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Authenticated Energy Efficient Clustering Algorithm for secure transmission in Wireless Sensor Networks

V. Asanambigai, A. Ayyasamy

Abstract*: Authenticated energy consumption is the main criteria for constructing the Wireless Sensor Networks (WSNs). Every sensor has the dissimilar processing, communication range, memory unit. Each sensor node has restricted energy and memory. All the WSN based transmission architecture has the problem of authentication. The transmission overload and energy utilization have complex structure to perform the quality of service in WSN routing in a secure way. In spite of providing efficient communication for WSN, clustering approach is used to transmit the data packet from beginning node to the end node. Data gathering helps to organize the network and minimize the network overhead during data communication. Effective cluster head selection method is used for enhanced energy efficiency. Authenticated Energy Efficient Clustering Algorithm (AEEC) is proposed for efficient authenticated energy consumption-based routing methodology for WSN. The effective communication is performed by generating the authentication code within the sensor nodes to construct the innovative secured transmission based framework. The simulation results proved that the proposed method is implemented to reduce the energy consumption, routing overhead, end to end delay and increased amount of throughput compared to the other techniques.

***Index Terms*: WSN, Cluster, Load balancing, Energy utilization.**

I. INTRODUCTION

Wireless Sensor Network is constructed with sensors which can be placed in the surroundings to observe and store the basic information like the temperature, humidity. The data gathered from the senor node is transmitted to the base station for enhanced processing. This kind of construction could be implemented in the inconvenient access of human being. Effective routing methodology will be used to improve the lifetime and improvement in the performance during the communication of data packets in the network.

Mobile users especially for Smartphone users are provided with access to real-time information even when they are away from their home or office.

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* Correspondence Author
V. Asanambigai*, Department of Computer Engineering, Government Polytechnic College, Perambalur, Tamilnadu, India
A. Ayyasamy, Department of Computer Engineering, Government Polytechnic College, Nagercoil, Tamilnadu, India.

WSN is an infrastructure-less self-forming and self-healing network used for voice and data range extension in mission critical applications. The Cognitive and Software Defined Radio (SDR) is a new paradigm for ubiquitous connectivity in tactical radios [1].

The current research work is mostly focused to incorporate WSNs over wideband data waveforms. Most of the tactical radios deployed in the field are High Frequency (HF), Very High Frequency (VHF) or Ultra High Frequency (UHF). Moreover, the next generation SDR will also support all the tactical waveforms. The cognitive communication device seamlessly integrates HF, VHF, UHF, 802.11 radios based mobile ad hoc network with GSM, WiMAX, CDMA, and Satellite networks. Mobile Ad-hoc networks are the basic building blocks to establish ubiquitous connectivity among mobile and fixed nodes in a geographical area. The nodes can either form local WSNs or establish connection with the backbone to communicate with other WSNs, over longer distances. The mobile nodes operate in a wireless environment where multiple media cover patches of specified area [2].

Every sensor node comprises of five elements like sensor unit, ADC, central processing unit (CPU), power unit and communication unit. ADC translates the sensed data and tells the CPU what can be done by the sensor unit. The device gets command or query and transmits information from the CPU to the outside world. The CPU interprets the ADC command or query, monitors the energy, procedures the information obtained, calculates the next hop to the sink, etc .

The routing of WSN can be produced robust and effective by integrating various kinds of local government data: connection quality, node distance, residual energy, and position data. If it is possible to measure some of the system parameters, a routing protocol will be regarded adaptive to adapt to the current network circumstances and available energy levels. These protocols can also be categorized into multi-path-based, negotiation-based, query-based, QoS-based, routing approach that depends on the operation of the 5 protocols. Again, the routing protocols can be categorized into three categories, based on how the source defines the path to the target, as reactive, proactive and hybrid protocols [3]. The former architecture of WSN consists of single central processing station that is connected to several sensor nodes. The recent migrating demands of applications in the wireless focus more on the distributed sensor node networks.

The distributed nature of network cause more than one fourth of energy consumption and are closer placement where the exact location is not known. Multiple sensing nodes need to overcome the information retrieval due to obstacles such as obstruction, line of sight constraint, and so forth. Recently, clustering technique has emerged as popular approach network architecture in WSNs.

Clustering method is an energy-efficient communication protocol, which is used to minimize the entire communication power by cumulative into distinct path for incrementing the network lifetime. Using clustering, the network appears smaller and more stable structure. By the clustering methods the nodes are constructed into tiny disjoint groups where every cluster has a controller referred as CH and nodes. In this approach, a sensor node of a network is segregated into group of clusters. Every cluster has a CH, receives the information from the neighboring nodes that is often redundant and highly correlated [4].

