International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

Extending the Lifetime of Wireless Sensor Networks using an Improved Clustering Protocol

Ikram Daanoune, Abdennaceur Baghdad, Abdelhakim Ballouk

Abstract: Wireless Sensor Network (WSN) is one of the underlying mechanics of IoT (Internet-of-Things) which has recently seen a worldwide interest by its use in several domains as military, automation, agriculture, environment, underwater and etc. Energy efficiency and reliability of transmitted messages are two of the major requirements for the surveillance and wireless detection applications in WSN. For this reason, a growing number of research studies are carried out. Several routing protocols have been developed to furnish better performance for optimizing the network's energy consumption in WSN; most of them are based in clustering and hierarchical topology. However, most of these routing protocols cannot consider all required and important metrics to increase the lifespan of the network. This work introduces an enhanced algorithm of the Low Energy Adaptive Clustering Hierarchy (LEACH) protocol called Balanced Current Energy-LEACH (BCE-LEACH) which aims to equity the power consumption of sensor nodes of the network due to extend the lifetime of the network. The proposed protocol is based on the residual energy of sensor nodes to pick out cluster heads (CHs) that means only nodes with sufficient current energy can participate in CH selection, and then it is focused on both current energy and the distance toward the base station (BS) to select a parent CH which has current energy greater than the mean energy of CHs and the distance to the BS is fewer than the average. This parent CH groups all data from other CHs. The root CH after doing data aggregation sends compressed information to the BS using the multi-hop process between CHs. The improved algorithm is simulated in MATLAB R2016b simulation tool. Simulation results in this paper indicate that the introduced protocol works better than LEACH through extending the lifetime of the WSN.

Keywords: LEACH, WSN, Clustering, multi-hop, current energy, lifetime of the network, distance.

I. INTRODUCTION

In recent times, WSN is widely used in different surveillance systems such as in military, medical, commercial, and etc. WSN composed of hundreds number of micro-sensor nodes which usually are alimented by batteries. These small and cheap sensor nodes manipulate several complex functions like a collection of data from the environment, treatment, aggregation and compression (for CH nodes) and transmission action that requires a high level of energy although the energy of batteries is restricted. Consequently, the interest in energy efficiency may be affected to this limitation of batteries [1], [2]. For this issue, a growing range of research studies is performed to enhance the power consumption of nodes of the network in reason to find an efficient WSN with good durability. Several works of these studies are focused on routing protocols which most of them are based on the clustering technique. Clustering implicates creating one or more clusters which any cluster contains a cluster head that groups information’s since other members source so as to send them to the collector.

Routing protocols adopt the clustering method in order to minimize the power consumption of nodes of the network[3]. LEACH is one of the more practical ways of low consumption hierarchical clustering routing protocol which split network to many clusters that is founded on the probability model to choose the cluster-head. The overall idea of the LEACH protocol is that establishing clusters where normal nodes deliver their information collected since the milieu to their corresponding CHs which are selected randomly at the beginning of each round. Every CH after doing aggregation of all nodes’ data forwards compressed data to the BS. However, LEACH has imported some improvements for energy-efficiency, the random selection of CHs without consideration the current energy of nodes and the communication between CHs and the BS directly increase energy consumption that decreases network lifetime. For this reason, we developed an improved LEACH protocol whose global purpose is to prolong the lifetime of the network.

To compare different routing protocols in WSN, numerous metrics can be used. The principal metrics considered in this study to prove the performance of the proposed protocol are the residual energy, communication distance, multi-hop process and network lifetime.

In this work, we present a new clustering protocol that considers a hybrid of current energy and distance to the sink. We introduce BCE-LEACH clustering protocol.

BCE-LEACH has five mainly goals:

- Prolonging the lifetime of the WSN by equalize power consumption.
- Determination of CHs according to the residual energy.

Revised Manuscript Received on December 10, 2019.

***** Correspondence Author

Ikram Daanoune*, Electronics, Energy, Automatic and Information Processing laboratory, Faculty of Sciences and Techniques, Mohammedia. Hassan II University, Casablanca- Morocco. BP 146, Mohammedia, 20650, Morocco. E-mail: daa.ikram@gmail.com.

Abdennaceur Baghdad, Electronics, Energy, Automatic and Information Processing laboratory, Faculty of Sciences and Techniques, Mohammedia. Hassan II University, Casablanca- Morocco. BP 146, Mohammedia, 20650, Morocco. E-mail: nasser_baghdad@yahoo.fr.

Abdelhakim Ballouk, Electronics, Energy, Automatic and Information Processing laboratory, Faculty of Sciences and Techniques, Mohammedia. Hassan II University, Casablanca- Morocco. BP 146, Mohammedia, 20650, Morocco. E-mail: balloukhakim@gmail.com.

- Minimize aggregation overload on weak energy nodes.
- Selecting a root CH with maximum current energy and minimum space to the sink.
- Using the multi-hop method to optimize the communication cost.

  Network lifetime is prolonged by BCE-LEACH protocol through:
- Clustering and data aggregation by CHs.
- Balancing energy consumption through the effective choice of CHs depending on the current energy of nodes.
- Communication between CHs.
- Consideration of distance between CHs and BS including CH's residual energy.

The arrangement of the document is as follows: Part II represents some existing routing protocols. The next section of the paper was concerned with the proposed protocol where we will describe the new improved LEACH protocol, the methodology followed then the simulation parameters setting. The simulation results are presented in part IV. Section V presents a discussion between the improved protocol and LEACH protocol. In the last part, VI concludes the article.

II. LITERATURE REVIEW

To ameliorate the performance of the WSN, numerous routing protocols are developed [4]. The energy consumed during transmission between the origin and the destination is the basis of the routing protocol's performance [5]. Routing protocols differ from protocol to another according to several properties. Therefore, several routing protocols were proposed for WSN that we can divide them into three main classes called: hierarchical, data-centric and geographic location-based.

