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Energetic Hybrid Routing Protocol

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Abstract: *The networks of sensors are characterized by limited capacity especially at the level of energy saw that the components constitute the network to know the sensors are powered by batteries, which influence on the life of the network.*
During our work of research we tried to increase this metric by the proposal of a new hybrid routing protocol E-HRP (Energetic Hybrid Routing Protocol) which is based on the principle of the EC zone which reduces the number of packets exchanged
Keywords: *Routing, E-HRP, Energy*

I. Introduction

This paper is devoted to the presentation of our new routing protocol of the wireless sensor networks. This protocol for first objective to improve the balance of the network, by decreasing the rate of energy consumption, especially that the nodes sensors are equipped with batteries and deployed in areas where it is virtually impossible to replace. According to the studies carried out on networks of sensors it was noticed that the radio module is the module which consumes more energy, which has pushed us has proposed a protocol which minimizes the number of transmissions; either at the initiation level during the construction of the graphs.

The size of the packets exchanged has a direct influence on the life of the WSN. To decrease the number of bit to transmit it has opted specific structuring packets of controls. Also it has provided in our protocol that the physical quantities that will be transmitted, are those who were undergoes a major change in their physical quantities with a difference exceeding a certain predefined threshold in advance.

Our new routing protocol intended for wireless sensor networks named E-HRP (Energetic hybrid routing protocol), which brings together the communication to chain inspired by ZRP (Zone Routing Protocol), with the communication approach to graph proposed by Leach (LowEnergy Adaptive Clustering hierarchy). Of this fact a protocol based on the concept of the zones must take into consideration the principles of operation of a routing protocol such as:

- Increased the rate of consumption of energy;
- Increased control traffic;
- Ensure the stability of the Topology: which increases the duration of validity of the routes and reduced the number of update messages at the time of the change of the topology;

II. Description of the Protocol E-HRP

The concept of areas implemented in our protocol and inspired by ZRP, ensures a stability to our network especially at the level of the consumption of energy. In effect the nodes belonging to the same zone communicate only with their close neighbors and not directly with the ch, which reduces the load on the latter. This concept saves energy and offers a wide band, also increases the life of the cluster head.

1. Description Of The Initiation Phase

E-HRP is a protocol that runs in three steps. The first step is to build the zones, the second allows you to gather the information necessary for the choice of the cluster head and the construction of the channels and for the last step is to maintain the areas in the case where there is a topology change caused the mobility Figure 5-1.

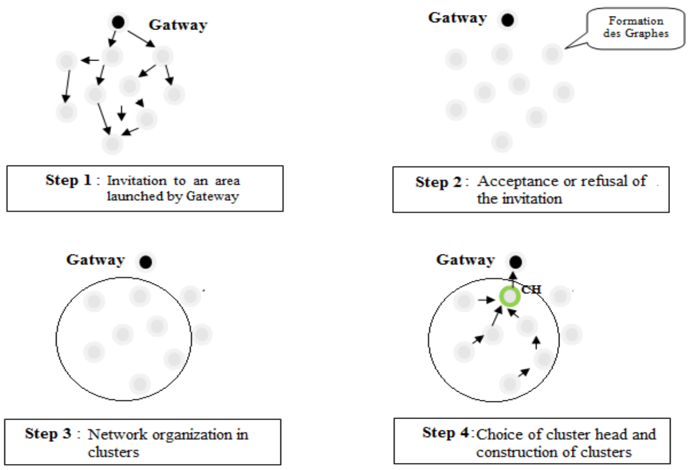

Figure 5.1: Steps for execution of E-HRP

1.1. Phase Setup - Step 1: Construction Of Area

In our approach to cutting of network in areas, no information of instrumentation is not present (example: position of nodes). A hypothesis that is possible by equipping the nodes sensors by systems of geo localization, but not practical in the case where the surveillance zones is a large surface which calls for a significant number of sensor. Of this fact we recital a random deployment of the nodes, where each sensor to a Global ID IdNode, with a number of known area in advance.

The process of segmentation in zone is triggered by specific nodes called Gateways. Of the nodes that it of energy resources important in relation to other nodes, as well as a focused superior to the others.

The Gatways send messages of Invitation (INV_Zone) to the other nodes by diffusion in the principle of close in close with the field 'SuMsg' to 1 to indicate that it is an invitation to the area of membership, and the field 'TypeSrc' equal to g to specify that it is a Gateway. Each node receiving these messages can either accept or refuse the invitation, constructing the zones.

