# Performance Evaluation of LEACH Variants

**Isha Mahajan[1*], R. C. Gangwar[2] and Sanjeev Mahajan[2]**

[1]Punjab Technical University, Kapurthala, Jallandhar - 144603, Punjab, India; ishamahajan27590@gmail.com
[2]CSE Department, B.C.E.T, Gurdaspur - 143521, Punjab, India

## Abstract

Wireless Sensor Networks comprise huge number of sensor nodes which collect facts from the backgrounds of environment where these nodules are fixed or prescribed in random manner. WSN is an energy built structure in which recognizing and communicating of data involves an enormous volume of energy. These sensor nodes are to be arrayed in a strict environment, there is a huge possibility that some of these nodes may get damaged and fail to work, in result these sensor nodes are proficient of sensing data till the energy remains inside them. Hence to diminish the intake of energy by the sensor nodes is the main aspect of the sensor networks. For the energy efficiency of network, there are many energy efficient protocols like LEACH, RZLEACH. They prolong the network lifetime and reduce the energy consumption. This paper has focused on the energy efficient protocol of WSN. LEACH, RZLEACH has been considered for evaluation purpose. The overall objective is to find the best protocol among LEACH, RZLEACH. The experiment has been done using MATLAB tool along with help of data analysis tool box. The experiment result has shown that the RZLEACH outperforms over available protocols.

**Keywords:** Cluster Head, LEACH, Multiplexing, Rendezvous Nodes, WSN

## 1. Introduction

A Wireless Sensor Network (WSN) consists of slew of nodes, which may be tightly or arbitrarily deployed in an area of interest. Sensing area has a Base Stations (BS), which have major function in WSN as sink who sends queries to nodes while nodes sense the received queries and send the sensed information in a joint way back to Base station. Base station also serves as an entrance for outer surface system viz. Internet. So Base Station collects information and sends only relevant data to customer via internet. As it is known, nodes have little batteries, which are hard to modify or recharge. So to follow such structural design is having a smaller amount transfer and concentrated communication space to raise power saving. There are positive structural design like flat-network architecture and hierarchical network architecture.

*Author for correspondence

## 1.1 Layered Architecture

This Architecture is derived for the wireless sensor network when it is needed to increase the power or energy of sensor nodes in both multi hop and single hop networks. The design of a layered architecture would normally consist of a base station and sensors scattered in the field. The layers of sensor nodes around the bottom station constitutes nodes that are in a single hop count to the base station, while nodes that are farther away can be multiple hop count to the base station depending on the size of the network.

## 1.2 Clustering Objectives

Various objectives have been pursued by different literatures in designing clustering architecture for WSN. Most objectives are set to meet the application constraints. This section present three main objectives that are relevant to the focus of this thesis.

### *1.2.1 Maximizing Network Life-time*

Unlike in cellular networks, where mobile gadgets (e.g. phones) can easily be recharged constantly after battery drainage, thus power management in these networks remains a secondary issue. However, WSN is heavily constrained in this regard, apart from being infrastructure-less system their battery power is very limited. Most of the sensor nodes are equipped with minimal power source. Thus, power efficiency will continue to be of growing concern and will remain one of the main design objectives of WSN. In order to cope with energy management in WSN, clustering scheme has been pursued, to extend network life-time and help ease the burden of each node transmitting directly to BS as in conventional protocols like Direct Transmission. When some nodes which are having less energy in the WSN then aim is to provide the energy to those nodes before they declared to be fully dead nodes.

### *1.2.2 Fault-Tolerance*

The failure of a sensor node should have a minimal elect on the overall network system. The fact that a sensor node is likely to be deployed in harsh environmental conditions, there is tendency that some nodes may fail or be physically damaged. Some clustering techniques have been proposed to address the problem of node failure by using proxy cluster-heads, in the case of failure of the initial elected cluster head or have minimal power for transmission. Some other literatures have employed adaptive clustering scheme, to deal with node failures such as rotating the cluster-head. Tolerating node failure is one of the other design goals of clustering protocols.