A. LEACH (Low Energy Adaptive Clustering ierarchy) [6]

LEACH is the first clustering routing protocol proposed by Heinzelman et al.[6] in 2000 for WSN. LEACH furnished a conception of clusters, where the CH is elected randomly according to (1). In each iteration, every normal node gathers information since the milieu then forwards it toward his corresponding CH. Role of CH was receiving all data from its cluster member, regrouping them, compressing them then sending them immediately toward the sink through a single communication [7].

The LEACH procedure is split to two stages: cluster formation stage and steady stage. In the first stage, every sensor node selects a value belongs to the interval [0, 1]. If this value is inferior to the threshold giving in (1), this node becomes as CH next turn. On the other hand, it remains as a common sensor node.

$$Th(i)=\begin{cases}\dfrac{P_e}{1-P_e*(R\%(1/P_e))} & i\in N\\ 0\end{cases} \qquad (1)$$

The signification of every symbol in (1) is as following:

P_e presents the percentage of the overall number of CH.

R defines the residual turn.

N introduces all sensor nodes which have not been CH in the $1/P_e$ turns.

Fig. 1 shows the LEACH topology structure.

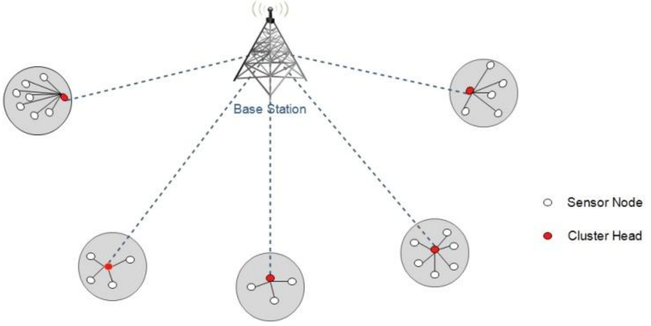

Figure 1: LEACH Protocol topology

LEACH is based on a dynamic selection of CHs, which can result in an imbalance of energy consumption because the CH consumes more energy than a normal node. It can also lead to not giving the possibility of being CH at all nodes. Owing to this imbalance, nodes may exhaust their energy early than others, which influences the network's lifetime. The energy is generally seen as a factor strongly related to the network lifetime. Thereby in LEACH, each CH communicates directly with the BS in unique hop whatever the conditions of distance and current energy which is not applicable to CHs at the edge of the network. The distance is an important factor in energy consumption.

B. V- LEACH (Vice cluster-head-LEACH) [8]

The random election of CH in LEACH can load to the CH exhausts its energy or has not had enough energy to forward news to the BS. For this reason, a new improved LEACH protocol has developed, namely V-LEACH [9]. Authors in [9] provide a solution to this problem by adding a vice-CH as a new component in the architecture of the protocol. So, the normal node collects information since the coverage area, sends them to the leader (CH) as in the LEACH algorithm, and then the vice-CH replaces the main CH when the latter dies [8]–[10].

Fig. 2 illustrates the architecture diagram of V-LEACH where it is seen that the V-LEACH protocol contains three main elements namely: normal node which collects data from the environment; CH which receives data from all cluster member, regroups them then sends them to the BS and the last element is the vice-CH which plays the act of the main CH where death case of the latter.

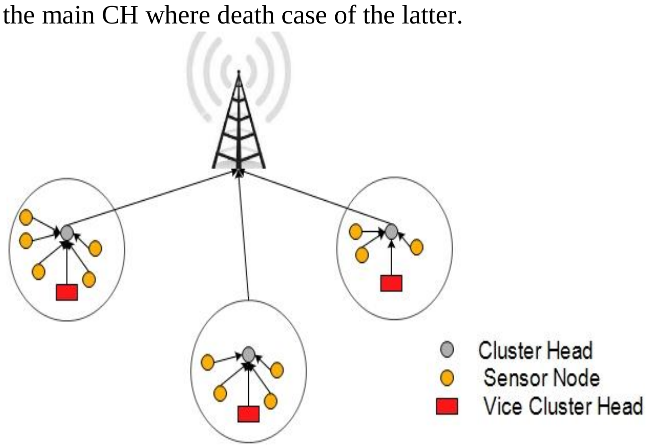

Figure 2: V-LEACH Protocol Topology[8]

This study serves to provide a vice-CH as a redundancy of the CH after the death of the CH in order that data of the cluster arrives at the BS and to extend the network lifetime.

However, this solution is not effective, remains limited and influences on decreasing the network lifetime when the vice-CH dies.

C. C-LEACH (Centralized-LEACH)

C-LEACH protocol is a centric check process, is worn to create groups in a different manner than clustering in LEACH. C-LEACH allows the distribution of CHs throughout the network. It is a modification of the regular LEACH algorithm, the selection of CHs and the distribution of nodes to these clusters is intended for the BS. In any round of cluster formation phase, each sensor node transmits its current energy as well as its location using GPS to the BS. The BS based on this information to decide which nodes will become CHs. It computes the mean power of nodes then the node with remaining power inferior to the mean cannot be CH for this round [11], [12].

Once CHs selected, the BS sends a packet to the network nodes containing the CH's ID for each node. Therefore nodes having similar ID became CH for this current turn. The rest of the C-LEACH method is similar to steady-phase in LEACH; the common sensor nodes forward their information to the corresponding CHs and CH after aggregating and compressing the information sends them to the BS [12].

In summary, considering the position of nodes, control at the BS level to choose the CHs and divide clusters then creating CHs in a way to be distributed throughout the network make C-LEACH performs upgrade than LEACH.

