International Journal of Computing, Intelligent and Communication Technology (2319-748X)
Volume 11 – Issue 3, September 2022
*https://doi.org/*10.57061/ijcict.v11i3.2

Performance Analysis of LEACH, LEACH-C, TS-LEACH, MOD-LEACH in WSN

Shaik Neeha[1], Ipshitha Charles[2], Sabbi Vamshi Krishna[3], Sandip Swarnakar[2],*

[1]*Department of Computer Science and Engineering, Ravindra College of Engineering for Women*, Nandikotkur Road, Kurnool, Andhra Pradesh -518002, India

[2]*Photonics Lab, Department of Electronics and Communication Engineering, G. Pullaiah College of Engineering and Technology*, Nandikotkur Road, Kurnool, Andhra Pradesh -518002, India

[3]*Department of Electronics and Communication Engineering, Ravindra College of Engineering for Women*, Nandikotkur Road, Kurnool, Andhra Pradesh -518452, India

*Corresponding author: drsandipece@gpcet.ac.in

***Abstract*— Energy efficiency has been a major research topic in Wireless Sensor Networks (WSN). Because the sensor networks are powered by batteries, they will die after a given amount of time. As a result, extending the life of sensor equipment by optimizing data dissipation in a cost-effective manner remains a difficulty. Generally, Flat, Hierarchical and location-based routing are the three types of routing Protocol. Awareness of the network structure and Routing Protocol is essential, and it must be suitable for the user need. The survey presents Comparison of various LEACH Protocols in WSN.**

Keywords*— Wireless Sensor Networks, Energy Efficiency, Network lifetime, LEACH.

I. INTRODUCTION

Wireless Sensor Networks consists of hundreds and thousands of small sensor nodes as illustrated in Fig. 1. The services such as Sensing, computation, wireless communication capabilities are used in commercial and industrial applications. The modules of WSN are sensor nodes, Cluster Head (CH), Base station (BS) or sink. Wireless sensor nodes have limited compute energy in order to hike the life time of a node which further increases the network life time therefore, routing protocol should be used.

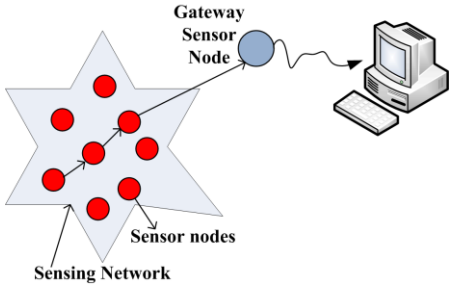


Fig 1: Architecture of WSN

WSNs have widely used in many applications such as Area Monitoring, agriculture, Military Services, Surveillance, Telecommunications. The main qualities of the WSNs are Power usage constraints for nodes, mobility of nodes. Advantages of WSNs are avoids of plenty of wires, it supports flexibility.

Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH is a self-organizing, adaptive clustering protocol [1]. It employs randomization to distribute the energy load among the network's sensors. The LEACH protocol makes the following acceptance [1]. The below Fig. 2 presents the flowchart of LEACH Protocol.

a. All nodes are capable of transmitting with sufficient power to reach the base station.

b. Each and every node has ample computational power to support multiple MAC protocols.

c. Correlated data exists between sensor nodes that are nearer to each other.

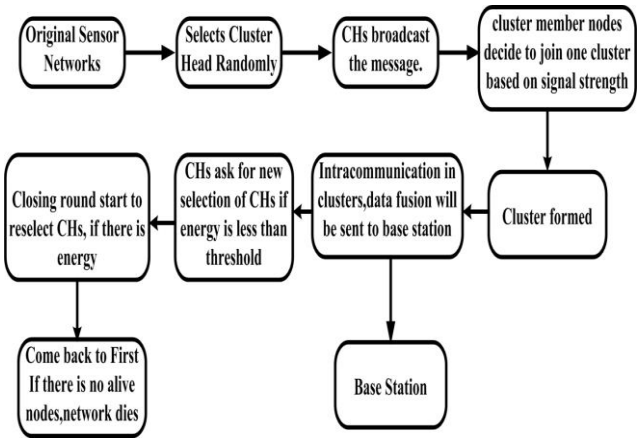


Fig 2: Diagrammatic representation of LEACH protocol

The base Station (BS) is fixed and positioned far away from the sensor nodes, and the nodes are homogeneous and energy is restricted, according to LEACH protocol. One node, referred as the cluster head (CH), serves as the local base station [1]. LEACH rotates the high-energy cluster head at random, distributing the activities evenly across the sensors and ensuring that the sensors use the same amount of battery power.

