodes typically powered by batteries, for which replacement or recharging is very difficult. With finite energy, we can only transmit a finite amount of information. Therefore, minimizing the energy consumption for data transmission becomes one of the most important design considerations for WSN. Unfortunately, the channel fading has a great effect on the reliability of data transmission and energy consumption in WSN. Cooperative diversity represents a potential candidate to combat the effects of channel fading by exploiting diversity gain achieved via cooperation among the relays nodes.

A wireless sensor network (WSN) consists of a large number of small-sensor nodes used to monitor areas, collect and report data to the base station (BS). Due to the accomplishment in low-power digital circuit and wireless transmission, most of the applications of WSN are implemented and used in military applications, object tracking, habitat monitoring. A typical WSN is composed of a huge number of sensor nodes, which are randomly disseminated over the network. The signals are picked by all types of sensors and the data acquiring unit, processing and transmitting them into a node called *sink node*. The sink node requests for the sensor information by forwarding a query throughout the network. When the node discovers the data matching the query, the response message is routed back to the sink node. The energy conservation of the network can be minimized by allowing the porting of the nodes called cluster heads. The data gathered from the nodes are aggregated and compressed by the cluster heads. After that, the aggregated data is forwarded to the BS, but it has some problems. The major problem is energy consumption and it is concentrated on the cluster heads. In order to resolve this issue, the cluster routing is used to distribute the energy consumption with the cluster heads.

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. 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.

In this paper, an energy-efficient LEACH Protocol is introduced. The proposed method focuses on defining an energy-efficient routing based on low energy adaptive clustering hierarchy (LEACH) clustering and optimal cluster head (CH) selection. The Gaussian distribution model is incorporated for the node deployment. The data are forwarded from the different sources to the BS based on the energy-efficient routing strategy. The rest of the paper is organized as follows. Section 2 presents a description about the previous research which is relevant to energy-efficient data-gathering approaches.

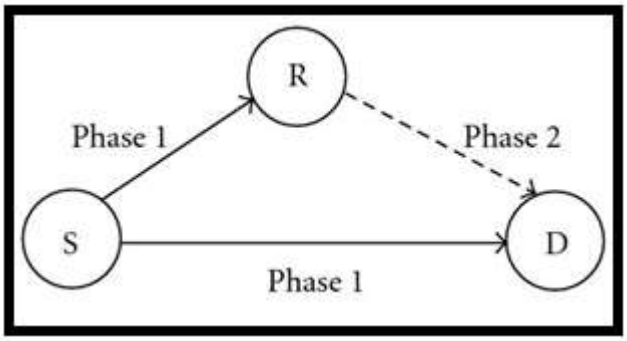

Figure: Typical scenario model in WSN

LEACH PROTOCOL:

LEACH is an adaptive clustering routing protocol proposed by Wendi B.Heinzelman, et al. The implementation process of LEACH includes many rounds. Each round has a setup phase and the steady data transmission phase. In the set-up phase, the cluster head nodes are randomly selected from all the sensor nodes and several clusters are constructed dynamically. In the steady data transmission phase, member nodes in every cluster send data to their own cluster head, the cluster head compresses the data that received from member nodes and sends the compressed data to the sink node. All the sensor nodes generate a random number between 0~1, and if it is less than a threshold T(n) , the sensor nodes will broadcast an announcement message to notify others that it is a cluster head. In each round, if a node has been elected as a cluster head, its T(n) is set to zero, so that the node will not be elected as a cluster head again. The working of LEACH is divided into rounds. Each round starts with a set-up phase when the clusters are organized, followed by a steady-state phase when data are transferred from the nodes to the cluster head and on to the BS [8].