Authentication will play avital role for communicating the valid data within the network. Communication the data within the long distance with multipath routing methodology has been constructed that reduce the network-based threat. An authenticated methodology is the important security metrics for WSN for secured routing for the reliable routing methodology for security.

The paper is organized in sections as the related work is in II, proposed work in III, Performance Evaluation in IV and Conclusion in V.

II. RELATED WORK

Secure Role related routing technique is proposed for dynamic mobile network that was key distribution. The encoding and the decoding methods are implemented with the help of dissimilar key frames. Cyber security technique is used to find the different kinds of threads in dynamic data communication-based systems. Several attacks are identified using this technique.

Muthukumaran et al [5] attempts to calm the energy efficiency at node level and increase the lifetime of the network by proposing a Hierarchical Routing Scheme based on Energy Efficient Cluster (ENEFC). ENEFC's design principle is to rotate the position of Cluster Head among all nodes and to closely determine the cluster sizes at distinct sections of the network in order to minimize energy consumption and also extend the lifetime of the network and energy efficiency.

Wei et al [6] presented algorithm creates greater opportunities for sensor nodes with more residual energy and less traffic load involvement to becoming Cluster Heads. In addition, clusters are structured adaptively in a manner that limits the variation of the proportion between complete cluster energy and total cluster traffic load (ETRatio) in order to balance energy use among clusters. This proposed algorithm presumed that the nodes add traffic load at distinct rates, thus proposing an energy-proficient clustering algorithm by considering both the remaining energy and each node's traffic load contribution during the set-up stage. Performance assessment demonstrates that the suggested method considerably expands the network's constant operating period.

Rao et al [7] Proposed an approach based on Gravitational Search Algorithm (GSA) called GSA-EEC (GSA-based Energy Efficient Clustering). The algorithm is intended with a fresh fitness function and an effective encoding system. The algorithm considers the Euclidian distance from the sensors to gateways and gateways to sink and remaining gateway energy for effective design. To demonstrate the effectiveness of the GSA- EEC, a quantity of clustering methodologies are contrasted.

Chuang et al [8] presented system includes a random statement delay model that selects the node with the shortest statement delay as its area's cluster head to decide the topology of the cluster. Such design will distribute all nodes ' cluster head statement delay to reduce the likelihood of producing superfluous cluster heads, achieve improved cluster head selection and reduce overhead cluster transmission. The fresh clustering strategy also includes a novel energy classification technique that categorizes all sensor nodes into multiple stages to improve their scalability according to the network's real condition.

Bozorgi et al [9] is the method that uses a unique methodology called a clustering approach that makes node arrangements in a network, establishes that the nodes needed or should not use neighboring data. To decrease transparency, clustering is intended as a constructed hybrid so that at each round there is no need to transmit control signal for clustering. Two new routing methods are being suggested. First, cluster heads support mechanism that enables cluster heads to acquire assist from some of their member nodes that have the appropriate energy and range to assist sharing the load of the cluster.

In other words, a fresh multi-hop routing intra-cluster is being suggested. Another method is a real-time discretionary license that enables nodes to avoid packet transmissions that could enter at a recipient node in an unfinished form. Furthermore, inter-cluster routing utilizes a fresh layering-related method. The outcome of the simulation showed that the suggested technique reduced overhead network, enhanced network stability, energy equilibrium and network lifetime.

Zhao et al [10] proposed model fuses the original model of energy consumption to generate a novel method for determining the optimum quantity of clusters for minimizing total energy utilization.

According to the balanced energy utilization, then proposed work optimize the AGNES methodology, including: (1) preamble of detachment variance, (2) the couple-cluster heads separation of the balance approach, and (3) the node dormancy mechanism.

In addition, the CHs precedence formula is framed related to the residual energy and location of the node. The performance results demonstrate that proposed methodology may minimize the network energy utilization, decay ratio, enlargement of the network lifetime, and progress the throughput in the optimized networks.

Santar Pal Singh and S.C. Sharma [11] proposes a novel Genetic-Algorithm-Based Energy-Efficient Clustering (GAEEC) which uses the genetic algorithm twice with distinct parameters and operators to conduct static and optimal clustering with enhancing cluster head assortment by framing the performed cluster heads in every cluster by considering the computed residual energy and broad communication expenditure to augment the network's general existence. In assessment from the positive notes of the LEACH algorithm, the simulation parameter metrics of this methodology has been analyzed by simulations related to that of the steadiness period, throughput, energy indulgence, and the amount of nodes involved in the network communication.