When data is transferred from the clusters to the base station, LEACH performs data fusion, which reduces energy dissipation and increases network lifetime. LEACH separates

the entire procedure into rounds, with each round having two phases: setup and steady. [1] As demonstrated in the below Fig. 3.

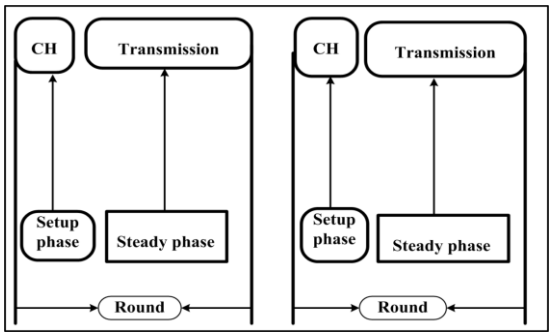


Fig 3: Illustration of two Phases in LEACH Protocol

Clusters are constructed and a CH is chosen for each cluster in the first phase, known as the setup phase as mentioned in the above Fig 3. At a given point in time, the CH is randomly selected among the sensor nodes. Each node produces a number ranging from 0 to 1. This node becomes a CH if its value is less than the threshold value [T (n)].

T (n) is given as follows:

$$T(n) = \begin{cases} \dfrac{P}{1 - P[r * mod\left(\frac{1}{P}\right)]} & if\ n \in G \\ 0 & otherwise \end{cases}$$

Where p denotes the likelihood of nodes becoming cluster heads, r denotes the current round, and G is the group of sensor nodes that have not served as cluster heads in the last 1/p rounds.

TDMA is used by nodes to deliver data to the CH during the steady state procedure throughout the time period allocated. When the cluster head gets data from its cluster, it aggregates it and transfers it to the base station (BS) or sink in compressed form. The BS needs a lot of energy to transfer data if it is so far from the CH. The LEACH protocol has a few drawbacks: It uses single-hop routing, in which each node can send data straight to the cluster head (CH), and sinks can choose CHs at random, potentially clustered all CHs in the same location. [1].

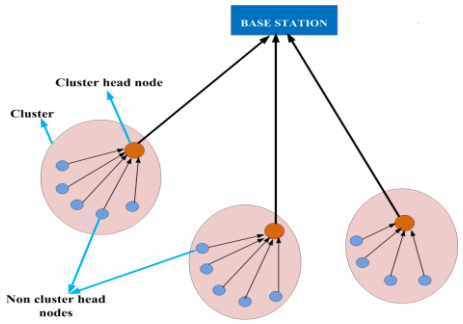


Fig 4: Cluster Formation in LEACH

II. Energy Efficient LEACH Protocols

2.1 Differentiation of LEACH, LEACH-C, TS-LEACH protocols

2.1.1. LEACH-C Protocol

In order to choose CHs, LEACH-C employs a centralized method [4]. Its foundation is LEACH. LEACH- C also divides a round into two phases: setup and steady state, and arranges sensor nodes into clusters, each with a cluster head [4]. It only differs from LEACH in that it completes the cluster head (master node) selection with a high-energy base station. During the set-up phase of each round, each sensor node transfers its energy information to a remote BS. Based on the energy data, the BS selects cluster heads (master nodes) and distributes the cluster heads' IDs to other member nodes. This strategy can give nodes more energy, increasing their chances of becoming the cluster head in the current round. The LEACH-C protocol has the potential to send more data packets to BS than the LEACH protocol. The centralized election algorithm necessitates information of each node's energy level coordinates. This algorithm considers the distance between each node and the base station to extend the network's life [4].