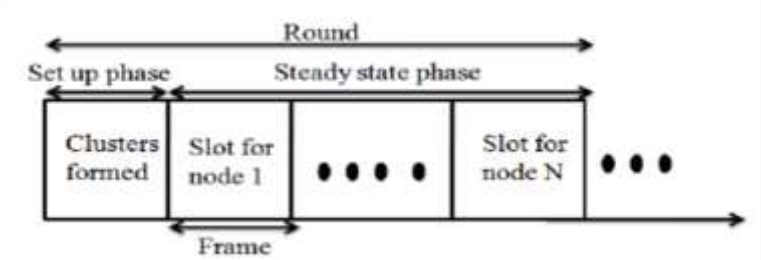

Figure: Cluster Frame

Set-up Phase: During the setup phase, the CHs are selected based on an elective percentage of deployed nodes also by considering a factor that so far how many times an individual node performed the role of cluster-head. The selection depends on decision made by the node by choosing a random number lies between 0 - 1. If chosen the number is less than a set threshold T(n) then the sensor node becomes a cluster-head for the existing round.

Steady State Phase: Steady Sate operation is broken into frames, where nodes send their data to the Clusterhead at most once per frame during their allocated slot. Cluster-Head sends the aggregated data to Base-Station (BS) in one hop manner.

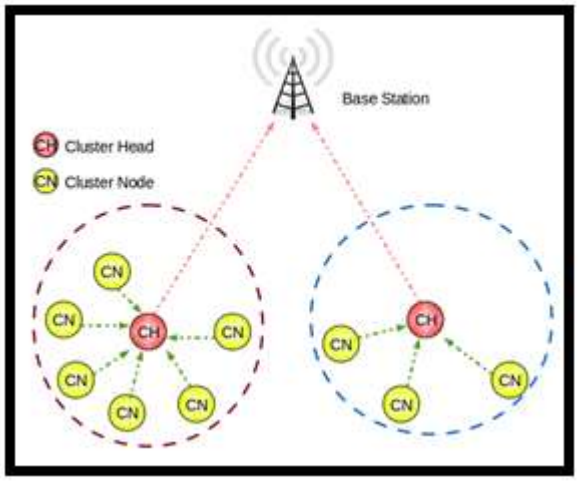

Figure: LEACH Architecture

There are some drawbacks of LEACH protocol: It uses single-hop routing where each node can transmit directly to the cluster-head and the sink. CHs are elected randomly; hence there is Possibility that all CHs will be concentrated in same area. The idea of dynamic clustering is used which leads to extra overhead due to cluster head changes, advertisements etc. The protocol assumes that all nodes are having same amount of energy. It also assumes that CH consume around the same amount of energy for each node. As LEACH protocol is one of the most important energy saving protocol but have some drawbacks. Many researchers worked on LEACH to improve the performance and remove the drawbacks.

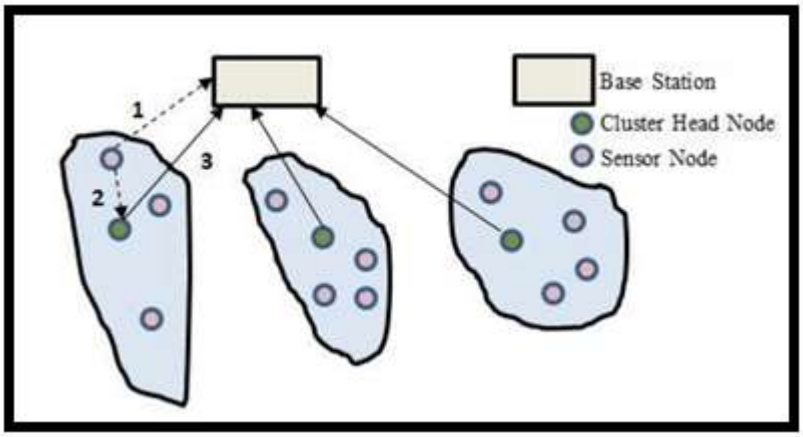

Figure: Representation of Nodes and Base station

LEACH-B (Balanced Low Energy Adaptive Clustering Hierarchy): Mu Tong and Minghao Tang proposed LEACH-B algorithm to balance the number of cluster heads based on the residual energy of the sensor nodes. LEACH-B uses decentralized approach of cluster formation in which each sensor node knows about its own position and position of final destination irrespective of position of rest of the nodes in the network. LEACH-B works in three stages: Cluster head selection, Cluster formation and data transmission with multiple accesses. According to energy dissipated in the path between a node and final receiver, each node chooses its cluster head. LEACH-B has better energy efficiency than basic LEACH protocol [11].