D. E-LEACH *[13]*

Authors in [13] proposed an enhanced LEACH protocol called E-LEACH, whose main purpose is improving the CH election through increasing the chance of the sensor nodes that have enough residual energy to become CHs and avoid nodes with the least energy to become CHs. Another aim of using the E-LEACH protocol is that it picks a root CH with the highest current energy. In [13], a threshold T (i) is determined as shown in(2).

$$T(i) = \begin{cases} \dfrac{P_{he}}{1 - P_{he} * (R \bmod (1/P_{he}))} * \dfrac{E_{current}}{E_{initial}} & j \in N \\ 0 \end{cases} \tag{2}$$

Where P_{he} is computed following (3), $E_{current}$ introduces the current energy of nodes and the initial energy is presented through $E_{initial}$.

$$P_{he} = \sqrt{\frac{N}{2\pi} * \frac{E_{fs}}{E_{mp}}} * \frac{M}{d_{toBS}^2 * N} \tag{3}$$

Where E_{fs} and E_{mp} are defined in section II. G.

Fig. 3 depicts the architecture of E-LEACH protocol.

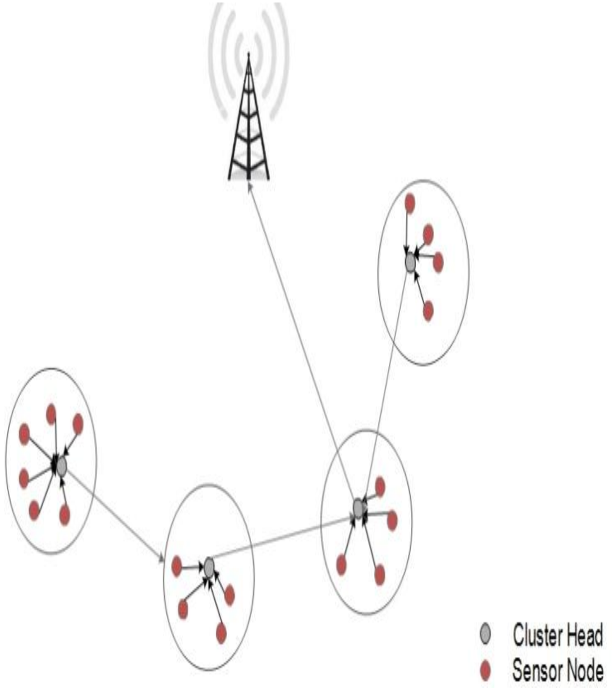

Figure 3: Architecture of E-LEACH protocol[13]

E-LEACH algorithm improves the CH selection depending on the current energy and avoids the participation of weak energy sensor nodes like CHs; also it picks out the shortest way depending on the current energy. However, this algorithm can decrease the network lifetime if the root CH is further away from the sink. The distance is also a key factor in extending the network lifetime.

E. LEACH-TLCH (LEACH Protocol with Two Levels Cluster Head) *[7]*

Owing to the dynamic and randomness of the cluster formation phase in LEACH protocol, the CH depletes more power than common sensor nodes. Therefore, it dies soon than other cluster members. For this reason, LEACH-TLCH is developed. Its overarching objective is to prolong lifetime of the network for WSN via balancing the power consumption of nodes. Cluster head choice and cluster formation phase used in LEACH-TLCH protocol is similar to that used in LEACH algorithm.

Once the cluster is established and the first round is finished (the same that LEACH method), the LEACH-TLCH protocol calculates the current energy of CHs and their distances to the BS. If the current energy is inferior to the mean energy of sensor nodes members or the distance to the sink is superior than the mean distance, then the algorithm picks the node that have maximum power in that group as a second CH whose its role is to collect information since cluster members, gathers them then forwards them to the mainly CH. Therefore, the principal CH receives just data from secondary CH then forwards it to the BS. On the other hand, this one cluster does not need a secondary CH [7]. So in this case, the CH has a similar role as in LEACH algorithm; it picks up the information since members of cluster and sends them directly to the sink as proved in Fig. 4. [7], [12].

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

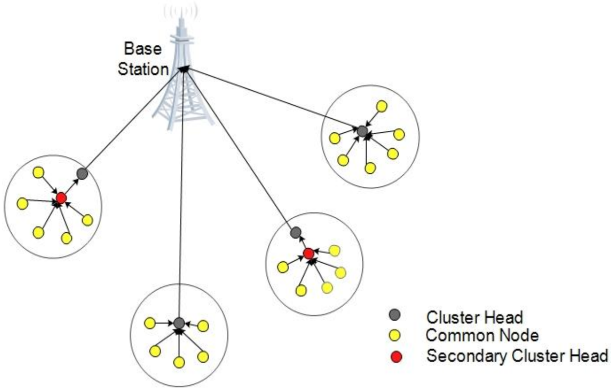

Figure 4: Architecture Structure of TLCH-LEACH Protocol [7].

F. PEGASIS (Power-Efficient GAthering in Sensor Information Systems)

PEGASIS is an enhancement form also called a prolongation of the LEACH algorithm. It serves to avoid the formation of several clusters. In PEGASIS algorithm, every sensor node has overall news about its entire detection network and perfect knowing of the emplacement of neighbouring sensor nodes. Every sensor node can deliver and take data since a neighbour and just one sensor node is elected in one channel at a round to communicate with the receiver [5]. The packets is united and passed since node to other, assembled and delivered to the receiver. Contrary to LEACH, PEGASIS averts the construction of multiple clusters and adopts a single sensor node in the chain to deliver toward the collector instead of using numerous CHs. The construction of the chain is done greedily. At every round, the sensor node that will transfer all grouped data to the sink is randomly selected [14], [15].

Fig. 5 presents the structure topology of the PEGASIS routing protocol.

This figure exhibits that node C1 receives data from C0, aggregates it with its proper and then transfers them to the leader C2. Afterwards, the node C3 receives C4's data when C2 gives the token to the node c4, then the node C3 regroups this data with its owner then forwards to C2. Afterwards The leader C2 receives information since the neighbours nodes, regroups it with its own and then sends only one packet to the BS [16].

