CONTRIBUTION TO THE DESIGN OF NEW APPROACHES FOR ENERGY MANAGEMENT IN WIRELESS SENSOR NETWORKS

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ABSTRACT

The Wireless sensor is a micro device that allows measuring a physical quantity from the environment and transforming it autonomous into a digital value that can be processing. The collection, processing and transmission of data are the main factors of the dissipation of the energy for the wireless sensors, since these Battery-powered sensors is limited in energy, and it is usually impossible to recharge or replace it, knowing that sensors are generally distributed in places which are difficult to reach. Indeed, the lifetime of the network is one of the major constraints facing in WSN. Therefore, the energy consumption of the sensors plays an important role in the network lifetime. Among scientific research developed to improve the lifetime of wireless sensors network is the integration of a new techniques of routing protocols existing. In this paper, we will solve two major energy problems. The first concerns the equitable distribution of energy on all the nodes of the network in order to eliminate the energy holes. The second is the minimization of energy consumption to maximize or extend the life of the network. To achieve these objectives, we propose firstly the EDE (Equitable Distribution Energy) protocol based on clustering. This guarantees an equitable distribution of energy across the entire sensor network. In the second phase, we propose a new protocol named EDEE, which is an improvement of the EDE protocol, to minimize the energy consumption of the nodes. At the end, the EEDE (Energy and Equitable Distribution Energy) protocol would thus be a complete and efficient protocol in terms of energy.

Keywords: *Wireless Sensor, Clustering, Energy hole, Equitable distribution energy, Energy dissipation*

1. INTRODUCTION

The wireless sensor is a micro device that allows measuring a physical quantity, such as temperature, light, or the movement from the environment and transforming it autonomous into a digital value that can be processing, and routing toward base station. The deployment of several wireless sensors communicating by wireless radio, form a Wireless Sensor Network. Several constraints prevent proper deployment these networks. One of the most significant challenges for Wireless Sensor Networks is energy consumption. However the economy of energy is among the major issues of these networks, and it is difficult even impossible to replace the sensors or their battery because of the location of deployment that is often inaccessible, especially that the purpose of traditional application scenarios is to deploy nodes in an unattended domain for months or years [1] [2] [3]. The life of a sensor network is the period of time that the network can, as appropriate: maintain enough connectivity, cover the entire domain, or keep the rate of information loss below a certain level. There are different definitions for the lifetime of a network, for example [4]:

•The duration can be defined until the first node dies.

•The duration until all sensors is depleting their energy, by the time until a proportion of nodes die.

•The duration on which, the network continually meets the needs of the application.

•The duration on which each target is covered by at least one node.

•The duration during which the area of interest is covered by at least K nodes.

The equitable distribution of energy throughout the network is another trouble, especially when the station base is not in the middle of the network [5]. In this work, we propose an improvement of routing protocols (EDE: Equitable Distribution Energy) based on Leach protocol by reducing the overload of cluster-head, in order to well distribute the energy overall network; avoid the energy hole (death node).

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This EDE protocol consists on creating a new node (Transfer-Node) in step up phase, within the cluster that is only responsible of transferring data into the base station (BS) in steady up phase. Our network will be structure as a producer-consumer pattern in order to organize intra-cluster exchanges. In addition, the protocol will maintain more or less the same energy performance in terms of lifetime of the network. We are going to show the efficiency of our proposed protocol by comparing it with other well-chosen protocols especially LEACH (homogeneous networks) and SEP protocol [6]. Indeed, we have added the SEP protocol (heterogeneous networks). The sensors are designed to work for months or even years. Thus, the energy capacity of the sensors must be used effectively to maximize the lifetime of the network. Note that once a sensor node has exhausted its energy, it is considered faulty. Thus, there is a high probability of losing network connectivity. In a sensor node, energy is consumed by performing the following functions: capture, processing and communication. Several factors intervene in these functions, for example the state of the radio module, the access policy to the transmission channel, the routing protocol and others factors. Since the EDE protocol has solved the problem of energy holes and its results on energy dissipation are not satisfactory, we proposed an improvement of the EDE protocol that is the EEDE protocol in order to optimize also the energy consumption. EEDE protocol modifies CH election method and eliminates redundant information.

The rest of the paper is organized as follows. In Section 2, related works. In section 3, we are presenting a Hierarchical Routing. In Section 4, we are going to expose the problem of energy distribution in WSNs. In section 5, we define our proposition, protocol EDE. Simulation results and discussion for EDE protocol are presented in section 6. In section 7, we define and present the EEDE protocol. Finally, a conclusion is given in the last section.

2. RELATED WORKS

The energy consumption remains a challenge for the research community, because of its paramount importance to ensure good network performance [7] [8].

Maximizing the life of the network generally aims to minimize the energy consumption of the sensors. In addition, we can optimize the life of a network without necessarily maximize it, indeed, ensure good management of energy consumption of the system in full or ensure a fair distribution of energy throughout the network to keep a total coverage and a smooth operation of the system.

Poor management of energy consumption in the networks can produce so-called energy holes [9] [10]. We have two types of this problem, the first, near to the base station for multi-hop transmission topology; the second one is far from the base station for the direct transmission topology. To solve this problem of energy holes or black zone, several approaches are proposed.

Sensors which are located closer to the base station, especially for multi-hop relays, participate in more data transfers (more load); sensors situated in this region should have a higher density. The method has been proposed to use mobile sensors [11], allowing sensors to move to meet density requirements, In order to extend the life of the network and achieve a balanced energy consumption. But this approach has also shortcomings like, the investment will be more expensive for network deployment and also the process may take longer to collect all the data, which is not desirable for real-time monitoring [12].