### *1.2.3 Load Balancing*

Load balancing technique could be another design goal of clustering schemes. It is always necessary not to over burden the cluster-heads as this may deplete their energies faster. So, it is very important to own even distribution of nodes in each cluster. Especially in cases when cluster-heads are performing data aggregation or other signal processing task, an uneven characterization can extend the latency or communication delay to the base station.

### *1.2.4 Cluster Properties*

- Cluster Count: Cluster heads are prearranged in some of the approaches. So, the numbers of clusters are fixed. Cluster head selection algorithms usually choose randomly cluster heads from the deployed sensors thus yields variable number of clusters.
- Intra-cluster topology: A few clustering schemes are based on direct communication between a sensor and its selected cluster head, but sometimes multi-hop sensor-to-cluster head connectivity is necessary.

- Connectivity of cluster head to base station: Cluster heads transmit the aggregated data to the base station directly or indirectly with help of other cluster head nodes. It means there exists a direct link or a multi-hop link.

### *1.2.5 Cluster Head Selection Criteria*

- **Initial energy:** To select the initial energy cluster head is an important parameter. When any algorithm starts it usually considers the initial energy.
- **Residual energy:** Once some of the rounds are completed, the cluster head selection should be based on the energy left behind in the sensors.
- **Average energy of the network**: This energy is used as the reference energy for each node. It is the ideal energy that each node should own in current round to keep the network alive.

# 2. Clustering Techniques

## 2.1 Low Energy Adaptive Clustering Hierarchy (LEACH)

WSNs are micro sensor systems that are spatially distributed. WSN is a power constrained system as the sensor nodes have limited battery life that shortens the network lifetime. Maximizing the network lifetime depends upon an efficient communication protocol. Energy consumption is, therefore, a critical design issue in WSN[11]. A cluster-based technique is the basic method to increase the scalability, performance, efficiency and lifetime of the network.

LEACH, a hierarchical clustering routing protocol, was proposed by Chandrakasan, Heinzelman and Balakrishnan, in MIT. Leach is a protocol that works well in homogenous networks. In a homogenous network, all nodes have equal amount of initial energy. Basically there are two types of routing protocols in WSNs: Flat routing protocols are those in which the routing condition of each node in the network is the same. There are no special nodes in network and each node has equal status. So, the network traffic is dispersed equally among all nodes[10]. Comparatively, hierarchical routing protocols make use of the concept of clusters that divides all nodes into groups or clusters. Nodes in this type of network have different levels. A CH is selected among all the nodes and different hierarchical routing protocols may use different methods of selecting CHs[9].

LEACH is a low energy protocol that may adapt clustering. It is a cluster-based protocol that utilizes the concept of randomized rotation of local cluster-heads and distributes the energy load evenly among all the sensor nodes in the sensing field of the network.

## 2.2 Characteristics of LEACH

- Set up of clusters through local collaboration and control.
- To reduce the Data aggregation in network traffic.
- Local compression to scale back world communication.
- Randomized rotation of the cluster heads and also the corresponding clusters.
- Random Death of nodes.

## 2.3 Assumptions of LEACH

- All nodes are similar in context of initial energy.
- All nodes make use of Omni-directional antenna.
- BS is fixed and is distant from WSN
- Energy consumption of each node to send data to other is equal.

LEACH uses the concept of rounds. The work period id referred as a round. Each round constitutes 2

Phases: 1. Setup phase, 2. Steady phase.

### 2.3.1 Stable Cluster Head Election (SCHE) Protocol

It is based on LEACH architecture that uses clustering technique. Its goal is to reduce the energy consumption of each sensor node and thus minimizing the overall energy dissipation of the network.