LEACH-C(Centralized Low Energy Adaptive Cluster Head): A modification over the LEACH protocol that uses a centralized clustering algorithm and the same steady state phase protocol [8] same as LEACH is called as centralized low energy adaptive cluster head (LEACHC) protocol. During setup phase of LEACH-C, each node sends the current location and remaining energy of itself to the base station. The location can be determined by GPS system or any other tracking method. In addition to determine good cluster head the base station will elect only those nodes which have energy above average level and ensure that the energy load is evenly distributed among all the nodes. Once the cluster heads and linked clusters are found, the BS broadcasts a message that contains the cluster head ID for each node. If a node's cluster head ID matches its own ID, the node is a cluster head; otherwise, the node determines its TDMA slot for data transmission and goes to sleep until it is time to transmit data. The steady-state phase of LEACH-C is same as that of LEACH.

LEACH-E (Energy Low Energy Adaptive Clustering Hierarchy): In LEACH-E protocol, initially all nodes have same energy and same probability of becoming the cluster head. After the first round, energy level of each node changes. Then the amount of residual energy of each node is used to select cluster head nodes. The nodes with highest residual

energy are preferred on rest of the nodes. LEACH-E enhance lifetime of network by balancing energy load among all nodes in the network [11].

LEACH-F (Fixed number of cluster Low Energy Adaptive Clustering Hierarchy): In 2000, Heinzelman proposed LEACH-F a modified version of LEACH with fixed clusters and rotating cluster heads [10]. This protocol uses centralized approach for cluster formation as that of LEACH-C. Once the cluster formation process is done, then there is no re-clustering phase in next round. The clusters are fixed and only rotation of cluster head nodes within its clusters. The steady-state is same as classical LEACH. The overhead of re-clustering in basic LEACH is removed by LEAC-F protocol as once the fixed number of clusters is formed; they are maintained throughout the network. But this protocol provides no flexibility of adding or removing the nodes once clusters are formed and nodes cannot adjust their behaviour on node dying.

MH-LEACH (Multi-Hop Low Energy Adaptive Clustering Hierarchy): In LEACH protocol, the cluster head nodes send data to the base station directly irrespective of distance between them. This will cause high energy dissipation of cluster head node if base station is located far away from it. As the network diameter increases, the distance between base station and cluster head nodes increases and this is disadvantages of LEACH protocol. To increase energy efficiency of the protocol, multi-hoping communication is introduced. Firstly cluster member nodes send data to their respective cluster head nodes which further transfer data to cluster head rather than base station directly. This protocol adopts an optimal path between cluster head and the base station [13].

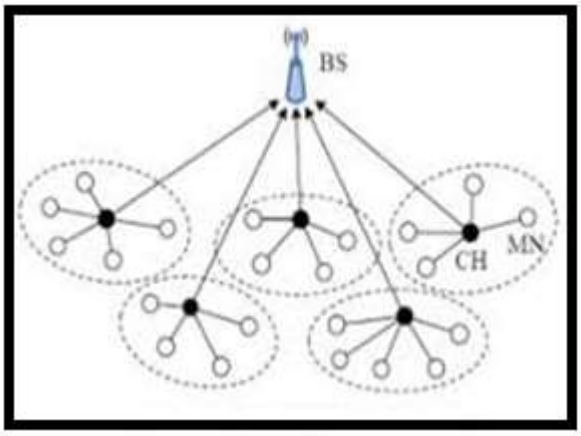

Figure: Basic Topology of LEACH

LEACH-M (Mobile Low Energy Adaptive Clustering Hierarchy): Mobility issue in LEACH protocol was resolved by introducing LEACH-M protocol. This protocol provides mobility to the both non-cluster head nodes and cluster head nodes while the set-up and the steady state. Nodes are homogeneous and location of each node is calculated by GPS. The nodes with minimum mobility and the lowest attenuation are being selected as cluster head nodes and the role of cluster head nodes is broadcasted to all nodes within its transmission range.