A pixel-based transmission mechanism is adopted by [13], to reduce the duplication of the same messages, in order to obtain equitable energy consumption per node. The default of this proposal is that each node must know its location [14].

Among the solutions proposed for this problem, we have the [15] approach of dividing the coverage area of the network into systematic cells and layers. These cells are classified into primary and secondary cells. The problem with this approach is the difficulty of deploying network node sensors.

Clustering is one of the techniques created to maximize life and balance energy in wireless sensor networks. The Leach protocol [16] is classified among one of the reference protocols based on clustering. This protocol has really succeeded in minimizing energy dissipation in the network, but it has not achieved the objective of solving the problem of energy holes or black areas (details in section 4).

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In the rest of this paper, we are focused on the second type black area for a far to the base station.

On the other hand, there are several techniques are proposed to solve the problem of energy consumption. Such as the data-centric techniques [17] of reducing the energy consumption of capture. Also the techniques based on the activity of the cycle, the latter aims to reduce the duration of the radioactivity to avoid over-consumption of energy due to the communication between the nodes. This technique is usually based on sleep / wakeup methods and protocols at the Mac level [18] [19] [20].

The improvement of existing routing protocols, for example the famous LEACH protocol, and also among the techniques proposed to minimize the energy consumption of the network, in particular the K-LEACH protocol, E-LEACH, MH-LEACH, LEATCH, etc. [21][22] [23] [24].

3. HIERARCHICAL ROUTING

A wireless sensor network is a network with certain energy constraints. One of the most crucial problems in the WSNs is the development of a more efficient system in terms of energy consumption. In hierarchical routing protocols, the network is broken down into clusters [25] [26]. Each cluster is composed of sensor nodes, one of them plays the role of Cluster-Head, and it is responsible for routing from its cluster to other clusters or to the base station (Figure 1). Typically, data travels from lower-level to higher-level clusters [27].

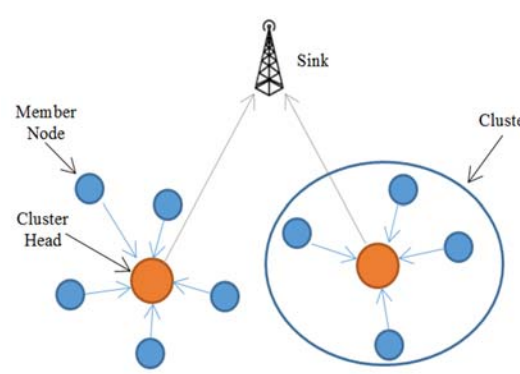

Figure 1: Hierarchical routing

3.1 Leach Protocol

Introduced by [16], LEACH (Low Energy Adaptive Clustering Hierarchy) is a hierarchical clustering algorithm. This is one of the most popular hierarchical routing algorithms for WSNs. The protocol takes rounds; each round consists of two phases.

- Set-up
- Steady-state

In set-up, the cluster-head is chosen randomly among the network nodes. After the election of cluster-head, it broadcasts an advertisement messages, based on the received signal strength, each non cluster-head node transmits a join request message containing its ID back to its chosen cluster-head using CSMA.

In steady-state, each cluster-head allocates its TDMA schedule to its member nodes. Based on the schedule, each member node transmits the sensed data to its correspondent cluster-head node. The cluster-head aggregates and compresses data received from all nodes and sends it to the base station [24].

3.2 SEP Protocol

SEP (Stable Election Protocol) is a heterogeneous routing protocol based on clustering a two level. SEP protocol consists of two types of sensor nodes, normal nodes and advanced nodes (nodes with more energy than normal nodes). In this protocol the advanced nodes become cluster-head more frequently than normal nodes to extend the period of stability of the clustering hierarchy process [6].

4. PROBLEM OF ENERGY DISTRIBUTION

4.1 Problem Statement

Generally, the cluster-head is the most active node of the cluster, because it manages all nodes member in the cluster. In effect, after the election of the cluster-head, it is in charge of the creation and the organization of the cluster, and then the data collection from member nodes, the treatment and the compression of this information in digital form, in order to transmit them to the Base Station [11]. In carrying out all these stains, the cluster-head loses a lot of energy, consequently it results a quick death of the cluster head. Therefore, this leads to have energy holes (dead nodes) in the network.

On another side, the location of the base station also creates a problem of energy. Indeed, cluster-head that are located away from the BS consume more energy, because the transmission distance to the BS is significant. As well, the areas that consist of these sensors die entirely. Therefore, when we work in a large area especially when we have a large number of nodes, sensors far from BS

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in the network lose a lot of energy [8] compared to other sensors. In this case, we can say that we do not have a fair distribution of energy over the entire network.

Reflecting what goes on the Leach protocol. Leach is based on the creation of clusters and the election of cluster-heads. CHs transmit data collected from member nodes directly to the base station. We obtain two cases (Figure 2):

1) First case:

There will always be a creation of the CHs in the far area of the BS to maintain a uniform distribution of CHs on the entire network. In this case, the CHs nodes will lose energy quickly.

2) Second case:

After an energy threshold, we will not have CHs in the far zone of the BS. In this case, the member nodes will lose energy because of the transmission of data collected each time to distant CHs.

In both cases, we will get black areas.