SCHE is a source driven protocol based on timely reporting. So the sensor node will always have some data to transmit to the Base station. It also makes use of data aggregation to avoid information overload. It provides an analytical framework to attain the stable probability for a node to be a cluster-head to minimize energy consumption. It is necessary to apply suitable CH election mechanism to minimize energy consumption of each sensor node that ultimately results in reduced energy dissipation. SCHE was proposed where this mechanism was applied by obtaining the optimum value of probability for a node to become a CH and consumes significantly less energy compared to LEACH. It also reduces consumption by minimizing distance between CH and BS.

### 2.3.2 Stable Election Protocol (SEP)

There are some drawbacks associated with LEACH such as: single hop routing is used where each node can transmit directly to CH and sink. CHs are elected randomly[7]. Therefore there is a possibility that all CHs will be concentrated in the same area. The concept of dynamic clustering is used which leads to unnecessary overhead due to cluster changes. The protocol also assumes that all nodes have amount of energy for each node. But recent protocols like SEP has been opposite to that of LEACH as it considers energy heterogeneity where the factors mentioned are just a possibility[12]. WSNs have assumed homogenous nodes for most of the time. But these nodes also differ in initial amount of energy and also in depletion rate[8]. This leads to the heterogeneous networks where they considered two or more types of nodes. SEP is proposed for two-level heterogeneous networks that has two types of nodes according to their initial energy. The nodes that have higher amount of energy than the other nodes are called advance nodes and the other nodes are the normal nodes. In SEP the election probabilities of nodes are weighted by the initial energy of each node to become the cluster-head relative to the other nodes in a network. This prolongs the time period before the death of first node in the system. SEP approach makes sure that CH election is done randomly and is distributed based on the energy of each node assuring the uniform utilization of the nodes energy. SEP consists of advance nodes that carry more energy than the normal nodes at the beginning, so it enhances the stability period of the network.

### 2.3.3 Extended Stable Election Protocol (ESEP)

It is a modified SEP protocol. Instead of two types of nodes, it considers three nodes based on their energy levels. These nodes are: normal, moderate and advance nodes. The goal of ESEP is to achieve a WSN that maximizes the network lifetime and stability period. Also it must reduce the communication cost and deployment cost. The operation to become a CH is same as in SEP by generating a random number and then comparing it with the threshold. In ESEP the moderate or intermediate nodes are selected in two ways either by the relative distance of advance nodes to normal nodes or by the threshold of energy level between advances nodes and normal nodes.

### 2.3.4 Threshold-Sensitive Stable Election Protocol (TSEP)

The early protocols SEP and ESEP were heterogeneity-aware protocols that improve the stability period and network lifetime but a major drawback of heterogeneity is that the increased throughput eventually decreases the network lifetime. Therefore, to control the trade-off between the efficiency, accuracy and network lifetime, a new protocol TSEP was proposed. It is a reactive routing protocol that senses data continuously over the network but transmits only when there is a drastic change in the value of sensed attributes. The transmission takes place only when a specific level of threshold is reached. It uses three levels of heterogeneity by considering three types of nodes: normal, intermediate and advance nodes. The highest energy nodes are advance nodes followed by intermediate and normal nodes. The intermediate nodes are selected by using a fraction *b* of intermediate nodes. The energy of intermediate nodes is assumed to be $\mu$ times more than that of normal nodes.

## 3. Energy Efficient Shortest Path Routing Protocol

Shortest Path Routing (SP) algorithm is one of the most powerful and popular algorithms used to find the shortest distance path amongst any two nodes in a network. But this algorithm is not applicable for energy constrained applications as it does not consider any energy parameter for the route discovery. A slight modification over the Shortest Path algorithm is given below so as to make the computed route energy efficient.