Table 1: Comparison Table for LEACH, LEACH-C, LEACH-TS

Architecture	**Distributed**	**Centralized**	**Distributed**
Election of CHs	CHs are elected by rotation wise by nodes (Randomly selecting)	CHs are elected by BS based on average energy value of all nodes	CHs selection using Threshold
Network Life time	Less	More	More than LEACH-C
Network Overload to BS	Less	More	Less than LEACH-C
Energy dissipation	Less	More	More than LEACH-C

2.1.2 TS-LEACH

TS-LEACH Stands for Threshold Based Stable, suggested a Threshold Based Stable –LEACH (TS-LEACH) technique and in this protocol, it primarily focuses on Cluster Head election of nodes using Threshold finally as a result, we end up with the total Network life time has improved. In this protocol first we will decide the Advance nodes as a cluster head since its energy is higher than that of a standard node which we usually called as normal sensor nodes, and then simultaneously check thresholds and compare energy with nodes during the choosing of Cluster heads [5]. While the energy of the advance node begins to decrease, so it considers normal node to become Cluster Head. Although the energy of Advance node decreases then after it takes the normal node as a master node or head node [5]. This Protocol is stable until first node dies so the name was suggested as threshold based stable –LEACH (TS-LEACH). The below flowchart represents working Principle of TS-LEACH

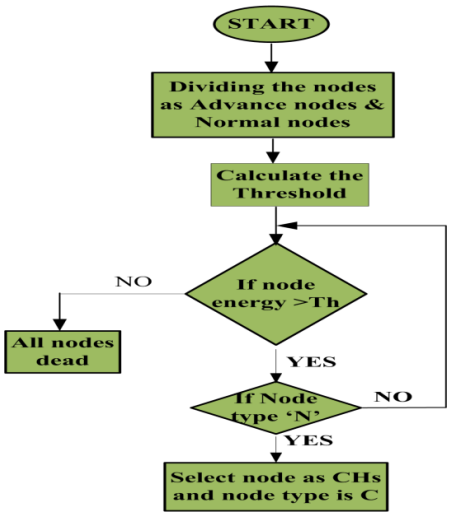
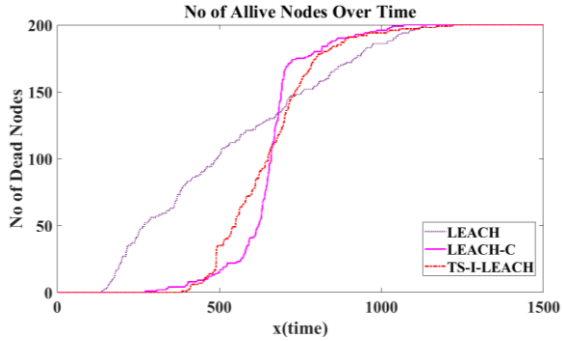


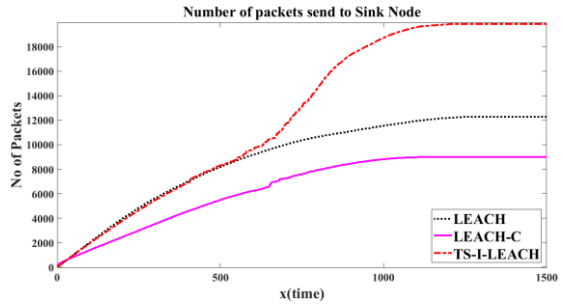
Fig 5: Flow chart for working principle of TS-LEACH

Simulation Results

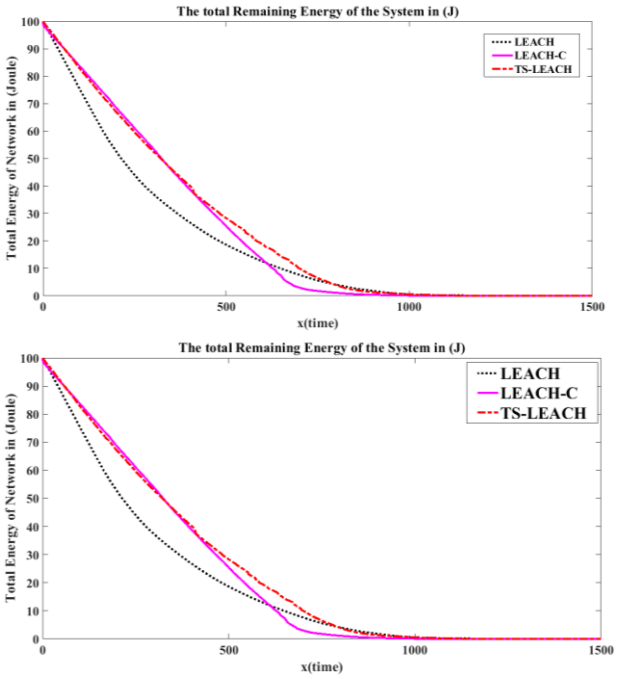
In this section the LEACH is compared with LEACH-C, TS-LEACH. The simulation is carried out using MATLAB. The parameters of the network are given in Table 1.