1.1.1. Structure Of The Control Message (INV_Zone)

During the segmentation of the network in Virtual areas, specific messages will be exchanged between the different nodes. Pour cela a particular package has been designed (*INV_zone*). The fields in this package are illustrated in Table 5-3.

IdSrc	The ID of the source
Areaid	Identifier of the area
TypeSrc	Type of the source
SuMsg	Message subject
TTL	The length of life of the package

Table 5-3: Message Structure inv_Zone

The field 'SuMsg' defines the message subject of control. There may be two different values:

- The value 1: if it is a message of invitation this field contains the value 1, and it is sent in a first time by the gateway rebroadcast by the nodes then who have agreed to join this area.
- The value 0: If the node refuses to join the zone, this field is set to 0. This type of packet is sent by nodes which are already assigned to other areas.

The field ' *TypeSrc'* allows you to define the type of source, either of gateway or a simple node. In this field you can have two values:

- G: if it is a node of Gateway
- S: S it is a simple node.

Figure 5-4 represents an organizational chart to schematize how the areas are created at the level of E-HRP.

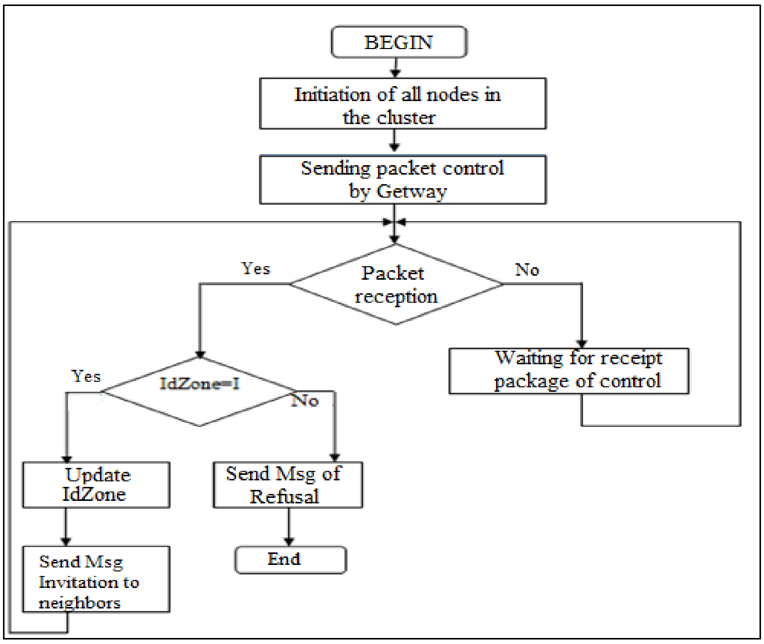

Figure 5-4: Chart of construction of Zones

1.2. The Phase Setup - Step 2: Selection Of Head Of Cluster

This method of construction of area not allows centralized to define, the areas from the Gatways, also the choice of a distributed system, limit the number of messages exchanged and decreases the rate of energy consumption. After the construction of the zones, the Gatways spend at the stage of election of CHS. A step that is very simple Where ch is the node that has a reserve important energy compared to the other, and also the most visible. And for more improvement we can introduce the criterion of mobility, that is to say the node that has a low mobility.

With these settings, we can deduce the weight of each node according to the following equation, which facilitates the choice of cluster head.

$$\textbf{Weight(u)} = \alpha * \textit{2-density}\ \textbf{(u)} + \beta * \textbf{Res-Energie(u)} + \Omega * \textit{Mobility}\ \textbf{(u)}$$

To choose a cluster head with a minimum weight, a second type of control messages will be introduced for the purpose of sharing useful information to the selection of this type of node.

(SEL_ch) is the control message sent by the Gatways in the aim of selecting the Clusters-Heads with fields: 'IdSrc' allowing to mention the source of the message, 'areaid' to know the area of belonging, also a field 'TypeSrc' where it is indicated the type of node, and weight which represents essential indicator of choice.

1.2.1. The Message Structure Of Control (SEL_Ch)

During the phase of the choice of cluster Head of typical messages will be exchanged between the Gatways and neighboring nodes. To make packets of selections have been designed. The structure of its packets is shown in Table 5-6..

IdDes	The ID of the destination
IdNode	Node identifier
Areaid	Identifier of the area
TypeSrc	Type of the source
Hop	Number of jump
Weight	The weight of node

Table 5-6: message structure (*SEL_c* h)

1.3. The Phase Setup - Step 3: Establishment Of The Chain

For the training of the graphs in the interior of the areas we adopt the idea of close neighbors. To make it has proposed an algorithm which allows the construction of graphs it based on the distance that separates two nodes which facilitates the choice of predecessors. This step is launched from the CHS in the objectives to establish the most court path, to all the nodes in the same area.