Yuvaraj Padmanaban and Manimozhi Muthukumarasamy [12] presented a straightforward and effectual clustering methodology, EESCA that is energy efficient. It is suggested for the areas of ecological controlling. Cluster heads are selected related to the average distance of transmission and constructed energy utilization in the network. In addition, an additional metric is used like Cluster Head to Normal Ratio is implemented to alternate the head position of the cluster between nodes.

The performance assessment is performed like the performance metrics like first node die, period of computing simulation, efficiency, load balance, and a fresh metric called absolute functional information rate. Simulation result was contrasted with the known current LEACH and SEECH algorithms and it is demonstrated that the suggested method benefits WSNs.

LEACH protocol is used for multipath data transmission using cluster head technique. Linear programming methodology is implemented for pair-wise key distribution algorithms.

III. PROPOSED WORK

The proposed methodology can be implemented using the formation of the cluster head with proficient energy based cluster head selection methodology that will help to improve the lifetime of the WSN and the secured authentication methodology is utilized for enabling the multipath routing with reduced delay in the network. The implication of this proposed methodology is as

i) Selecting secured cluster heads using enhanced techniques and recommendation of the cluster head.
ii) Energy proficient selection of cluster head will increase the lifetime of the network.
iii) Authenticated method is used for multipath routing using the sensor nodes to minimize the delay.

Assume that the WSN has a large number of cluster groups and every group has a cluster head. For that, the device which consists of the sensor nodes is furnished with a sensor and it is controlled by the microcontroller. The sensor node has the capacity for data communication in the network with the help of the energy. For utilizing multipath routing in the network, the cluster head has the responsibility for communication of data packet in the network. The Energy is computed using Eq. (1) and Eq. (2).

$$Energy_{Total} = Energy_i \left(x + \sum_{i=1}^{\infty} \delta_i \right) \quad (1)$$

$$Energy_{ij}(p) = \frac{Energy_{ij}(p) - Energy_{ij}(p-1)}{Energy_{ij}(p) - Energy_{ij}(p+1)} \quad (2)$$

where $Energy_{Total}$ is the total quantity of energy needed.

A. Algorithm – Authenticated Energy Efficient Clustering Algorithm (AEEC)

Input: Node Identifier, Weight
Output: Cluster Head is elected with Cluster Head Identification.
Step 1: Construct the WSN with relevant Sensor Nodes.
Step 2: Compute the Level of actions of the sensor nodes in spite of the malicious attack.
Step 3: The waiting period is computed for the data transmission.
Step 4: Compute the weight for every stage.
Step 5: If the weight of the current node is greater that the adjacent node then selects the current node is the cluster head.
Step 6: carry on the Step 2 to 5 until every sensor node is checked with the condition.

B. Authenticated Data Communication with Cluster Heads

The sensor Nodes are formed a group called the cluster group. The authenticated data communication has been performed using the cluster heads. The proposed algorithm is developed to increase the security in the multipath routing in the network. Whenever the data packet is communicated it might source on the security issues. The proficient authenticated routing is acclimatized to trounce the security issues. The data communication from the beginning node to the destination node is computing the position of every node such that the active path is formed in the network.

IV. PERFORMANCE EVALUATION

Network Simulator 2 is utilized for simulating the wireless sensor network. In this simulation, 150 nodes were deployed in the WSN to demonstrate the sensor node. The proposed method AEEC is compared with the related methods of LEACH-M [13], EMGR [14] and LEMA [15].

Fig. 1 demonstrates the Mean avoidance ratio for the malicious node in order to the total amount of nodes. The simulation result illustrates that the proposed work has the better mean avoidance ratio compared to the related methods of LEACH-M, EMGR and LEMA.

Fig. 2 illustrates the Mean ratio of compromised node for Cluster Head. The simulation results suggest that the proposed work has the minimized amount of mean ratio of compromised node compared to the related methods.

The conclusion is that the proposed work has better security enhancements in order to reduce the security vulnerability in the Wireless Sensor Networks.