### 3.1 Algorithm

The EESP protocol follows the thought of SP. Unlike SP, in EESP route computation is based not only on the distance but also on the residual energy in the nodes. The EESP routing algorithm is as follows:

- Here as the communication is wireless, the distance to all neighbouring nodes from a given node is considered to be 1 indicating the connectivity else it is zero.
- Assign to every node a distance value: set it to zero for the initial node and to infinity for all other nodes.
- Mark all nodes as unvisited. Set initial node as current node.
- For current node, consider all its unvisited neighbours and calculate their tentative distance.
- If this distance is less than the previously recorded distance, overwrite the distance. Also update its distance value by including the effect of the residual energy level of that node. This can be accomplished by introducing the energy metric at the denominator of the distance parameter.
- The distance parameter will be high for low energy nodes and thus making them less likely to be included in the path.
- A node whose energy level is greater than the threshold and has the least distance value is chosen to be the current node for the next iteration.
- The process continues till the destination node becomes the current node
- The optimal distance will be given by the distance value of the destination node and the corresponding path can be determined by considering the processors of the nodes.

### 3.2 Literature Survey

S. Mottaghi et al.[1] proposed an algorithm that combines the use of the LEACH clustering algorithm, MS and Rendezvous Points (RP). Simulation results showed that this method is more efficient than LEACH in terms of energy consumption, particularly in large regions. Wireless sensor networks are composed of a large number of disposable wireless sensors that collect information about their surrounding environment and transmit them to the end user. Because these sensors do not have rechargeable batteries, increasing their lifetime is important and various methods have been proposed to increase the lifetime of the sensor nodes in a network. Most of these methods are based on clustering or routing algorithms. The Low Energy Adaptive

Clustering Hierarchy (LEACH) algorithm is an efficient clustering algorithm where nodes within a cluster send their data to a local cluster head. Some researchers recommend a Mobile Sink (MS) as a way to reduce energy consumption and a Rendezvous Node (RN) to act as a store point for the MS.

Ahmed Salim et al.[2] discussed about Wireless Sensor Networks (WSNs) that are composed of many low cost, low power devices with sensing, local processing and wireless communication Capabilities. Recent advances in wireless networks have led to many new protocols specifically designed for WSNs where energy awareness is an essential consideration. Most of the attention, however, has been given to the routing protocols since they might differ depending on the application and network architecture. Minimizing energy dissipation and maximizing network lifetime are important issues in the design of routing protocols for WSNs. In this paper, the Low-Energy Adaptive Clustering Hierarchy (LEACH) routing protocol is considered and improved. They propose a clustering routing protocol named Intra-Balanced LEACH (IBLEACH), which extends LEACH protocol by balancing the energy consumption in the network. The simulation results show that IBLEACH outperforms LEACH and the existing improvements of LEACH in terms of network lifetime and energy consumption minimization.

N. N. Javaid et al.[3] proposed a protocol designed for the characteristics of reactive homogeneous WSNs, HEER (Hybrid Energy Efficient Reactive) protocol. In HEER, Cluster Head (CH) selection is based on the ratio of residual energy of node and average energy of network. Moreover, to conserve more energy, they introduced Hard Threshold (HT) and Soft Threshold (ST). Finally, simulations show that the protocol has not only prolonged the network lifetime but also significantly increased the stability period.

Ahlawat et al.[4] have discussed a latest approach to advance network life span. Writer has suggested choosing a secondary cluster head as a resulting cluster head which will job in case Cluster head would expire writer has explained that how secondary cluster head would be chosen. According to writer, these criteria could be less space between sensor nodes, highest residual power in sensor nodes, and lowest amount power loss. So according to writer the cluster head would on no account expire. There are secondary Cluster Head which will substitute the lifeless cluster. Simulation results show that this new approach raises life span in contrast of the conventional approaches.

Beiranvand et al.[5] have analyzed and proposed a new enhancement in LEACH named I-LEACH, An Improvement has been done by considering basically three factors; Residual Energy in nodes, Distance from base station and Number of neighboring nodes. A node has been considered as head node if it has optimum value for discussed three factors i.e. have more residual energy as compare to average energy of network, more neighbors than average neighbors for a node calculated in network and node having less distance from base station as comparison to node's average distance from BS in network. Reduction in energy consumption and prolongation in network life time has been observed.