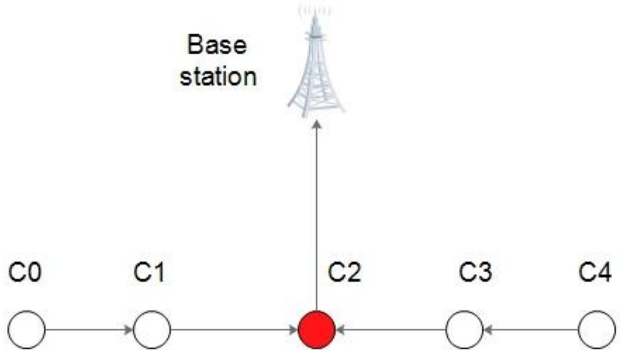

Figure 5: Architecture of PEGASIS Protocol[16]

PEGASIS protocol avoids clustering overload. But, every node sends its information to another neighbour without knowing the energy state of the latter then; it may be that the node that will regroup its own data to others does not have enough energy to do. In fact, PEGASIS needs again a reorganization of the topology [17].

G. Energy Consumption Model

In the radio model, to send a b bit packet to remote receiver di meters, the channel of emission depletes $E_{Tx}(b,d)$ described in (4). Otherwise, to take a b bit packet, the reception chain depletes $E_{Rx}(b)$ as defined in (6).

$$E_{Tx}(b,d)=\begin{cases} b.E_{elec}+b.E_{fs}.d^2, d_i<d_0 \\ b.E_{elec}+b.E_{mp}.d^4, d_i>=d_0 \end{cases} \tag{4}$$

$$d_0=\sqrt{\frac{E_{fs}}{E_{mp}}} \tag{5}$$

$$E_{Rx}(b)=b*E_{elec} \tag{6}$$

The signification of every indication in previous formulas is as pursue:

E_{Tx} : Energy depleted by sensor node for delivering b bit data from di distance between the emission chain and the receiver.

E_{Rx} : Energy consumed by sensor node when receiving b bit from the transmitter.

E_{elec} : Energy consumed in the electronics system.

E_{fs} : Energy depleted by the amplifier circuit for dispatching 1-bit data to the zone in the free space.

E_{mp} : Energy exhausted by the amplifier circuit for dispatching 1-bit data to the zone in the multipath propagation.

The energy consumption design is shown in Fig. 6.

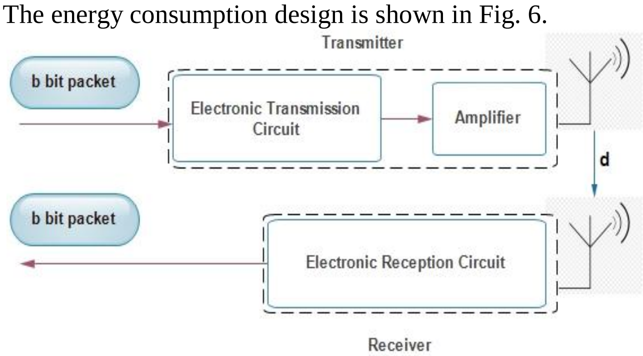

Figure 6: Energy Consumption Design.

III. THE PROPOSED WORK

In WSN some nodes exhaust their energies before others owing to dynamically and arbitrary choice of CHs, since the CH gathers several data from members of cluster and groups them then forwards them to the sink. Consequently it consumes more power than a common sensor node. Thereby, communication between CH and the sink directly regardless the distance and the current energy of CH effect on the lifetime of the network. So, it is essential to choose the ideal route to achieve the sink. In this document, we suggest an improved protocol based on LEACH and certain developed algorithms, namely BCE-LEACH. It is built on two metrics: the current energy of nodes and distance to the sink.

In the WSN, the most energy is consumed by cluster-heads and the communication between them and the sink. First, receiving all packets from the cluster nodes, aggregating and sending them to the base station, make the CH consume more energy than other normal nodes. So, we must choose the CH and let only the nodes that have more current energy participate as CHs so as to avoid the death of nodes earlier than others. The benefit of our methodology is that pick out CH depending on the current energy. Secondly, the communication between CHs and BS also consumes more energy depending on the distance. Consequently, more than the number of CHs that communicate with the base station is high, more than the power consumption of the network will increase. So, it is important to select an only route to the BS to minimize power consumption. The second benefit of our methodology is that the BCE-LEACH protocol selects the CH with more current energy and its distance to the sink is minimum as a parent cluster-head. The other CHs send their data to this root CH so that the latter sends all the gathered data to the BS.

The Fig.7 shows the structure of the proposed protocol.

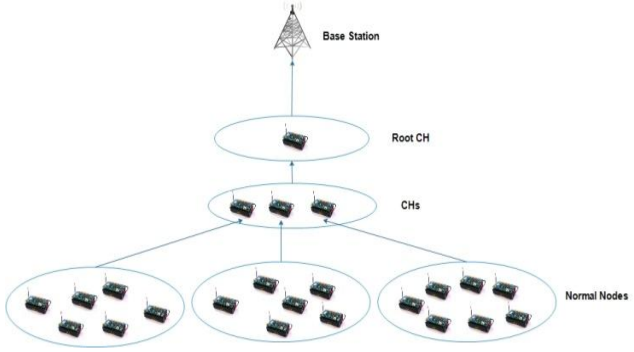

Figure 7: Structure of Proposed Protocol.

In this section, we describe the proposed protocol BCE-LEACH. Firstly, we demonstrate the methodology followed by our protocol and the organizational chart of the proposed algorithm. Secondly, we define the parameters used in the clustering and hierarchical method.