Table 1: Common Simulation Parameters for LEACH, LEACH-C, TS-LEACH





Presented the differentiation between LEACH algorithm and TS-LEACH. It indicates that the first advance node dead in TS-LEACH is early but last advance node dead later than LEACH which prolong the life time of the network. MOD-LEACHs.



III. Elucidating Facial Expression Recognizing Through Different ResNet Composition

MOD-LEACH

In this section the LEACH is compared with the Modified LEACH (MOD-LEACH). The simulation is carried out using MATLAB. The parameters of the network are given in the following Table 2: MOD-LEACH differs from LEACH in that the number of cluster heads is stable at first, and later cluster head creation behavior resembles LEACH. Modify LEACH by introducing "efficient cluster head replacement scheme [3]. Finally, soft and hard threshold schemes are also implemented in MODLEACH that gives improved outcome [3]. Basically, there are three types of transmission mode in Cluster Based Network

1. Intra cluster Transmission
2. Inter Cluster Transmission
3. CH to Base station Transmission

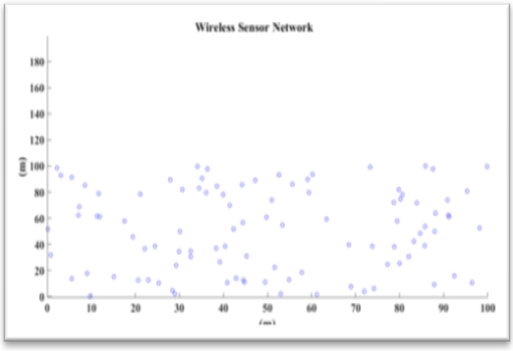
Intra Cluster Transmission is responsible for all communication within a cluster, such that it Cluster members perceive data and report it to the cluster head.Inter Cluster reception is the transmission of data between two cluster

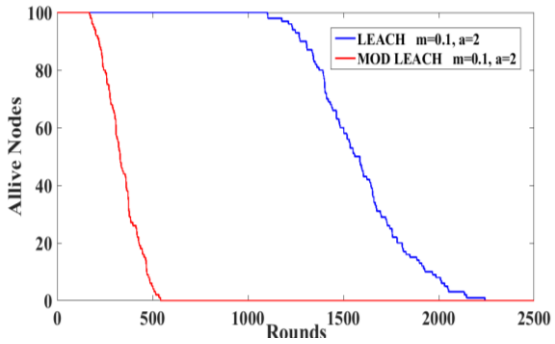
Heads. Whereas Cluster head directly transmits to Base station then it comes under CH to Base Station.

Table 2: Common Network Parameters for LEACH and MOD-LEACH

Parameter	Value
Channel type	Wireless
Network size	100*100m^2
Intial energy of sensor node	0.5J
Number of nodes	100
Packet size	4000 bits
Amplication energy cluster to BS Efs	10pJ/bit/m^2
Amplication energy cluster to BS Emp	0.0013pJ/bit/m^2
Intra cluster communication	Efs/10
Intra cluster communication	Emp/10

Comparison table between LEACH & MOD-LEACH Protocol





Among all Protocols MOD-LEACH increases network life time by introducing "Efficient Cluster Head Replacement Scheme".

Conclusion:

In this paper, an experiment was conducted based on a MATLAB simulation of a WSN to compare between prominent energy efficient protocols, LEACH, LEACH-C, TS-LEACH, and MOD-LEACH. Compare to all Protocols MOD-LEACH tends to minimize network consumption by efficient cluster head replacement MOD-LEACH, a cluster head will only be replaced when its energy falls below certain threshold value.