G. Jayaseelan et al.[6] This paper depends on cluster-based scheme that extends High Energy First (HEF) clustering algorithm and enables multi-hop transmissions among the clusters by incorporating the selection of cooperative sending and receiving nodes. The performance of the proposed system is evaluated in terms of energy efficiency and reliability. Simulation results show that tremendous energy savings can be achieved by adopting hard network lifetime scheme among the clusters. The proposed cooperative MIMO scheme prolongs the network lifetime with 75% of nodes remaining alive when compared to LEACH protocol. HEF algorithm proved that the network lifetime can be efficiently prolonged by using fuzzy variables (concentration, energy and density). Providing trustworthy system behavior with a guaranteed hard network lifetime is a challenging task to safety critical and highlyreliable WSN applications.

### 3.3 Gaps in Literature Survey

The review on the existing techniques has shown the following limitations:-

- The use of the multiplexing of data has been neglected in the most of existing protocols.
- The use of Energy Efficient Shortest Path Routing Protocol for efficient path selection has also been neglected by the most of researchers.
- However the rendezvous nodes based LEACH outperforms over the LEACH in terms of the network lifetime, but has very poor stability period i.e. the first node become dead too early.

## 4. Objectives

- To evaluate the performance of the LEACH and rendezvous nodes based LEACH for mobile sink based WSNs.
- To evaluate the effect of the nodes scalability on the network lifetime.
- To compare the LEACH, rendezvous nodes based LEACH and upon the following parameters:-
    - Alive nodes
    - Packets sent to Base station
    - Packets sent to cluster heads
    - First node dead time
    - Last node dead time average remaining energy

## 5. Proposed Algorithm

### 5.1 Steps of Proposed Approach

Following are the various steps required to successfully simulate the proposed algorithm.

- First of all initialize WSN with their respective characteristics.
- For each node i repeat the following steps:
- If given node has energy more than 0 that means it is alive node only then repeat upcoming steps else move back to step 2.
- Select node as a CH if it holds the properties of improved node waiting based cluster head selection.
- Now association of the nodes will be done with their nearest CHs.
- Evaluate energy dissipation and move to step 2.

## 6. Results and Discussion

### 6.1 Test Scenario

The simulation is carried out for the original parameters where the position of base station are Bs.x=100 and Bs.y=100. The number of nodes taken for transmission are n=100. The initial energy of the network is supposed to be Eo=0.1. The maximum lifetime of the network

**Table 1.** Performance metrics

| Parameter | Value |
|---|---|
| Area(x,y) | 100,100 |
| Base Station(x,y) | 100,100 |
| Nodes(n) | 100 |
| Probability(p) | 0.1 |
| Initial Energy(Eo) | 0.1 |
| receiver_energy | 50nj/bit |
| transmiter_energy | 50nj/bit |
| Free Space(amplifier) | 10nj/bit/m2 |
| Multipath(amplifier) | 0.0013pj/bit/m4 |
| Maximum Lifetime | 600 |
| Effective Data aggregation | 5nj/bit/signal |

is taken as 600. These four parameters are used for all the simulations that are further conceded out for different values of these parameters.

## 6.2 First Dead Node

Table 2 is the quantized analysis of the first dead node. This table represents the various numbers of nodes and according these nodes different values of first dead nodes in existing and proposed technique respectively.

Figure 1 show the comparison when first node dies in the LEACH and the RZLEACH technique for number of nodes from 100 to 300. Green Color is showing results for the Leach and blue color is used to depict first dead node in the rendezvous Leach algorithm. We can see very clearly from the graph and from table that first node dead for the LEACH technique is at 48 and that for RZLEACH is at 76 that indicates great improvement over the objective quality of the node in RZLEACH.