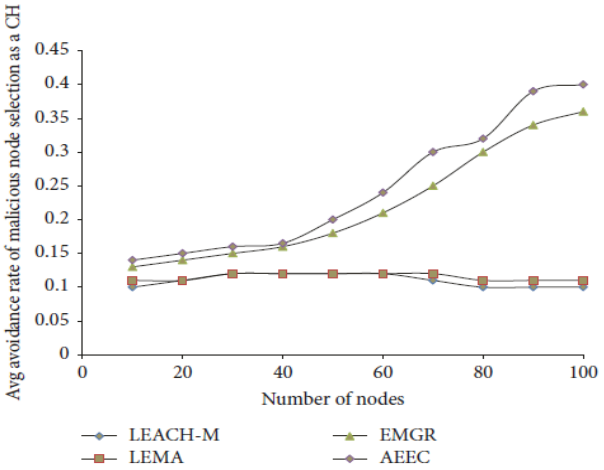

Fig. 1: Mean avoidance ratio for the malicious node

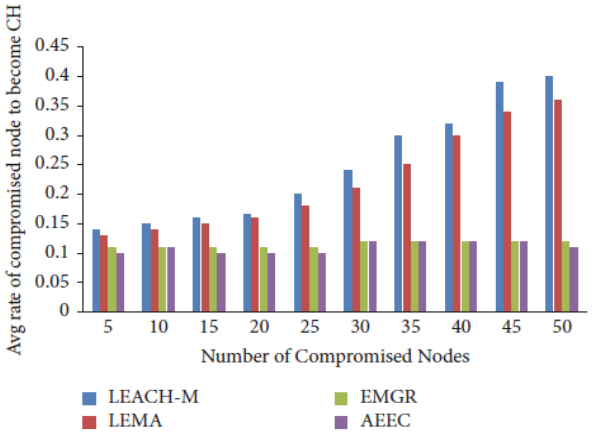

Fig. 2: Mean ratio of compromised node for Cluster Head

Fig. 3 demonstrates the failure rate with respect to the anomaly detection in percentage. The simulation result proves that the proposed method AEEC has the reduced amount of failure rate. This also concludes that the proposed method has the increased amount of packet delivery ratio compared to the related methods.

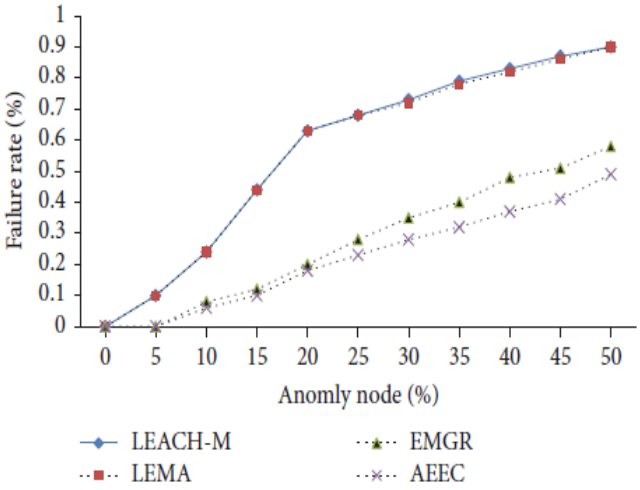

Fig. 3: Failure Ratio in %

Fig. 4 demonstrates that the total amount of live nodes in the network within the particular period of time. The result proved that the proposed work AEEC has more amounts of live nodes in the network for the particular time compared to the related methods of LEACH-M, EMGR and LEMA.

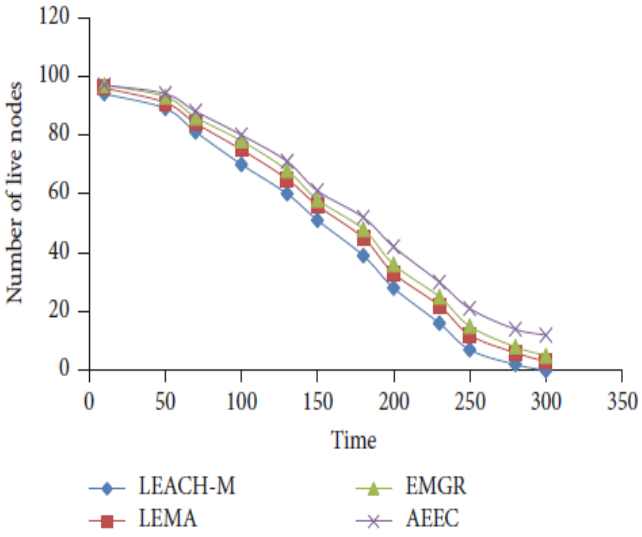

Fig. 4: Total amount of live nodes

Fig. 5 demonstrates the total amount of dead nodes in the network; this can also be related with the Energy consumption. If the sensor node is alive for the exceeding amount time means it has the better energy proficient model. The simulation result proves that the proposed work has the reduced number of dead nodes compared to the related methods.