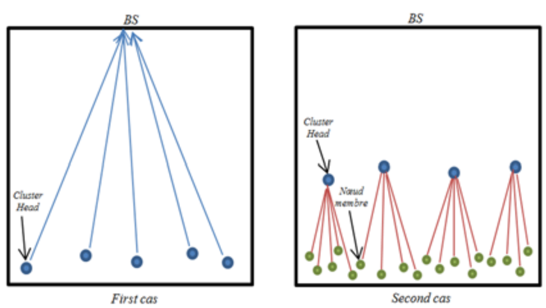

Figure 2: (First case) energy dissipation of CH and (second case) energy dissipation of member nodes

4.2 Energy model

The first step in designing a sensor energy system is to analyze the power consumption characteristics of a wireless sensor node. This systematic analysis of the energy of a sensor node is extremely important in identifying problems in the energy system to enable efficient optimization. Generally, a sensor uses its energy to perform three main functions detection, processing and communication.

We are interested by the energy of the detection, the energy of the transmission and the energy of the reception [6] [9]:

- Sensing energy

$$E_S(k) = \beta * k \qquad (1)$$

- Transmission energy

$$E_{Tx}(k,d) = E_{elec} * k + \epsilon_{amp} * k * d^2 \qquad (2)$$

- Reception energy

$$E_{Rx}(k,d) = E_{elec} * k \qquad (3)$$

Where k is the message length in bits, E_{elec} is the data rate of each sensor node, and d is the distance between the node transmitter and receiver.

5. EDE PROTOCOL

5.1 Definition of the EDE Protocol

To reduce the functionalities of the cluster-head, we propose a new concept of routing (EDE protocol) based of Leach protocol, which consists in creating a node that is only responsible of the transfer of the data. The cluster-head delegates the task of the transmission of packets to the base station to another node of the cluster. This node called Transfer-Node (TN), Figure 3.

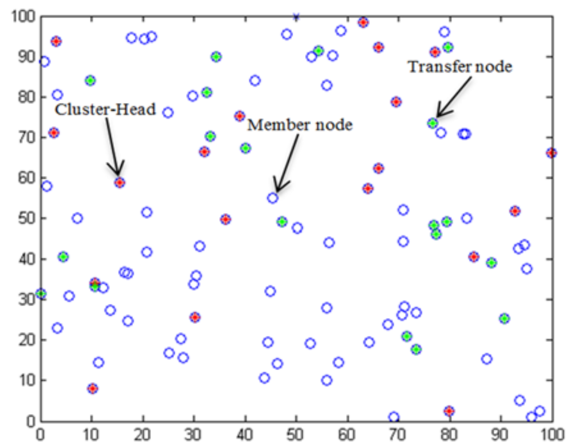

Figure 3: Random distribution of sensors node

The EDE protocol process takes place on two phases same as the Leach protocol. In step up phase, we add the selection of NT node. Indeed, in a defined cluster, the energy capacity of the chosen Node Transfer must be greater than greater than or equal to the energy of the cluster-head. Otherwise, the latter will be TN node. In addition, the difference in the steady up phase is that the CH transmits the data to the TN node.

We consider that the advanced EDE protocol has the same properties as the EDE protocol, but with normal nodes and advanced nodes that have more energy (heterogeneous node sensor network).

5.2 Impact energy

We can expose cluster energy E_{C-CC} for a classic clustering routing protocol as follows:

Moreover, the energy of a cluster for our proposition as follows:

$$E_{C-CC} = E_{S-all} + E_{P(CH)} + E_{R(CH)-all} + E_{T(CH)-S} \quad (4)$$

Moreover, the energy of a cluster for our proposition as follows:

$$E_{C-EDE} = E_{S-all} + E_{P(CH)} + E_{R(CH)-all} + E_{R(TN)-CH} + E_{T(TN)-S} + E_{T(CH)-TN} \quad (5)$$

Where E_{S-all} is the sensing energy, $E_{P(CH)}$ is the processing energy from cluster-head, $E_{R(CH)-all}$ is the reception energy consumed by the CH by receiving data from the member nodes, $E_{T(CH)-TN}$ is the transmission energy from CH to the TN node, $E_{T(CH)-S}$ is the transmission energy from CH to the sink, $E_{R(TN)-CH}$ is the reception energy consumed by the TN node by receiving data from the member nodes, and $E_{T(TN)-S}$ is the transmission energy from TN node to the sink. We consider that,

$$E_{C-CC} = E_{C-EDE} \quad (6)$$

And

$$E_{CH-CC} = E_{P(CH)} + E_{R(CH)-all} + E_{T(CH)-S} \quad (7)$$

And

$$E_{CH-EDE} = E_{P(CH)} + E_{R(CH)-all} + E_{T(CH)-TN} + E_{T(CH)-S} \quad (8)$$

According to the above

$$E_{CH-CC} = E_{CH-EDE} + E_{R(TN)-CH} + E_{T(TN)-S} \quad (9)$$

We assume that E_{TN} is the energy consumed by TN node

$$E_{TN} = E_{R(TN)-CH} + E_{T(TN)-S} \quad (10)$$

$$E_{CH-CC} = E_{CH-EDE} + E_{TN} \quad (11)$$

Finally, we have the energy dissipated by CH is greater than the energy by TN.

$$E_{CH-CC} \geq E_{CH-EDE} \quad (12)$$

The remaining energy, since we have the same energetic mass, is shared on the other nodes that are selected TN nodes.

5.3 Studies

In this study, we will explore a few cases that reflect the energetic properties above of the proposed protocol. We consider a small network that consists of four wireless sensors that communicate between them. These nodes form a cluster and we will initial by 20 units energies (figure 4).