A. Methodology

Clustering is one of the most common procedures to extending the lifetime of WSN. A number of algorithms have been proposed to enhance the first energy-efficient clustering hierarchical routing protocol LEACH such as PEGASIS, V-LEACH, E-LEACH, B-LEACH, LEACH-TLCH, etc. Most previous methods have imported some good improvements in LEACH. However, there are certain drawbacks associated with either the current energy concentration, multi-hop to achieve the BS or the distance to the BS. Therefore, it must take into account all of these metrics. For this reason, the overarching objective of our algorithm is to prolong network lifespan centered on three main metrics that current energy of nodes, multi-hop method to reach the BS and the distance between CHs and the sink. Our protocol consists of two main steps:

1. Cluster formation

Firstly in each round, nodes calculate their current energy through (7), if it is greater than the mean energy, then these nodes can participate in the selection of CHs.

Where
$$\begin{aligned} E_{res} &= E_0 - E_{cons} \\ E_{cons} &= E_{Tx} + E_{Rx} \end{aligned} \qquad (7)$$

Where E_{Tx} and E_{Rx} are defined respectively in (4) and (6) in section II.G.

A new threshold energy function is defined in our paper for cluster head formation as follows in (8).

$$S(j) = \begin{cases} \dfrac{P_e}{1 - P_e * (R\%(1/P_e))} * \dfrac{E_{res}}{E_i}, j \in N \\ 0 \end{cases} \qquad (8)$$

Where P_e presents the percentage of the CHs;

R introduces the number of the actual round;

N demonstrates the groups of nodes that was not been CH in the last $1/P_e$ rounds;

E_i represents the initial energy of nodes and E_{res} introduces the current energy of nodes at the R round. The ratio of E_{res}/E_i is used to select nodes with enough residual energy to be CHs.

The choice to become CH in the cluster formation return to the node through taking an arbitrary value belongs to the interval 0 and 1. If this value is less than a threshold value S (j) defined in (8), this node becomes as CH in the following turn; else it remains like a common node.

Subsequently, after the dissemination of the information by the CH, the normal nodes determine their CHs corresponding to the strength of the received signal by the CH. Finally, normal nodes forward a confirmation message to their close CHs [6].

2. Steady phase

After cluster construction, each CH establishes TDMA (Time Division Multiple Access) schedules depending on the sum of members of the cluster and the distance. Each sensor node delivers its information in its TDMA time slot to corresponding CH [18].

whenever clusters have shaped and TDMA time slots have reserved, we pick out the root CH which has residual energy higher than the mean energy of CHs and the distance to BS is fewer than the mean distance between CHs and BS where are defined respectively in (9) and (10). Thus the other CHs know information by broadcasting from root CH.

$$E_{ave} = \frac{\sum_{c=1}^{CH} E_{res}(c)}{CH} \qquad (9)$$

$$d_{avetoBS} = \frac{\sum_{c=1}^{CH} d_{toBS}(c)}{CH} \qquad (10)$$

Where E_{res} indicates the current energy of CH at the current round and d_{toBS} presents the distance between each CH and the sink.

In the data communication stage, the normal nodes starting the collected information from the environment in order to transmit it to the CH belong.

The data of the furthest CHs from the root CH achieves this latest by using the multi-hop process. The root CH is the only component that communicates directly to the sink; it receives data from others CHs, aggregates them and sends them to the BS.

Fig.8 shows the architecture of the proposed model.

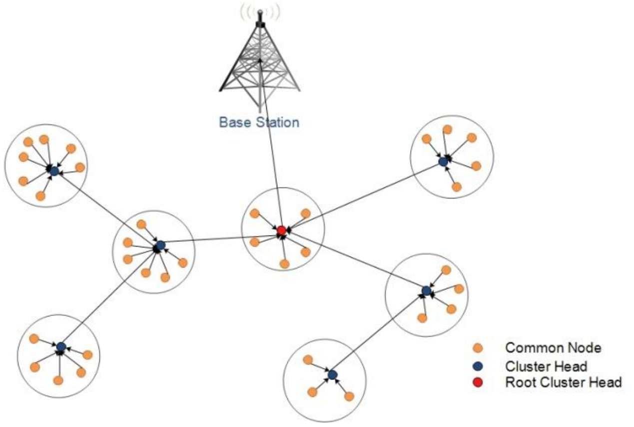

Figure 8: Architecture of the proposed model BCE-LEACH.

Fig.9 exhibits the flowchart of the proposed model.

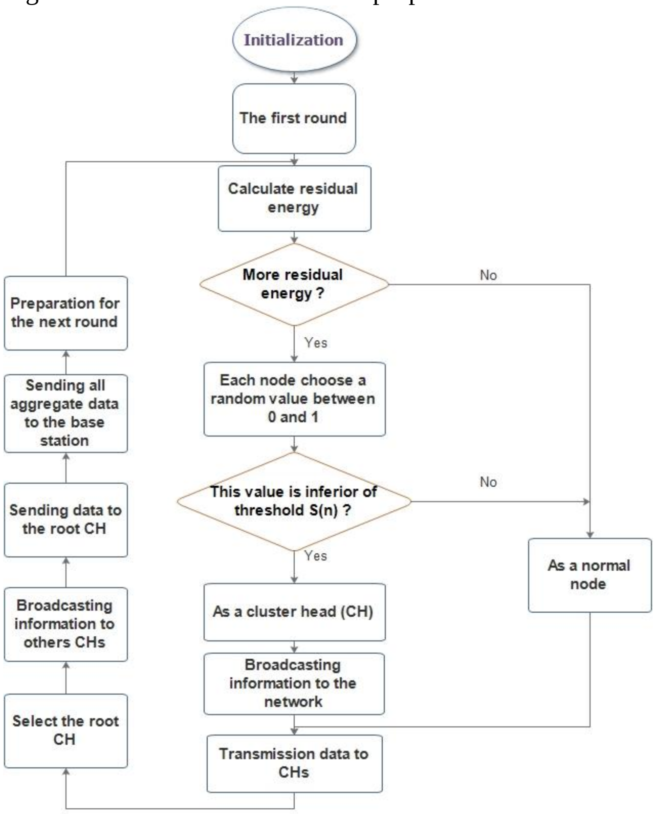

Figure 9: The flowchart of the proposed model.