**Table 2.** First dead nodes

| No. of Nodes | Existing Technique | |
|---|---|---|
| | LEACH | RZ-LEACH |
| 100 | 48 | 76 |
| 120 | 41 | 78 |
| 140 | 49 | 77 |
| 160 | 44 | 77 |
| 180 | 45 | 76 |
| 200 | 43 | 74 |
| 220 | 45 | 70 |
| 240 | 51 | 70 |
| 260 | 47 | 81 |
| 280 | 41 | 71 |

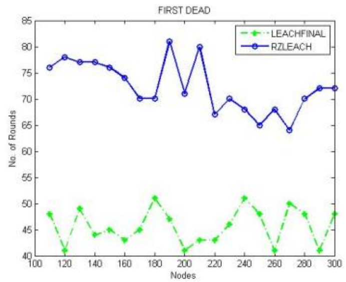


**Figure 1.** First node dead.

**Table 3.** Last dead nodes

| No. of Nodes | Existing Technique | |
|---|---|---|
| | LEACH | RZ-LEACH |
| 100 | 148 | 243 |
| 120 | 147 | 242 |
| 140 | 167 | 241 |
| 160 | 176 | 242 |
| 180 | 150 | 244 |
| 200 | 162 | 242 |
| 220 | 178 | 244 |
| 240 | 183 | 244 |
| 260 | 187 | 242 |
| 280 | 189 | 243 |

## 6.3 Last Dead Node

Table 3 is the quantized analysis of the last dead node. This table also represents the various numbers of nodes taken for simulation and according to that we obtained different values of last dead nodes in existing and proposed technique respectively.

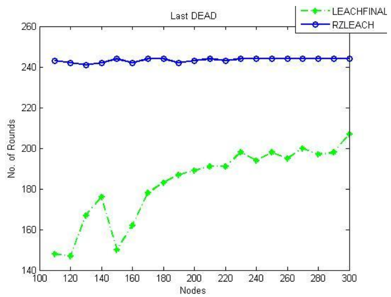


**Figure 2.** Last node dead.

Figure 2 shows the comparison when all nodes are dead for LEACH and RALEACH algorithm for the number of nodes from 20 to 200 and x-axis represents number of nodes taken and y-axis represents the number of rounds. Green color in the graph displays dead nodes for the Leach and blue color showing dead nodes for the Rendezvous Leach. It is very clear from the graph that there is increase in last dead node with the use of RZLEACH protocol over other method. This kind of increase indicates improvement inside the objective quality of the node.

## 6.4 Throughput

Following Tables are displaying comparative analysis of total number of packets sent to the cluster head. As the major purpose of proposed algorithm is to maximize throughput, so it is necessary to make most of the throughput. It is depicted very clearly from the Table 4 and Table 5 that there is huge difference in the packets sent to the cluster head and to the base station in case of the RZLEACH algorithm. This difference is directly proportional to maximized or improved throughput. Therefore, RZLEACH procedure is better than LEACH procedures.

Figure 3 shows the comparison of total number of packets sent to cluster head of Leach, Rz Leach. In the graph it is noticeably revealed that packets sent to cluster head using RZLEACH protocol is greater than the other protocol. It is only thinkable when supplementary quantity of nodes is connected with the cluster and more packets are communicated by them.

**Table 4.** Packets sent to Cluster Head

| No. of Nodes | Existing Technique | |
|---|---|---|
| | LEACH | RZ-LEACH |
| 100 | 7586 | 15653 |
| 120 | 9552 | 18299 |
| 140 | 11581 | 22495 |
| 160 | 13777 | 24759 |
| 180 | 14197 | 28559 |
| 200 | 16614 | 32044 |
| 220 | 19085 | 36162 |
| 240 | 20565 | 38163 |
| 260 | 22862 | 40520 |
| 280 | 24271 | 45898 |

**Table 5.** Packets sent to Base Station

| No. of Nodes | Existing Technique | |
|---|---|---|
| | LEACH | RZ-LEACH |
| 100 | 892 | 1779 |
| 120 | 1113 | 2055 |
| 140 | 1348 | 2531 |
| 160 | 1592 | 2742 |
| 180 | 1664 | 3222 |
| 200 | 1915 | 3534 |
| 220 | 2209 | 4029 |
| 240 | 2375 | 4236 |
| 260 | 2651 | 4533 |
| 280 | 2812 | 5132 |