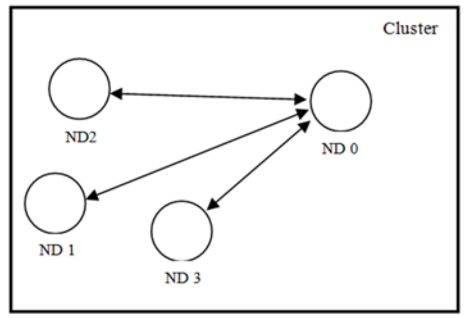

Figure 4: Cluster

- Concerning the collection, processing of data and communication intra-cluster, the following nodes ND0, ND1, ND2, and ND3 lose respectively 2 units, 3 units, 2 units, 4 units of energy.
- The cluster-head loses five energy units, during the processing, aggregation, and the compression of data.
- The cluster-head and TN node loses five energy units, during the transmission to the base station.

We will treat three cases; each step is comprised of two phases:

- The election of the cluster-head until the compression of the data.
- Transmission of data to the Base Station.

1) First case:

At the level of the proposed method, the algorithm will designer each time the node that has less energy such as cluster-head.

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Table 1: Comparison between the classical clustering protocol and the proposed protocol (1st case).

			ND 0	ND 1	ND 2	ND 3
Initial		Classic Clustering	20	20	20	20
		Proposed work	20	20	20	20
Step 1	**Phase 1**	Classic Clustering	15	17	18	16
		Proposed work	15	17	18	16
	Phase 2	Classic Clustering	10	17	18	16
		Proposed work	15	17	13	16
Step 2	**Phase 1**	Classic Clustering	8	14	13	12
		Proposed work	13	14	8	12
	Phase 2	Classic Clustering	8	14	8	12
		Proposed work	13	9	8	12
Step 3	**Phase 1**	Classic Clustering	6	11	5	5
		Proposed work	6	11	5	8
	Phase 2	Classic Clustering	**6**	**11**	**0**	**8**
		Proposed work	6	6	5	8

2) Second case:

Concerning the method of Classic clustering, the algorithm is going to designate in each round the node that contains more energy as Cluster-Head.

Table 2: Comparison between the classical clustering protocol and the proposed protocol (2nd case).

			ND 0	ND 1	ND 2	ND 3
Initial		Classic Clustering	20	20	20	20
		Proposed work	20	20	20	20
Step 1	**Phase 1**	Classic Clustering	15	17	18	16
		Proposed work	15	17	18	16
	Phase 2	Classic Clustering	10	17	18	16
		Proposed work	15	17	13	16
Step 2	**Phase 1**	Classic Clustering	8	14	13	12
		Proposed work	13	14	8	12
	Phase 2	Classic Clustering	8	14	8	12
		Proposed work	13	9	8	12
Step 3	**Phase 1**	Classic Clustering	11	4	6	8
		Proposed work	6	4	6	8
	Phase 2	Classic Clustering	**4**	**1**	**4**	**3**
		Proposed work	**4**	**1**	**4**	**3**

3) Third case:

In this case, we are going to fix the Cluster-Head up to the one which energy is exhausted.

Table 3: Comparison between the classical clustering protocol and the proposed protocol (3rd case).

			ND 0	ND 1	ND 2	ND 3
Initial		Classic Clustering	20	20	20	20
		Proposed work	20	20	20	20
Step 1	**Phase 1**	Classic Clustering	15	17	18	16
		Proposed work	15	17	18	16
	Phase 2	Classic Clustering	10	17	18	16
		Proposed work	15	17	13	16
Step 2	**Phase 1**	Classic Clustering	5	14	16	12
		Proposed work	10	14	11	12
	Phase 2	Classic Clustering	**0**	**14**	**16**	**12**
		Proposed work	10	9	11	12

In the first and third case, the nodes ND2 and ND0 die in the classical clustering protocol contrary to the proposed protocol. In the second, case the two protocols in the same results. Energy side notes that the sums of the energies of the two protocols in the last rounds are equal.

It can be deduced that the proposed protocol can assure us more node alive for more round, although the energy of the whole cluster remains approximately the same.

5.4 Network model

Now, our cluster has three main actors: the member nodes, the cluster-head and the transfer node. Therefore, we propose the producer-consumer pattern [28], in order to organize and manage our cluster.

A cluster schematize as a producer-consumer pattern. The member nodes are the producers, the cluster-head is the buffer whose data processes, aggregate and compress, and then the consumer is the transfer node. The latter that will pick up the data from the cluster - head to transfer them to the base station.

6. SIMULATION RESULTS AND DISCUSSION

6.1 Simulation environment

We chose to compare with the Leach protocol, since our proposed protocol is an improvement of the Leach protocol. In order to

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obtain a diversity of topology on the networks, we chose to compare with the SEP protocol because it is based on heterogeneous sensor networks [6]. In SEP, protocol m is the fraction of advanced nodes and α is the additional energy factor between advanced and normal nodes.

The wireless sensors deployed on an area of 100m*100m with a base of station located at the point (50, 100). We use Matlab environment to run simulation.

Table 4: Parameters Table.

Parameter	value
Initial energy of nodes	0.25 joule
Transmitter and receiver energy	50nj/bit
Aggregation energy	5nj/bit
Data packet length	4000 bit
amplifier energy E_{fs}	10pj/bit/m2
amplifier energy E_{amp}	0.0003pj/bit/m4

6.2 Simulation results

In this simulation, we compare our protocol EDE with Leach protocol the distribution (position) of dead nodes in the surface of the network. We consider that all nodes have an equal initial energies and each death node excluded from the next round.