B. Simulation parameters setting

In this part, we determine the parameters using in the simulation. We can define them as follows:

- Random distribution of 200 sensor nodes in a 200 * 200 m^2 square area.
- The initial energy is distributed uniformly in the nodes of a magnitude of 2J.
- The sink is situated at (100, 250).
- The percentage of CHs in the total number in the network is 20%.

The table I below illustrates the specific parameters accredited in the simulation of our protocol against LEACH.

Table- I: Parameters Value

Parameter	***Symbol***	***Value***
Nodes	n	200
Number of sinks	S	1
Area	M*M	200m * 200m
The cluster probability	P	20%
Initial energy	E0	2J
BS location	(x,y)	(100, 250)
Energy exhausted in the Radio module to send or take the signal	Etx=Erx	50 nJ/bit
Energy exhausted in the amplifier to deliver at a short distance	Efs	10 pJ/bit/m^2
Energy exhausted in the amplifier to forward at a longer distance	Emp	0.0013 pJ/bit/m^4
Energy of data aggregation	EDA	5 nJ/bit
Packet size	b	4000 bits
Number of rounds executed	r	6000

IV. SIMULATION AND RESULTS

This section presents simulations to estimate the performance of the proposed protocol. BCE-LEACH protocol is simulated using MATLAB R2016b simulation platform. The simulation parameters setting are mentioned in table below (table I). Performance comparison of the BCE-LEACH clustering algorithm against the hierarchical LEACH protocol is given in this part to verify the importance of BCE-LEACH on prolonging the lifetime of the network.

Fig.10 presents the random deployment of the 200 nodes in 200*200 m^2 square areas and the location of the BS at coordinates (100, 250).

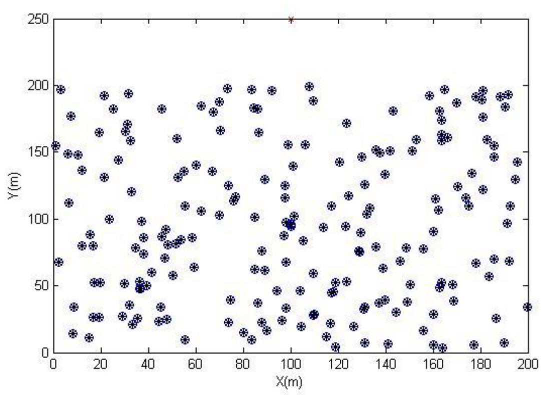

Figure 10: the Random Deployment of Nodes in the Network.

Fig. 11 compares the result of dead nodes in the network, obtained from the simulation of the proposed protocol and LEACH.

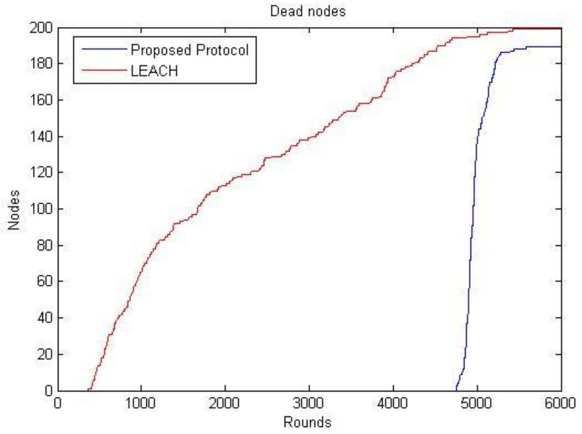

Figure 11: Dead nodes

From the chart above we can see that the first node died in the LEACH algorithm at 361st round, whereas the stability period of BCE-LEACH protocol is 4750th rounds which the first node died.

The aim of the graph presented in Fig. 12 was to estimate the alive nodes in 6000 rounds applying BCE-LEACH protocol and LEACH protocol.

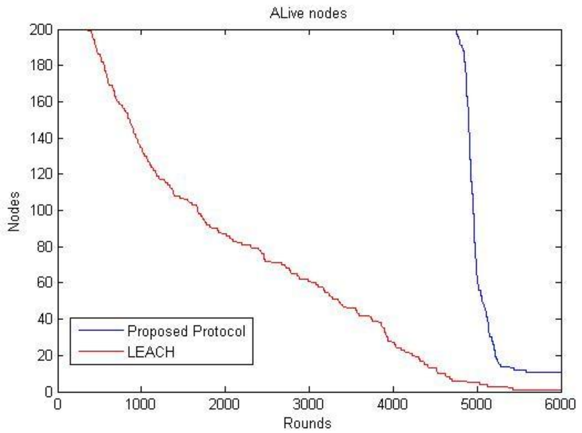

Figure 12: Alive nodes

As Fig. 12 shows, there is a significant difference between the two protocols (LEACH and BCE-LEACH). This difference has been presented in numbers in the diagram (see Fig. 13).

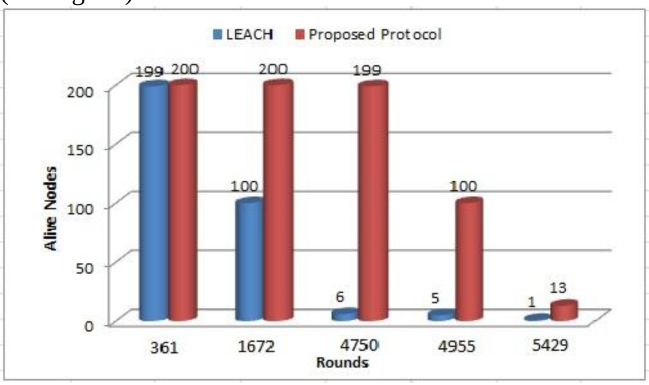

Figure 13: Diagram of comparison between LEACH and the proposed protocol.