REFERENCES

[1] Akash Chandanse, Pratik Bharane, Sujoy Anchan, Hemlata Patil, "Performance Analysis of LEACH Protocol in Wireless Sensor Network," 2nd Int. Conf. Adv. Sci. Tech. (ICAST) on 8th, 9th April 2019. http://dx.doi.org/10.2139/ssrn.3375325

[2] Liang Zhao, Shaocheng Qu, Yufan Yi, "A modified cluster-head selection algorithm in wireless sensor networks based on LEACH," EURASIP J. Wireless Com. Network, 287 2018. https://doi.org/10.1186/s13638-018-1299-7

[3] D. Mahmood, N. Javaid, S. Mahmood, S. Qureshi, A.M. Memon, T. Zaman, "MODLEACH: A Variant of LEACH for WSNs," Eighth Int. Conf. Broadband Wireless Comp., Com. Appl., 28-30 Oct. 2013. https://doi.org/10.1109/BWCCA.2013.34

[4] Al-Shaikh, A., Khattab, H., & Al-Sharaeh, S., "Performance Comparison of LEACH and LEACH-C Protocols in Wireless Sensor Networks," J. ICT Res. Appl., 12(3), 219-236 2018. https://doi.org/10.5614/itbj.ict.res.appl.2018.1

[5] D. Mahmood, N. Javaid, S. Mahmood, S. Qureshi, A. M. Memon, T. Zaman, "MODLEACH: A Variant of LEACH for WSNs," IEEE 8th Int. Conf. Broadband Wireless Comp., Com Appl. (BWCCA'13), Compiegne, France, 26th July, 2013. https://doi.org/10.48550/arXiv.1307.7059

[6] M. Dong, K. Yung, W. Kaiser, "Low Power Signal Processing Architectures for Network Micro-sensors," Proc. Int. Sym. Low Power Electron. Design, 81997, pp. 173 – 177 1997.

[7] Rashmi Jain, Manali Kshirsagar, Latesh Malik, "Analysis of Setup Energy of LEACH Protocol for Wireless Sensor Networks," Int. J. Sci. & Eng. Res, Vol. 7, Issue 5, pp. 757-764 May-2016.

[8] W. B. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy- efficient communication protocol for wireless micro-sensor networks," Proc. 33rd Annual Hawaii Int. Conf. Sys. Sci., USA, 2000. https://doi.org/10.1109/HICSS.2000.926982

[9] F. Akyildiz, Mehmet Can Vuran, "Wireless SensorNetworks," John Wiley and Sons Ltd, 2010.

[10] Heinzelman, W. R., A. Chandrakasan, H. Balakrishna Energy-Efficient Communication Protocol for Wireless Microsensor Networks. – In: Proc. of 33rd Annual Hawaii Int. Conf. Sys. Sci., pp. 1-10 2000.

[11] Heinzelman, W. B., A. P. Chandrakasan, H. Balakrishnan. An Application- Specific Protocol Architecture for Wireless Microsensor Networks. – IEEE Transactions on Wireless Communications, Vol. 1, No 4, pp. 660-670 2002.

[12] Islam, J., M. Islam, N. Islam. A-sLEACH: An Advanced Solar Aware Leach Protocol for Energy Efficient Routing in Wireless Sensor Networks. In: Proc. of 6th International Conference on Networking Technology (ICN'2007), 2007, Vol. 7, pp. 1-6 2007.

[13] Gautam, G. Sen, B., "Design and Simulation of Wireless Sensor Network in NS2," Int. J. Comp. Appl., 113(16), pp. 14-16, 2015.

[14] Tan, N. D., L. Han, N. D. Viet, M. Jo. "An Improved LEACH Routing Protocol for Energy-Efficiency of Wireless Sensor Networks," – J. Smart Comp. Rev. (Smart CR), Vol. 2, No 5, pp. 360-369 2012.

[15] Singh, J. A New LEACH-Based Routing Protocol for Energy Optimization in Wireless Sensor Network–In: Proc. of International Conference on Computer and Communication Technology (ICCCT'2014), pp. 181-186 2014.

[16] Ganeshkumar, P., Vijayakumar, K.P. & Anandaraj, M., A Novel Jammer Detection Framework for Cluster-Based Wireless Sensor Networks, EURASIP J. Wireless Com. Netw., 2016 (1), Article No.35, 2016.

[17] Fahim, H., Javaid, N., Khan, Z.A., Qasim, U., Javed, S., Hayat, A., Iqbal, Z. & Rehman, G., "Bio-inspired Routing in Wireless Sensor Networks," in 2015 9th Int. Conf. Inovative Mobile and Internet Services in Ubiquitous Computing (IMIS), Santa Catarina, Brazil 2015. https://doi.org/10.1109/IMIS.2015.16

[18] Ferng, H-W., Tendean, R. & Kurniawan, A., Energy-Efficient Routing Protocol for Wireless Sensor Networks with Static Clustering and Dynamic Structure, Wireless Personal Communications, 65(2), pp. 347- 367, 2012.