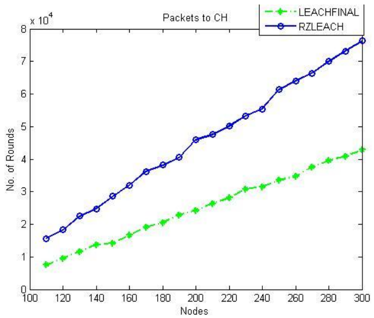


**Figure 3.** Total number of packets to cluster head.

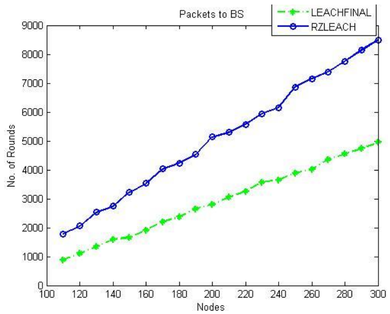


**Figure 4.** Total number of packets to base station.

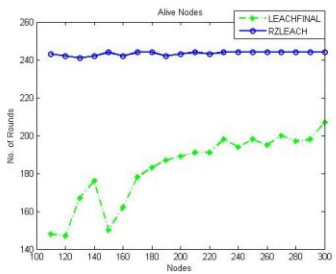


**Figure 5.** nodes during network lifetime.

Table 5 is displaying comparative analysis of total number of packets sent to base station. All the information that is sent by nodes to cluster heads is aggregated and is forwarded to base station

Figure 5 shows the comparison of throughput of all protocols. It is seen that in the RZLEACH protocol the number of packets that are forwarded to the base station is more than the other protocol. It shows that the nodes in the RZLEACH protocol participate for a longer time in transmitting the packets to the base station. It characterizes that data sent to base station is more for RZLEACH protocol than others.

## 6.5 Network Lifetime

Table 6 shows total number of alive nodes of LEACH techniques and RZLEACH algorithm. Alive nodes for the RZLEACH algorithm are for more timespan than the other procedures or protocols.

Figure 6 shows clearly that proposed protocol is more efficient than the existing techniques i.e Leach and Rz-Leach.

**Table 6.** Network lifetime

| No. of Nodes | Existing Technique | |
|---|---|---|
| | LEACH | RZ-LEACH |
| 100 | 148 | 243 |
| 120 | 147 | 242 |
| 140 | 167 | 241 |
| 160 | 176 | 242 |
| 180 | 150 | 244 |
| 200 | 162 | 242 |
| 220 | 178 | 244 |
| 240 | 183 | 244 |
| 260 | 187 | 242 |
| 280 | 189 | 243 |

### 6.6 Remaining Energy

Table 7 is showing comparison of remaining energy of protocols. More the energy is retained by the nodes; more they remain alive for the data transmission. Hence, to make nodes use energy in well determined and mannerd way so that energy consumption is less as well as lifespan is increased is quite possible by the RZLEACH algorithm.

The maximum energy of all the protocols is shown in Figure 6, which is their primary energy at the beginning of transmission. As the number of rounds passes by, the energy starts getting deteriorated. Leach is first to end up transmission as the energy decreases at the faster rate. The nodes that retain their energy for the maximum number of rounds belong to RZLEACH protocol which clearly shows that the energy consumption rate of the RZLEACH is better than the other protocol.