1) First simulation (Energy distribution)

In Figure 5, where treated by the classical Leach protocol, shows clearly, that the lower part of the network represents a black area of which all sensors are dead. Thus, we may not have the information of this area that is not covered. Shows clearly, that the lower part of the network represents a black area of which all sensors are dead. Thus, we may not get the information of this area that is not covered.

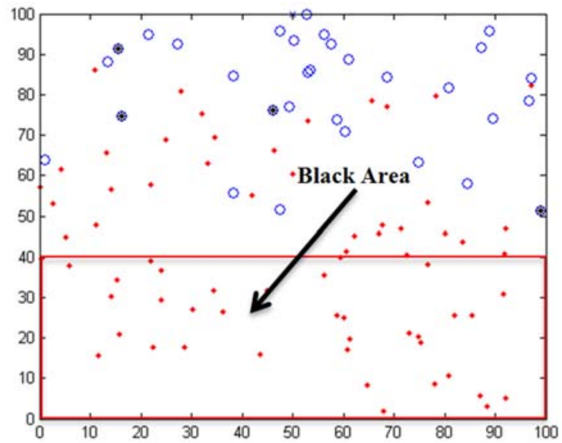

Figure 5: Blue nodes represent the member nodes, the black nodes represent the cluster heads and the red dots represent the dead nodes.

Figure 6 illustrates, treated by EDE in which we show the death of the nodes well distributed across the network. Consequently, we can have a data collection on the whole area of the network.

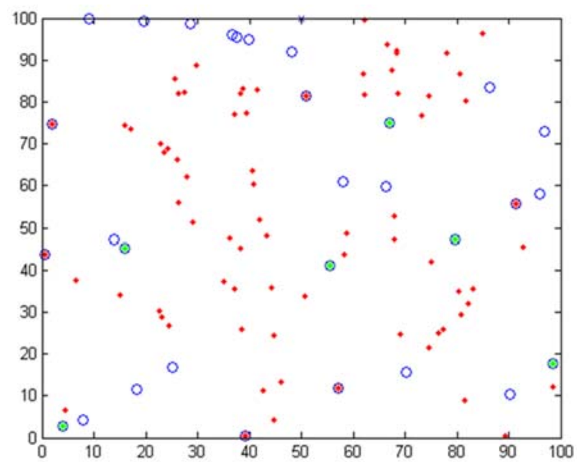

Figure 6: Blue nodes represent the member nodes, the red nodes represent the cluster head, the green nodes represent the transfer nodes and the red dots represent the dead nodes.

In Figure 7 we compare our EDE protocol with the SEP protocol with α=0 .2 and m=1.

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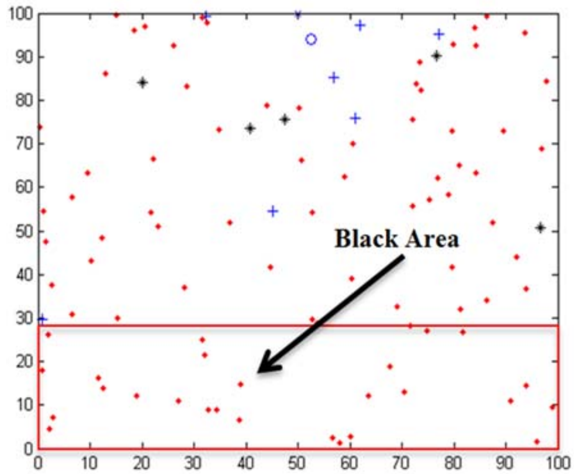

Figure 7: Blue nodes represent the member nodes, the black nodes represent the cluster heads, the red dots represent the dead nodes, and nodes in the form of the "plus sign" represent the advanced nodes.

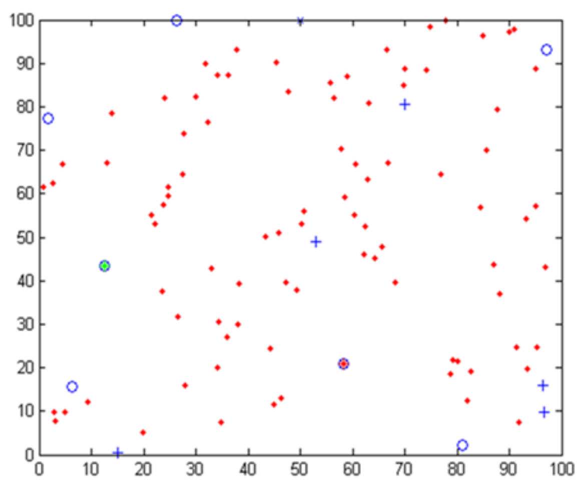

Figure 8: Blue nodes represent the member nodes, the red nodes represent the cluster head, the green nodes represent the transfer nodes, the red dots represent the dead nodes, and nodes in the form of the "plus sign" represent the advanced nodes.

Note also that, for SEP, the distribution of energy is not fair on the network (Figure 7), contrary to our proposition (Figure 8) which we have no energy holes. In addition, for the SEP protocol, the normal nodes died first, while for the proposed protocol, as shown in Figure 9, there remain the two categories of nodes, normal and advanced. This implies that we do not have an overload on some nodes.

From the simulations above, it is concluded that the EDE protocol has guaranteed a fair distribution of energy better than the Leach and SEP protocol.