ADVANTAGES AND DISADVANTAGES OF LEACH

The various advantages of LEACH protocol are:

1. The Cluster Heads aggregates the whole data which lead to reduce the traffic in the entire network.
2. As there is a single hop routing from nodes to cluster head it results in saving energy.
3. It increases the lifetime of the sensor network.
4. In this, location information of the nodes to create the cluster is not required.
5. LEACH is completely distributed as it does not need any control information from the base station as well as no global knowledge of the network is required.

Besides the advantages of LEACH it also has some demerits [11], [12] which are as follows:

1. LEACH does not give any idea about the number of cluster heads in the network.
2. One of the biggest disadvantage of LEACH is that when due to any reason Cluster head dies, the cluster will become useless because the data gathered by the cluster nodes would never reach its destination i.e. Base Station.
3. Clusters are divided randomly, which results in uneven distribution of Clusters. For e.g. some clusters have more nodes and some have lesser nodes. Some cluster heads at the center of the cluster and some cluster heads may be in the edge of the cluster; this phenomenon can cause an increase in energy consumption and have great impact on the performance of the entire network.

Sr. No.	Paper Title	Method Used	Advantages	Disadvantages
1.	LEACH: An Energy Efficient Routing Protocol using Omnet++ for Wireless Sensor Network[1]	Low Energy Adaptive clustering Hierarchy	1: Periodic rotation among cluster head nodes so every node gets a chance to become cluster head. 2: distribution of energy consumption between nodes.	Some of cluster heads concentrate in a particular area of the network. Therefore some non-cluster head nodes may become orphan nodes
2.	Improving Lifetime of Wireless Sensor Networks by Mitigating Correlated Data using LEACH Protocol[2]	Improved Lifetime Low Energy Adaptive Clustering Hierarchy	The correlated data transmissions is reduced which helps in energy conservation and less congestion in the network. The proposed approach helps improve lifetime of a wireless sensor network at an average of 30.006 %.	Grouping through TSC can lead to exclusion of an node with high power which is outside its coverage range
3.	H-LEACH: Hybrid-Low Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks[3]	Hybrid low energy adaptive clustering hierarchy.	The disadvantages of HEED is overcome i.e. it cannot be operated for different levels of energy considerations from the first round	Node is declared dead if it lacks in energy
4.	OE-LEACH: An Optimized Energy Efficient LEACH Algorithm for WSNs[4]	Optimized Energy- Low Energy Adaptive Clustering Hierarchy	1: Enhancement of steady phase of LEACH Method. 2: Improvement in terms of stability period, network lifetime and throughput of the network.	Overhead of frames, and only for the idle nodes in the network.
5.	LEACH-T: LEACH Clustering Protocol Based on Three Layers[5]	Low Energy Adaptive Clustering Hierarchy-Three Layer	Eliminates the distance issue of LEACH protocol	Only suitable if the distance between nodes is long.

II. LITERATURE SURVEY

Wendi B.Heinzelman.et.al(2002)

When we set hundreds or thousands of cheap microsensor nodes in a network they allows users for combining the data from the individual nodes by accurately monitoring a remote environment. In this network robust wireless communication protocols are required which is energy efficient and provide low latency. In this paper, the author develop a protocol architecture called LEACH for microsensor networks that combines the idea of both media access and energy-efficient cluster-based routing with application-specific data assembling for the achievement of good performance in terms of latency, system lifetime and application-perceived quality. A new distributed cluster formation technique in LEACH is used that enables self-organization of numbers of nodes, rotating cluster head positions for even distribution of the energy load among all the nodes and algorithm for adapting cluster. Author's results show that the system lifetime improves by LEACH by an order of magnitude compared with general-purpose multihop approaches [1].