The function more short path allows you to find the shortest path between the nodes from the cluster head. The principle is simple it is sufficient to calculate the weight of each arc which composed the graph using the time and the speed of transmission, and then choose the node to link to the CRA to weights min as predecessor. The communication between the nodes during this is done via control packets called (short_W).

1.3.1. The Message Structure Of Control (Short_W)

Messages of specific control (*Short_W*) will be exchanged during this period, in the aim to collect information as IdNode IdSrc,, T_Send, and Ty_msg allowing the construction of the Court path from the different nodes to the CH. Table 5-8 shows the structure of the package of control (*Short_W*)

IdDes	The ID of the destination
IdNode	Node identifier
T_Send	The time of dispatch
Ty_Msg	Type of message
Hop	Number of jump

Table 5-8: message structure (*Short_W*)

The field *ty_MSG* can take two values it-type of message depends on the:

- Req: if it is a query
- Res: In the case of a response

2. Collection Of Data

The operation collection of data is done by nodes sensors. During our simulations we assuming that the collection is triggered after a request made by the Gateways, who will send a request to the network of wireless sensors.

At the level of each node two types of collection are distinguished, the first relates to the physical quantity taken by the sensor itself, and the second is the value transmitted by the nodes son.

Each node that receives the request of collection shall transfer to his sons, before saves in its own value captured buffer by its unit of capture.

If the new value collected is greater than the sum of the old value and the predefined threshold an update is necessary.

3. Failure Or Mobility Of A Node

In the case where a node sensor fails; the reaction of the system appears to be a need for the update of the routing information. The periodic exchange of messages '*hello*' allows you to detect the faulty sensors. This made an update of the table intra area will be accomplished and propagated in the area.

With the concept of mobility can have new nodes in some areas, which influence on the topology of the network. In this case the sending of a new package ***N_node*** is required to report its presence. The node receiving this kind of packet must respond by a packet of invitation indicating the area of belonging. If the node joins the area, an update of the routing table is required followed by a broadcast on the network.

III. Simulation and Implementation

The purpose of this part is to assess the performance of our new approach E-HRP to the point of view of energy. For this we conducted a series of simulation.

In this part we begin by the description of the different metrics that we are going to take into consideration, namely the energy consumption, the duration of end-to-end and the rate of lost packets, then the simulation environment NS2 The point of view of the topology of the network as well as the different parameters of simulations and we finish by the analysis of the results obtained, which will show the value added of our protocol by report to the hybrid routing protocol ZRP.

1. Performance Measured

For measuring the effectiveness of our protocol E-HRP, we are going to compare with the routing protocol similar ZRP. This comparison will focus on the following points:

1.1. Packets Lost

The METRIC lost packet represents the number of data lost physically in the network, is this due to the important traffic, or the waiting time high. When the connections are lost due to the movement of the receiving nodes, the nodes routers will lose their data or even packets of controls. To avoid this kind of problem it must be generates several paths to the destination [1].

1.2. End-To-End Delay

End-to-end delay [2] represents the interval of time between the generation of a packet by the source and its reception. This metric is represented in second, mathematically and it is demonstrated by:

$$\textbf{End to End delay} = \frac{\sum_{1}^{n} CBRsentTime - CBRrecvTime}{\sum_{1}^{n} CBRrec}$$

1.3. Energy consumption

This allows metric to calculate the consumption of energy at the level of a given node during the simulation. Several operation consume the energy that this is the transmission, reception, or the treatment of data. To do this on the fact reference to the model proposed by Heinzelman radio [3].

2. Mobility Model In NS:

In the Networks of Sensors the mobility is considered important characteristic has not neglected. He may be considered at the level of the nodes to capture or at the level of the wells, or still at the level of the base stations. NS2 provides a simulation environment with several models of mobility which allow us to measuring this important factor. And this fact, we can assess the behavior of multiple routing protocols for the WSN. Among the models of the motilities offered by NS2, we found:

2.1. Model Of Random Waypoint (RWP):

In this type of mobility [4], the displacement of the nodes is typically random, in effect the destination and the speed of movement is random. The Nail and the speed are chosen from an interval well determined. After a move the node stops for a finite time, before this moved in the same way as the first time, and this until the end of the simulation.