**Table 7.** Remaining energy

| No. of Nodes | Existing Technique | |
|---|---|---|
| | LEACH | RZ-LEACH |
| 100 | 4.2318 | 8.8790 |
| 120 | 4.4227 | 8.5905 |
| 140 | 4.5704 | 8.9432 |
| 160 | 4.7598 | 8.6277 |
| 180 | 4.3769 | 8.9860 |
| 200 | 4.5820 | 8.8763 |
| 220 | 4.7823 | 9.1801 |
| 240 | 4.7224 | 8.8180 |
| 260 | 4.8590 | 8.6386 |
| 280 | 4.8065 | 9.1024 |

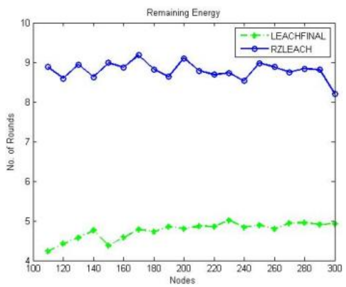


**Figure 6.** Remaining energy.

## 7. Conclusion and Future Work

In the projected work, the performance of LEACH and RzLEACH protocols is evaluated. These protocols determine how lifetime and stability period of sensor nodes can be increased. For the determination of working of proposed algorithm or protocol, results of these protocols in form of graphs have been taken in this paper i.e. these protocols are considered for evaluation purpose. The overall objective is to determine the best protocol among LEACH and RZLEACH. The experiment has been done using MATLAB tool along with help of data analysis tool box .The experiment result has shown that the RZLEACH outperforms over available protocols. In near future we will modify the path selection criteria by the sensor nodes in such a way that it provides more efficient results. However the use of multiplexing of data facts has also been neglected in these protocols.

## 8. References


1. Mottaghi S, Zahabi MR. Optimizing LEACH clustering algorithm with mobile sink and rendezvous nodes." AEU-International Journal of Electronics and Communications 69, no. 2, pp. 507-514, 2015
2. Salim A, Osamy W, Khedr AM. IBLEACH: Intra-Balanced LEACH protocol for wireless sensor Networks. New York: Springer Science + Business Media; 2014.
3. Javaid N, Mohammad SN, Latif K, Qasim U, Khan ZA, Khan MA. HEER; Hybrid energy Efficient Reactive Protocol. IEEE; 2013.

4. Ahlawat A, Malik V. An extended vice-cluster selection approach to improve V LEACH Protocol. WSN IEEE 3rd International Conference on Advanced Computing and Communication Technologies; 2013. p. 236-40.
5. Beiranvand Z, Patooghy A, Fazeli M. I-LEACH: An efficient routing algorithm to improve performance and to reduce energy consumption in wireless sensor networks. IEEE 5th International Conference on Information and Knowledge Technology; 2013. p. 13-8,
6. Jayaseelan G, Rajalaxmi SK. Hard network lifetime wireless sensor networks with high energy first clustering. Engineering Science IJEST. 2013; 5(03).
7. Hussain K, Abdullah AH, Awan KM, Ahsan F and Hussain A. Cluster head election schemes for WSN and MANET: A survey. World Applied Sciences Journal. 2013; 23(5):611-20.
8. Munjal R, Malik B. Approach for improvement in LEACH protocol for wireless sensor network. 2nd International Conference on Advanced Computing and Communication Technologies (IEEE); Rohtak, Haryana. 2012. p. 517-21.
9. Chen G, Zhang X, Yu J, Wang M. An improved LEACH algorithm based on heterogeneous energy of nodes in wireless sensor networks. IEEE International Conference on Computing, Measurement, Control and Sensor Network; 2012. p. 101-4.
10. Kashaf A, Javaid N, Khan Z, Khan I. TSEP: Threshold-Sensitive Stable Election Protocol for WSNs. IEEE 10th International Conference on Frontiers of Information Technology; 2012. p. 164-8.
11. Sharma M, Shaw AK. Transmission time and throughput analysis of EEE LEACH, LEACH and Direct Transmission Protocol: A Simulation Based Approach. ACIJ. 2012; 3(5).
12. Shi S, Liu X, Gu X. An energy-efficiency optimized LEACH-C for wireless sensor networks. IEEE 7th International ICST Conference on Communications and Networking in China (CHINACOM); Kun Ming. 2012. p. 487-92.