Mortaza Fahimi Khaton Abad.et.al(2011) Research on WSN has received much attentive as they offer an advantage of monitoring different kinds of environment by sensing physical phenomenon. The important application of the sensor network applications are scalability, Prolonged network lifetime and load balancing. For achieving these goals cluster sensor nodes technique is used. In this paper the author introduce an LEACH based energy efficient clustering algorithm for sensor networks.WSN uses LEACH which is the most popular cluster-based structures. TDMA and MAC both are used by LEACH for balancing the energy consumption. The proposed protocol integrated some feature to LEACH for reducing the consumption of energy in each round. The result of proposed work shows a significant reduction in network energy consumption compared to LEACH[4].

Tripti Sharma.et.al(2012)

WSN is the network in which power-limited sensing devices are present these are called sensors. These sensors spread in a region for sensing different types of information which is present in the environment. The considerable amount of energy is dissipated when these sensors sense and transmit data to other sensors nodes which are present in the network. In this paper, F-MCHEL is propose which is a homogeneous energy protocol. In LEACH protocol on the basis of threshold values clusters are formed; whereas, in the proposed protocol we use fuzzy logic approach for electing the cluster-head based on two form - energy and proximity distance. The master cluster head is elected out of the previously elected cluster heads. Master cluster head is having the maximum residual energy if the energy is low so it is not called as a master cluster head. In conventional LEACH all cluster heads are send the aggregated information to the BS but in the proposed protocol only master cluster head is used for sending the information to the BS. Simulation results on MATLAB shows that this proposed protocol provides better stability period, higher energy efficiency and lower instability period as compared to LEACH protocol. Results obtained shows that an suitable Master cluster-head election can enhance the lifetime of the network and reduce the energy consumption [5].

Mona El_Saadawy. et.al(2012)

Security solutions for WSN are not developed easily due to the dangerous nature of wireless medium and limited availability of resources in WSN. The encryption/decryption algorithms are the most essential part of the secure communication and their implementation is very intricate in WSNs. since they integrated routines that having very complex and intense computing procedures. In WSN the designing of a secure clustering protocol that achieves the desired security goals while keeping an acceptable level of energy consumption is a very challenging task. LEACH protocol is a basic clustering-based routing protocol for WSNs. S-LEACH is the modified version of LEACH which protect against the outside attack by using cryptographic technique. This paper proposes MS-LEACH for enhancing the security of S-LEACH by offering data confidentiality and node to CH authentication by using pair wise keys which is shared between their cluster members and the CHs. MS-LEACH has efficient security properties and achieves all goals of the WSN security. The result shows that the protocol accomplish the in demand security goals and perform better than other protocols in terms of energy consumption, network [6].

Baiping Li.et.al(2012)

Alisha Gupta.et.al(2013)

Encryption schemes which are operated over ciphertext are of extreme importance for WSN & especially in LEACH protocol. Energy is the salient limit of LEACH. Due to this limitation, the designing of a confidentiality scheme for WSN is important by doing this the sensing data can be transmitted to the receiver efficiently and securely and at the same time energy consumed must be minimum. Hence the author proposed LEACH-HE in which homomorphic encryption is added to LEACH protocol. The homomorphic encryption is the confidentiality scheme in LEACH-HE. In this encryption technique algebraically aggregation of data is occurring the decryption of data hence energy consumption is less. In this proposed work results are obtained in terms of three forms - amount of data transmitted, total energy consumed and number of nodes alive. The performance of LEACH_HE is somewhat similar to LEACH[8].