2.2. Random Direction Model (Rd)

Model of random Direction (RD) [5] is similar to the first model of mobility (RWP), each node that wants to move randomly chosen its destination and its speed of travel, from an interval well precise, the difference which is located is that the mobile node must reach the terminals of the surface of the simulation to be immobilized. Once the sensor reached the terminals of the surface, it may undertake to new son random movement.

2.3. Modified Random Direction Model (Mrdm)

It is a modified version of the model random Direction Model (ROW), where each node on the move may not reach the terminals of the surface of simulation.

We note that the model that reflects the reality of the mobility is the RWM, because it offers a random mobility to the nodes belonging to the ad hoc network. Unlike the two models RDMS and MRDM which affects the movement of nodes. Of this fact we have opted for the first model (RWM) for our simulation.

IV. Topology and Simulation Parameter

2.4. Network Topology

Has End to validate the performance of our protocol, it was realized a set of simulation, the nodes are distributed in a square environment of 100m x 100m. In the network there is a base station, and a set of nodes which varies between 5 to 50 and also with a number of nodes varying sources which do not exceed the 40 nodes (nodes that generate packets and also provide the routing function). Figure 5-11 shows the structure of a network consisting of a number of nodes equal to 100, with a base station and three Gatways.

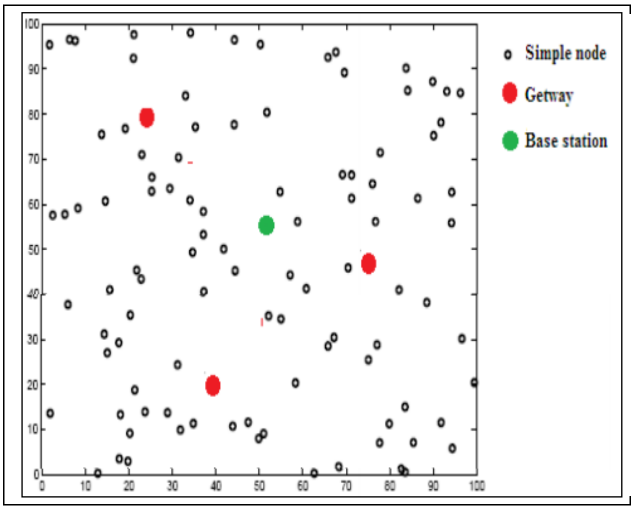

Figure 5-11: Scenario of Simulation with 100 Node Sensors

2.5. Simulation Parameter

During the simulation the nodes are distributed in a random manner, our simulation model is curriculum vitae in the table below.

Parameter	*Value*
The surface of the network	100 x 100 m^2
The location of the BS	(50, 60)
The number of	100 nodes
The number of Gateway	3
The initial energy of the Nodes	2 J
Data packet size of	500 bytes
Eelecte	50nJ/Bit

Table 5-12: Simulation Parameters

The base station will be positioned in the center (X=50 and Y=60), the bandwidth of transmission is initialized to 1Mbit/s, with a latency of transmission and reception equal to 25 ms, and a packet size of data that does not exceed the 500 bytes.

2.5.1. The Energy Model

For each operation of the transmission or receipt of the package, the node consumes energy without forgetting of cases where it runs of processing operations. To calculate the consumption of energy during each action (transmission, reception, or treatment), reference is made to the radio model proposed by Heinzelman [3].The energy necessary to transmit q-bit of data on a distance of is::

$Ee = Eelec\ Eamp * PK + * \ pk *^{2}$.

For the energy consumed during the reception is given by the equation:

$Er = Eelec * PK$:

With:

- *Eelec:* the energy consumed by the transmitter-receiver (100 pj/bit).
- *Pk* : the size of the message
- D: The distance between nodes in meter
- *Eamp:* the energy consumed by the amplifier of the transmitter (50 nj/bit).
- All the sensors have the same scope of communication R, equal to 25 meter
- The duration of the simulation is 200 seconds

2.6. Scenario Simulation Of

To assess the performance of our routing protocol E-HRP, we have opted to ZRP as the Protocol for comparison, since it is based on the concept of zones, such as E-HRP, and also it is considered as the basis of all protocols hybrid that combine the routing proactive and reactive.

And as we mentioned earlier, the model of mobility chooses is the RWM (random Waypoint Model) a model where the locations of the mobile nodes is chosen in a random manner, as well as the displacement of their On the surface, and the speed of travel.

Four scenarios of simulation are used has end of check the three metrics, energy, the rates of lost packets and the end-to-end delay.