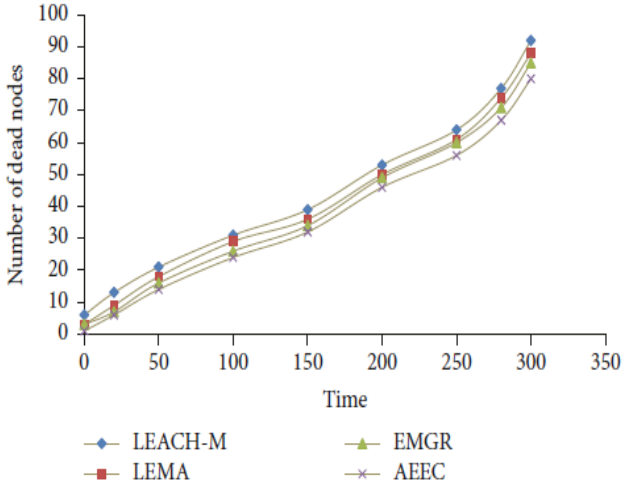

Fig. 5: Total amount of dead nodes

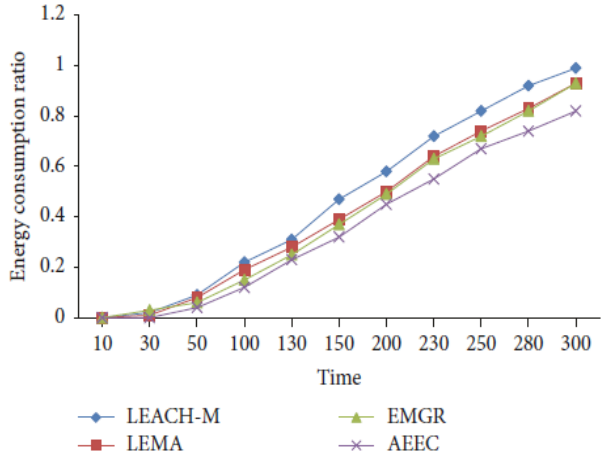

Fig. 6: Energy consumption ratio

Table 1 : Performance analysis

Performance metrics	Methods	Number of Nodes						
		25	50	75	100	125	150	175
Energy utilization (mJ)	AEEC	2.37	2.442	2.21	2.32	2.06	2.11	2.42
	LEMA	2.44	2.56	2.32	2.42	2.16	2.21	2.54
	EMGR	2.58	2.66	2.42	2.82	2.23	2.44	2.54
	LEACH-M	2.65	2.78	2.49	2.91	2.29	2.52	2.72

Fig. 6 demonstrates the Energy consumption ratio with respect to the time period. The proposed method has the improved energy consumption ratio compared to the related methods. Table 1 demonstrates the performance analysis of the comparison for energy utilization

V. CONCLUSION

We constructed an authenticated energy-proficient transmission framework to provide the protection and improved the data transmission within the wireless sensor networks. It also minimizes the transmission overhead compared to the related methodologies. The constructed Authenticated Energy Efficient Clustering Algorithm for developing Wireless Sensor Network is demonstrated in this paper. The proposed methodology is constructed with the implementation of security enhancements in the network and every sensor nodes are communicated throughout the communication range. The malicious attacks are reduced in the proposed model that increases the performance of the network by the improved energy utilization and improved live nodes, reduced amount of dead nodes and also the reduced amount of failure rate in percentage.

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AUTHORS PROFILE

Dr. V. Asanambigai received the B.E. and M.E. Degrees in Computer Science and Engineering from Madras and Annamalai University, India, in 2002 and 2005 respectively, and completed her Ph.D in 2017. She has been working as an Assistant Professor in the Department of Computer Science and Engineering, Annamalai University, Tamil Nadu, India, since 2007. She has the credit of publishing nearly 15 research articles in the referred and peer reviewed inter-national journals/conferences and presented nearly 7 papers in the international conferences. Her research interests are in the area of evolutionary algorithms, image processing and wireless network.

Dr. A. Ayyasamy is B.E. & M.E. in Computer Science and Engineering from Annamalai University, Chidambaram, Tamilnadu, India in the year 2006 and 2008 respectively. He is working as Assistant Professor in Department of CSE, FEAT, Annamalai University from 2007 where he obtained his Doctorate in 2015. He has publishing nearly 57 research articles. He acts as co-author for book “Micro Controller” (ISBN: 978-81-934315-5-9). His areas of interest are wireless network, and network security. He is also serving as a reviewer in IEEE, and Springer. He received Young Faculty award from Center for Advanced Research and Design in 2015.