The results, as shown in diagram Fig. 13, indicate that at the 361st round, applying LEACH, already the first node is dead while the 200 nodes stay alive by applying the BCE-LEACH protocol. In turn 1672nd, LEACH lost half of the initial nodes whereas the BCE-LEACH keeps the initial total of nodes alive (200 nodes). The BCE-LEACH lost his first node in the 4750th tower where 6 nodes that remain alive in LEACH. Half of protocol BCE-LEACH's nodes died in round 4955th while just 5 nodes that are still alive in LEACH. From the 5429th, almost all nodes are dead in LEACH except one. In contrast, In BCE-LEACH 13 nodes continue to live.

The purpose of simulation three shown in Fig. 14 was to present the pace of the overall current energy of network nodes in both protocols: LEACH and BCE-LEACH.

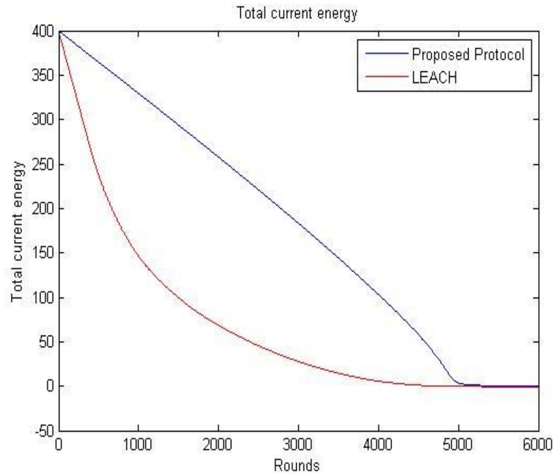

Figure 14: Total energy of node in the network.

From the data in Fig.14, it is apparent that the pace of total residual energy of the proposed protocol is above that of LEACH. Thus, the linearity of the LEACH curve ends in 584th round. In contrast, the linearity of the BCE-LEACH protocol terminates at the 4676th iteration. These results indicate that the total current energy of nodes in LEACH becomes almost zero from the iteration 3839 whereas in the BCE-LEACH protocol stays up to 4982nd round.

In summary, these results are significant and sufficient to show that our protocol has great importance on the extension of the lifetime of the network, so it is more efficient than LEACH protocol.

V. DISCUSSION

In [6], authors elect CHs in a random way at every turn, and then they use a single-hop between CHs and the sink. Therefore, these techniques consume more energy which decreases the sustainability of the network. As mentioned in the literature review, energy-efficiency is an important factor in WSN. The present study was designed to define the proposed protocol that takes into account the residual energy of sensor nodes and the space to the sink to improve the lifetime of the network owing to the energy can be conserved through reducing the communication distance and the volume of data to deliver. LEACH method was adopted in this algorithm to provide clusters.

One interesting finding in the current study is that residual energy and distance both have an importance on the minimization of consumption energy of nodes in the network. Another important finding was that a single communication between the collector and the root CH which aggregates all data from the other CHs economize energy consumption and allows CHs with low remaining energy to live even as shown the result of table II below.

Table- II: Comparison between LEACH and BCE-LEACH

Rounds	***Alive nodes in LEACH***	***Alive nodes in BCE-LEACH***
361	199	200
1672	100	200
4750	6	199
4955	5	100
5429	1	13

The benefit of this study is to prove the added value of the proposed BCE-LEACH algorithm in increasing the network lifespan.

VI. CONCLUSION

In LEACH and some of its improved protocols, voting CH randomly regardless of residual energy of nodes can lead to that some CH finished their energy early than others. Thus, this dynamical electing of CH is an underlying factor to not give the chance at all nodes to become CH even if they have enough current energy. Also, numerous CHs send to the BS whatever the remaining power and the space to the sink may have a negative effect on decreasing network lifetime. Therefore, the space to the sink and the energy are the most essential factors in the protocol design for WSN. For this reason, this paper suggested a new enhanced protocol of LEACH namely BCE-LEACH that has been built on the current energy to pick out CHs, it considers both current energy and distance to the sink to choose an optimal path to achieve the collector by selecting a root CH, then it adopted multi-hop method between CHs to reach the root CH.

The aim of the present research was to examine a comparison of BCE-LEACH and LEACH protocol through simulation in MATLAB simulation platform. Results of simulation argued that the proposed protocol makes a improved decision of the CH electing and the root CH selecting because of the number of living nodes in the system is higher than the original LEACH protocol, dead nodes is fewer than LEACH then, the total current energy of network nodes decreased very gradually than the original LEACH algorithm. In summary, considering the residual energy of nodes to choose the CHs and divide clusters then creating CHs, taking into account the current energy of CHs and the distance between CHs and the sink to elect the root CH make BCE-LEACH performs upgrade than LEACH.