2) Second simulation (Energy Consumption)

In this simulation, we compare energy conservation efficiency between EDE and leach protocol, also EDE and SEP protocol. We consider that all nodes have an equal initial energy.

In Figure 9, we have focused on the case of network that consists of 100 nodes. We are comparing the number of round with the dead node.

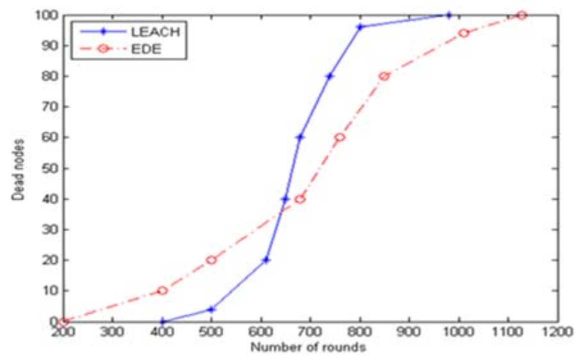

Figure 9: Number of rounds in relation with dead nodes

Although, EDE protocol starts to lose its own nodes, from round number 200, but the Leach protocol begins to lose its nodes from round number 402, as shown in Figure 9. In round 648 the Leach protocol loses energy faster than the EDE protocol. The total number of rounds of the EDE protocol is slightly higher than the number of rounds of the Leach protocol.

Next, we are comparing the energy conservation between the SEP protocol and the EDE protocol with 100 nodes. We consider that we have 100 nodes distributed in normal and advanced with α=0.2 and m=1.

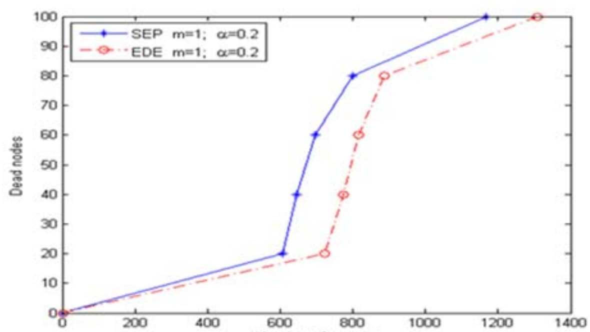

Figure 10: Number of rounds in relation with dead nodes

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The Figure 10 also shows that the rounds number of the EDE protocol that equal 1311 is slightly higher than the number of rounds of the SEP protocol that equals 1189.

According to the Figure 10 and Figure 11, we can conclude that the EDE protocol retains performance in maximizing network lifetime of the network as compared to the Leach and SEP protocol.

7. EEDE PROTOCOL

In this section, we propose an improvement of the EDE protocol in order to minimize energy consumption, as well as the establishment of a sustainable network.

7.1 Definition of EEDE Protocol

The election of cluster-heads in EDE protocol, like LEACH protocol, is done with a random rotation within the entire network. However, at each rotation, the energy is more consumed because, with each election of CH, a frequency and message-broadcasting phase CSMA and TDMA is needed to make the new CH known and to organize the cluster. In addition, the member nodes transmit the collected data to the CH, and sometimes, they transmit the same data in several rounds, which overloads the bandwidth and cause an over consumption of energy by useless and redundant data.

The idea to avoid these problems, we must first consider that the sensors play this role in two successive rounds r and r + 1, which means that the clusters remain the same in two successive rounds. On the other hand, we consider that the member nodes compare their collected data at round r + 1 with those of the previous round r. Therefore, if they are different, they transmit them to the CH, if they are not, they do not transmit them. This operation repeated with each new role rotation of CH (Figure 11).

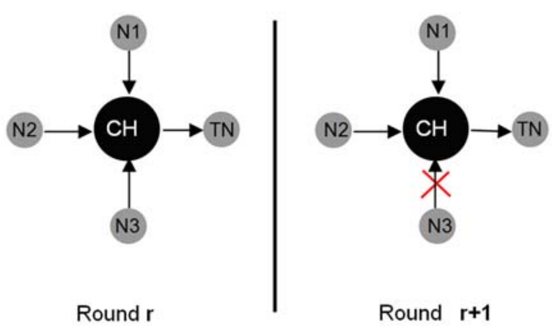

Figure 11: Two successive rounds in the EEDE protocol

7.2 Impact energy

We can expose cluster energy E_{C-EDE} for EDE routing protocol with n member node as follows:

$$E_{C-EDE} = E_{S(n)} + E_{P(CH)} + E_{R(CH)-n} + E_{R(TN)-CH} + E_{T(n)-CH} + E_{T(TN)-S} \quad (13)$$

Moreover, cluster energy E_{C-EEDE} for EEDE routing protocol with n′ member node as follows:

$$E_{C-EEDE} = E_{S(n')} + E_{P(CH)} + E_{R(CH)-n'} + E_{R(TN)-CH} + E_{T(n')-CH} + E_{T(TN)-S} \quad (14)$$

Where $E_{S(n)}$ and $E_{S(n')}$ are the sensing energy, $E_{P(CH)}$ is the processing energy for cluster-head, $E_{R(CH)-n}$ and $E_{R(CH)-n'}$ are the reception energy consumed by CH by receiving data from the member nodes, $E_{R(TN)-CH}$ is the reception energy by CH from the TN node, $E_{T(n)-CH}$ and $E_{T(n')-CH}$ are the transmission energy from member node to CH, $E_{T(TN)-S}$ is the transmission energy consumed by the TN node by transmit data to the sink. We suppose that n = n′ and we have,

$$E_{S(n)} = E_{S(n')} \quad (15)$$

$$E_{T(n)-CH} = \sum_{m}^{n} E_{T(m)-CH} \quad (16)$$

$$E_{R(CH)-n} = \sum_{m}^{n} E_{R(CH)-m} \quad (17)$$

$$E_{T(n')-CH} = \sum_{m'}^{n'} E_{T(m')-CH} \quad (18)$$

$$E_{R(CH)-n'} = \sum_{m'}^{n'} E_{R(CH)-m'} \quad (19)$$

With m and m′ are respectively the node member numbers of the EDE and EEDE protocol that transmit collected data to the cluster head.