Muneer Alshowkan. et. al(2013)

Working with WSN is a challenging task because in this many challenges are present such as the limited resource in processing power, energy and storage. The security maintenance in WSN is a challenging task due to presence of

A.S.Poornima. et. al (2010)

In WSN large number of nodes is consist of with limited communication capabilities, sensing and computation. In such network resource constrained nodes are present and transmission of data in this is a energy-consuming operation. By reducing the number of bits transmitted on a network the lifetime of a network is increased. The data aggregation method is used for reducing the data transmission. The issues of security such as confidentiality, data integrity and freshness in data aggregation become essential When the WSN is deployed in a remote or hostile environment where sensors are prone to node failures. For achievement of security in data aggregation we use secure data aggregation schemes. In this paper the author propose a Secure Data Aggregation scheme which provides end-to-end data privacy. In this 30%-50%. of the average number of bits transmitted are reduced [2].

Abderrahim Beni Hssane.et.al(2010)

In WSN for increasing the lifetime and scalability of a network we can use a clustering algorithm. In this paper, the author propose a Position-Based Clustering (PBC) algorithm in this algorithm he evaluate a distributed energy-efficient clustering algorithm for heterogeneous WSNs. PBC is an improvement of LEACH-E. The ratio between the remaining energy of network and residual energy of each node give the probabilities on the basis of those probabilities the PBC elected the cluster heads. In this 2 level hierarchy is used by selecting a intermediate node for the data transmission. Moreover, in this a new technique is used for cluster formation which not only based on the

received signal strength of the cluster head's advertisement but also on its position. The lifetime of the whole network is increased by this algorithm and in performs it is better than LEACH, LEACH-E and SEP [3] limited energy. The aim of the paper is reducing the power consumption and improving the current security mechanisms in WSN. The energy routing protocol is provided by LEACH and it do not cover the security requirements. Alternatively, this paper aims to design LS-LEACH (Lightweight Secure LEACH) which is more secure and energy efficient routing protocol. Authentication algorithm is added to this for assuring authenticity, data integrity and availability. Furthermore, this paper shows the improvement over LEACH protocol which makes it more secure and tell how the energy efficiency is increased [9].

Mayur S.et.al(2015)

Hierarchical routing protocol is used by many applications in WSN for routing of the sensed data to the sink, LEACH is one of those application and it is the first and most widely used hierarchical distributed clustering protocol in WSN. Security is the most important factor in WSN because they are prone to intrusion and different types of network attack. The joining of nodes in a cluster head on the bases of Received Signal Strength (RSS) of HELLO packets which are received from CHs making it susceptible to HELLO Flood attack. HELLO Flood attack is detected by either cryptographic approach this approach is less suitable in terms of battery power and memory or non cryptography approach the packet are sending for detection which increases communication overhead as the energy needed for transmission of packet is more than the energy needed for processing. In this author proposed a detection scheme for HELLO Flood attack on the basis of cryptography and non cryptography solutions. The no. of transmission of test packets is reduced in this paper and in this location dependent key (LDK) management scheme is used which provides the security [10].

III. PROBLEM FORMULATION

Several approaches for WSN LEACH protocols and securing connected networks have been presented by researchers. Some of these ideas have been implemented and some implementations have been based on the developers own ideas. Larger networks may favor a more distributed approach where peers are allowed, at their own discretion, to invite new peers they trust to the network. In other networks it may be some other form of relation, such as location or presence that allows users into the network, one such system. This diverse selection of systems and the diversity of peers using them offer and demands different aspects security. Before we are able to identify the complete scope of the problem, we must look at the different levels of security that may be implemented and desirable as per the required system.

IV. CONCLUSION

In this paper literature study can be concluded and how we help in such network through in real education. Such networks help in information technology security. For instance, it can be used for securing the higher education environment without disrupting the openness, accessibility, academic and intellectual freedom which is at the very heart of the higher education environment. It is one of the fundamental process towards the broader security because the further processing steps depends of what types of security breaches has been occurred and what strategies are in place to cope up with these. IT security with the protocols LEACH in Higher education is still a subject of on-going investment and it cannot be conclusively stated that education field is highly secured because of the application, technological and intrusion's diversity. Lastly WSN connected with new ideas and techniques for a secured and authentic network with the help of LEACH protocols.

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