REFERENCES

1. F. Engmann, F. A. Katsriku, J.-D. Abdulai, K. S. Adu-Manu, and F. K. Banaseka, "Prolonging the Lifetime of Wireless Sensor Networks: A Review of Current Techniques," *Wirel. Commun. Mob. Comput.*, vol. 2018, pp. 1–23, Aug. 2018.
2. T. R. and A. B. and Y. Challal, "Energy efficiency in wireless sensor networks: A top-down survey | Kopernio," Jul-104AD. [Online]. Available: Doi: 10.1016/j.comnet.2014.03.027. [Accessed: 10-Dec-2019].
3. S. K. Singh, M. P. Singh, and D. K. Singh, "A Survey of Energy-Efficient Hierarchical Cluster-Based Routing," in *in Wireless Sensor Networks‖ Int. J. of Advanced Networking and Applications (2010), VOL: 02, Page: 570-580 www.ijmer.com 489 | Page*, 2010, vol. 02, pp. 570–580.
4. G. S. Brar, S. Rani, V. Chopra, R. Malhotra, H. Song, and S. H. Ahmed, "Energy Efficient Direction-Based PDORP Routing Protocol for WSN," *IEEE Access*, vol. 4, pp. 3182–3194, 2016.
5. A. M. Zungeru, L.-M. Ang, and K. P. Seng, "Classical and swarm intelligence based routing protocols for wireless sensor networks: A survey and comparison," *J. Netw. Comput. Appl.*, vol. 35, no. 5, pp. 1508–1536, Sep. 2012.
6. W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in *Proceedings of the 33rd Annual Hawaii International Conference on System Sciences*, Maui, HI, USA, 2000, vol. vol.1, p. 10.
7. C. Fu, Z. Jiang, W. E. I. Wei, and A. Wei, "An energy balanced algorithm of LEACH protocol in WSN," *Int. J. Comput. Sci. Issues IJCSI*, vol. 10, no. 1, p. 354, 2013.
8. Yassein, "Improvement on LEACH Protocol of Wireless Sensor Network (VLEACH)," *Int. J. Digit. Content Technol. Its Appl.*, vol. 3, no. 2, 2009.
9. A. Ahlawat and V. Malik, "An extended vice-cluster selection approach to improve v leach protocol in WSN," in *2013 Third International Conference on Advanced Computing and Communication Technologies (ACCT)*, 2013, pp. 236–240.
10. L. Aziz, S. Raghay, H. Aznaoui, and A. Jamali, "A new enhanced version of vleach protocol using a smart path selection," *Int. J. GEOMATE*, vol. 12, no. 30, pp. 28–34, 2017.
11. W. Xinhua and W. Sheng, "Performance comparison of LEACH and LEACH-C protocols by NS2," in *2010 Ninth International Symposium on Distributed Computing and Applications to Business, Engineering and Science*, 2010, pp. 254–258.
12. V. K. Arora (Research Scholar), V. Sharma, and M. Sachdeva, "A survey on LEACH and other's routing protocols in wireless sensor network," *Optik*, vol. 127, no. 16, pp. 6590–6600, Aug. 2016.
13. J. Xu, N. Jin, X. Lou, T. Peng, Q. Zhou, and Y. Chen, "Improvement of LEACH protocol for WSN," in *2012 9th International Conference on Fuzzy Systems and Knowledge Discovery*, 2012, pp. 2174–2177.
14. M. N. Khan, S. O. Gilani, M. Jamil, A. Shahzad, and A. Raza, "Efficient energy utilization in wireless sensor networks: an algorithm," *3C Tecnol. Innov. Apl. Pyme*, vol. 7, no. 4, Jan. 2019.
15. M. Nasir Khan and M. Jamil, "Performance Improvement in Lifetime and Throughput of LEACH Protocol," *Indian J. Sci. Technol.*, vol. 9, no. 21, Jun. 2016.
16. K. Akkaya and M. Younis, "A survey on routing protocols for wireless sensor networks," *Ad Hoc Netw.*, vol. 3, no. 3, pp. 325–349, May 2005.
17. P. A. Kumar and D. P. M. Hadalagi, "Survey Of Routing Protocols In Wireless Sensor Networks:-," *Int. J. Eng. Sci. Invent. IJESI*, vol. 07, no. 01, 2018, pp. 28–37.
18. S. B. Bore Gowda and G. Nayak Subramanya, "DUCA: An Approach to Elongate the Lifetime of Wireless Sensor Nodes," in *Engineering Vibration, Communication and Information Processing*, vol. 478, K. Ray, S. N. Sharan, S. Rawat, S. K. Jain, S. Srivastava, and A. Bandyopadhyay, Eds. Singapore: Springer Singapore, 2019, pp. 329–337.

AUTHORS PROFILE

Ikram Daanoune, is born on December 29, 1993, in Beni Mellal, Morocco. She obtained her license degree in electronic engineering and telecommunications, from Faculty of Sciences & Techniques of Beni Mellal, Sultan Moulay Slimane University, in 2015, and an engineering diploma on electrical & telecommunications at Faculty of Sciences & Techniques of Mohammedia, Hassan II University, in 2018. Presently, she is a Ph.D. student, nominee in the Electronics, Energy, Automatic and Information Processing (EEA&TI) laboratory at Faculty of Sciences & Techniques, Mohammedia, Hassan II University Casablanca. Her study interests include the development and simulation of classical and computational intelligence routing protocols to optimize energy consumption in Wireless Sensor Network. Thus, her researches are concentrated also on the design and optimization of the performance of

Rectenna for supply wireless sensor networks by radio frequency waves.

Abdennaceur Baghdad, is a doctoral holder in Electronics from Lille University France in 1992. Presently, He is a university professor with PES grade at the Faculty of Sciences & Techniques of Mohammedia, Hassan II University Casablanca-Morocco whither he educates the hyper-frequencies, electronic engineering, antenna, and systems of telecommunication. He is a participant of the “electronics, energy, automatic and information processing” laboratory at Hassan II University. His researches focused on optical communication, electronic and embedded systems, telecommunication systems and information technology. He oversees and he co-supervises many doctoral theses. He is a member of the organizing committees of several international congresses in the same research area.

Abdelhakim Ballouk, is a doctoral holder in Electronics from Bordeaux University France in 1992, in the automatic domain. Presently, He is a university professor with PES grade at the Faculty of Sciences & Techniques of Mohammedia, Hassan II University Casablanca-Morocco where he educates regulation & digital control, and linear & nonlinear automatic. He is a participant of the “electronics, energy, automatic and information processing” laboratory at Faculty of Sciences & Techniques of Mohammedia, Hassan II University. He oversees and he co-supervises many doctoral theses. His researches concentrated on Automatic (robust commands, predictive controls, etc.). His researches focused also in Telecommunication systems (Antenna, wireless sensor network, etc.).