According to the definition of the EEDE protocol, we have $m \geq m'$.

From where:

$$E_{T(n)-CH} = \sum_{m}^{n} E_{T(m)-CH} \geq \sum_{m'}^{n'} E_{T(m')-CH} = E_{T(n')-CH} \quad (20)$$

And,

$$E_{R(CH)-n} = \sum_{m}^{n} E_{R(CH)-m} \geq \sum_{m'}^{n'} E_{R(CH)-m'} = E_{R(CH)-n'} \quad (21)$$

Then,

$$E_{C-EDE} \geq E_{C-EEDE} \quad (22)$$

Equation (22) shows that the energy dissipated by the EDE protocol is greater than the energy dissipated by the EEDE protocol.

On the other hand, EEDE minimizes the energy consumed by the TDMA and CSMA protocols, since the election of the cluster-head and the creation of the cluster is done one time out of two compared to the EDE protocol.

7.3 Simulation and results

In the MATLAB simulator, we considered a network of 100 sensor nodes distributed randomly over 100 m * 100 m. We use Matlab environment to run simulation. We chose to compare with the EDE protocol.

Table 5: Parameters Table.

Parameter	value
Initial energy of nodes	0.2 joule
Transmitter and receiver energy	50nj/bit
Aggregation energy	5nj/bit
Data packet length	4000 bit
amplifier energy E_{fs}	10pj/bit/m2
amplifier energy E_{amp}	0.0003pj/bit/m4

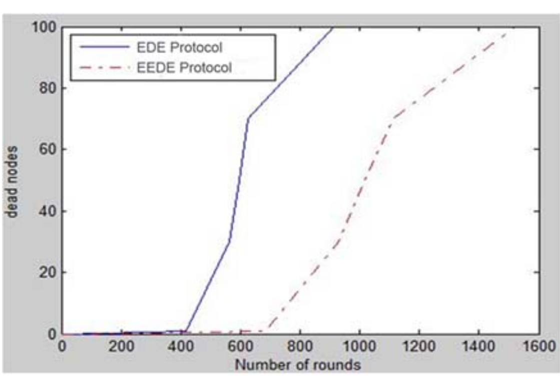

Figure 12: Number of rounds in relation with dead nodes

At the beginning of the simulation, we note on the graph provided in Figure 12 that, on the one hand, the two protocols are more or less equal in terms of the number of dead nodes. But from round 419, it is clear that the network treated by the EDE protocol begins to lose many nodes. Whereas the network managed by the EEDE protocol does not begin to really lose the nodes until round 678.

On the other hand the number of rounds of the proposed protocol, 1508 rounds is higher than the EDE protocol, which does not exceed 900 rounds, which lets us say that the energy conservation improvement of the EEDE protocol is better than that of the LEACH protocol.

8. CONCLUSION

Unlike traditional networks, which are concerned with ensuring good quality of service, sensor networks must, in addition, give importance to energy conservation. They must incorporate mechanisms that allow users to extend the lifetime of the entire network, as each node is powered by a limited and generally irreplaceable power source. Scientific research in the energy field is focused, generally on maximizing the life of wireless sensors. However, it must be remembered that the good distribution of energy throughout the network has an impact on the lifetime of the entire network, sometimes knowing that the loss of a part of the network makes the whole network defective network and that causes the problem of energy holes or black area. The integration of the transfer node (Transfer-Node) and the producer-consumer model into a hierarchical protocol has given birth to a contribution that is the EDE (Equitable Distribution Energy) protocol. The latter has shown an efficiency that makes it possible to obtain a fair and equitable distribution of energy on the entire network, which solved the problem of energy holes. Indeed, the results of the simulation verify the effectiveness of ours analyzes and proposed solutions.

In order to complete the performances of the EDE protocol, we propose the EEDE (Energy and Equitable Distribution Energy) protocol that optimizes the energy consumption obtained by the EDE protocol. Thus, the simulations show the extension of lifetime of the network.

REFRENCES:

[1] L. P. Clarea, G. J. Pottieb and J. R. Agrea, “Self-Organizing Distributed Sensor Networks” Proc. SPIE 3713, Unattended Ground Sensor Technologies and Applications, July 30, 1999, pp. 229-237

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[2] C. FU, Z. JIANG, Wei WEI and Ang WEI, "An Energy Balanced Algorithm of LEACH Protocol in WSN", IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 1, No 1, January 2013, pp. 354-359

[3] J. Gnanambigai, Dr. N. Rengarajan, K. Anbukkarasi, "Leach and Its Descendant Protocols: A Survey". International Journal of Communication and Computer Technologies Volume 01 – No.3, Issue: 02, September 2012, pp. 15-21

[4] R. KACIMI, "Techniques de conservation d'énergie pour les réseaux de capteurs sans fil", Doctorat de l'universite de toulouse, Juillet, 2009

[5] O. N. Koyi, H. S. Yang, Y. Kwon, "Impact of Base Station Location on Wireless Sensor Networks," Advances in Intelligent Systems and Computing book series (AISC, volume 348), 2015, pp. 151-162

[6] G. Smaragdakis, I. Matta, A. Bestavros. "A Stable Election Protocol for Clustered Heterogeneous Wireless Sensor Networks", Proceedings of the second International Workshop on SANPA 2004, Massachusetts, U.S, 2004, pp. 1-11

[7] R. Kaur, D. Sharma and N. Kaur, "Comparative Analysis of Leach and Its Descendant Protocols in Wireless Sensor Network", International Journal of P2P Network Trends and Technology-Volume3, issue 1, 2013, pp: 22-27

[8] H. Dhawan, S. Waraich, "A Comparative Study on LEACH Routing Protocol and its Variants in Wireless Sensor Networks: A Survey", International Journal of Computer Applications (0975 – 8887) Volume 95– No.8, June 2014, pp. 21-27

[9] Md. A. Hossain, Md. I. Khalil, Nur-E-Alam Siddiqi and Md. M. Reza, "Energy Hole Minimization Using Redundant Route in Wireless Sensor Network," International Journal of Computer Science and Software Engineering (IJCSSE), Volume 6, Issue 9, September 2017, pp. 202-206.

[10] M. A. Khan, A. Sher, A. R. Hameed, N. Jan, J. S. Abassi, N. Javaid, "Network lifetime maximization via energy hole alleviation in wireless sensor networks," Advances on Broad-Band Wireless Computing, Communication and Applications, 2016, pp. 279-290

[11] M. Cardei, Y. yang, and J. Wu, "Non-uniform sensor deployment in mobile wireless sensor networks," in IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks, (WoWMoM'08), June 2008 pp: 1-9

[12] J. Li and P. Mohapatra, "Analytical Modeling and Mitigation Techniques for the Energy Hole Problem in Sensor Networks". Pervasive and Mobile Computing, 2007, pp. 233-254

[13] J. Jia, J. Chen, X. Wang, and L. Zhao, "Energy-Balanced Density Control to avoid Energy Hole for Wireless Sensor Networks," Int. J. Distrib. Sens. Netw, 2012, pp. 1-10

[14] Rohini Sharma, "Energy Holes Avoiding Techniques in Sensor Networks: A survey", International Journal of Engineering Trends and Technology (IJETT) – Volume 20 Number 4, Feb 2015, pp. 204-208

[15] S. Halder, A. Ghosal, S. Sur, A. Dan, and S. DasBit, "A lifetime Enhancing node deployement strategyin WSN", LNCS , SpringerVerlag, 2009, pp. 295-307

[16] W.B. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient Communication Protocols for Wireless Microsensor Networks", in Proc.33rd Hawaii International Conference on SystemSciences, vol. 2, January 2000, pp. 1-10

[17] B.Omodunbi, O.T. Arulogun, J.O. Emuoyibofarhe. "A Review of Energy Conservation in Wireless Sensor Networks", Network and Complex Systems Vol.3, No.5, 2013, pp. 17-23

[18] G. Anastasi, M. Conti, M. Di Francesco, and A. Passarella. "Energy conservation in wireless sensor networks: A survey", Ad Hoc Networks, 7(3), 2009, pp. 537-568

[19] L. CHAARI and L. KAMOUN. "Wireless sensors networks MAC protocols analysis". Journal of telecommunications, volume 2, issue 1, April 2010, pp. 42-48

[20] M. Calle, J. Kabara. "MAC Protocols Used by Wireless Sensor Networks and a General Method of Performance Evaluation", International Journal of Distributed Sensor Networks. January 2012, pp. 1-11

[21] J. H. Brand Neto, A. da Silva Rego, "MH-LEACH: A Distributed Algorithm for Multi-Hop Communication in Wireless Sensor Networks". ICN: The Thirteenth International Conference on Networks, 2014, pp. 55-61

[22] A. Rai, S. Deswal, Dr. P. Singh. "An Energy-Efficient E-LEACH Protocol for Wireless Sensor Networks". International Journal of Engineering Science and Computing, July 2016, pp. 1654 -1660

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[23] P. Bakaraniya, S. Mehta. "K-LEACH: An improved LEACH Protocol for Lifetime Improvement in WSN". International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 5, May 2013, pp. 1521-1526

[24] W. Akkaria, B. Bouhdida, A. Belghithb, "LEATCH: Low Energy Adaptive Tier Clustering Hierarchy," 6th International Conference on Ambient Systems, Networks and Technologies, Procedia Computer Science 52, 2015, pp. 365 – 372

[25] K. Pawar, Y. Kelkar, "A Survey of Hierarchical Routing Protocols in Wireless Sensor Network", International Journal of Engineering and Innovative Technology, Volume 1, Issue 5, May 2012, pp. 50-54

[26] X. X. Liu, "A Survey on Clustering Routing Protocols in Wireless Sensor Networks", Sensors 2012, August 2012, pp. 11113-11153

[27] NEETIKA, S. KAUR, "Review on Hierarchical Routing in Wireless Sensor Networks", in International Journal of Smart Sensors and Ad-Hoc Networks (IJSSAN), Vol. 2, Issue 3, 2012, pp. 85-90

[28] T. Preud Homme, J. Sopena, G. Thomas, B. Folliot. Batch Queue, "file producteur / consommateur optimisée pour les multi-cœurs. " 8ème Conférence Française sur les Systèmes d'Exploitation (CFSE'11), Saint-Malo, France, May 2011, pp.1-12