2.6.1. First Scenario Of Simulation

During the first scenario of simulation we have used 20 sources nodes on 100, for a surface of simulation of 100 x 100 m ^{2}. The CBR traffic is chosen as the traffic load and the RWM as a model of mobility.

2.6.2. Second Scenario Of Simulation

In this tenth scenario on a increased the number of sources nodes to 40 node on 100, in a surface of 100 x 100 m ^{2}, with a CBR traffic and a Mobility RWM.

2.6.3. Third Scenario Of Simulation

In this scenario of a simulation the set of nodes is fixed, with a number of sources nodes equal to 20, and traffic of CBR load

2.6.4. Fourth Scenario Simulation Of

During this last scenario of Simulation 100 nodes of our network are immobile, with a number of sources nodes equal to 40, and a load traffic type CBR.

V. Evaluation of Performance

In this part we will analyze the results obtained during the simulations, following the metrics cited previously.

In this section we present the simulation results of the two routing protocols ZRP and HRP following the two metrics of simulation to know the energy and the rate of success and this in function of the number of nodes mobile as well as the number of nodes fixed.

HRP has shown a grade performance by report to ZRP especially when the number of nodes is reduced. As soon as the number of nodes increases the performance of the two protocols will decrease.

4.1. Energy Consumption

Figures 5-13, 5-14, 5-15 and 5-16 represent the variation of energy at the level of the node 0 with a number of sources variable nodes in the case of a mobile network and fixed network.

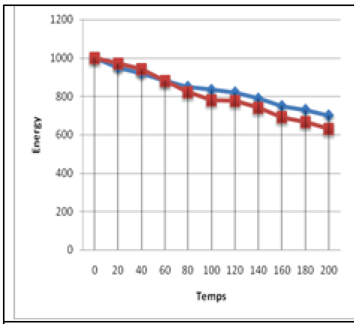

Figure 5-13: Variation of energy for 20 sources on 100 without mobility

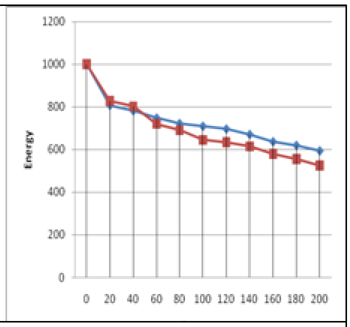

Figure 5-14: variation of energy for 20 Sources On 100 node With Mobility

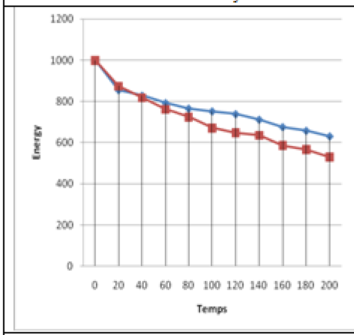

Figure 5-15: The variation of energy for 40 sources On 100 whiteout mobility

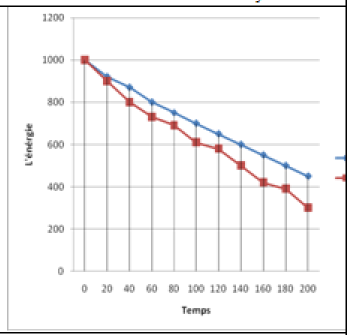

Figure 5-16: The variation of energy for 40 sources on 100 San mobility

From the results obtained we note that the new protocol E-HRP has consumed less energy compared to ZRP, also one note that mobility is the number of nodes sources influence on this metric

4.2Packets Lost

For this metric we have two curves. The first illustrates the variation of lost packets depending of the Nodes sources in the case where the nodes are fixed (Figure 5-17) and the second shows the number of packets lost also in function of the number of nodes sources but this time with mobility (Figure 5-18).

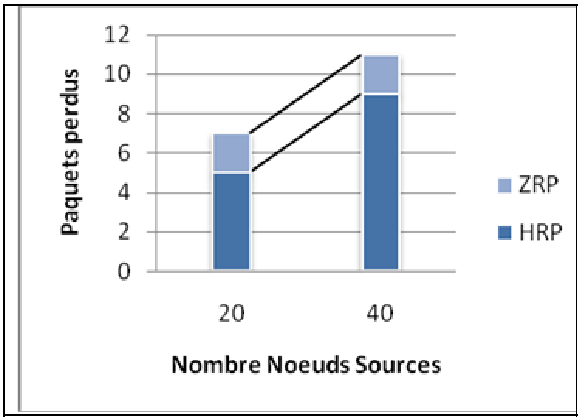

Figure 5-17: Ratio Packet loss without mobility

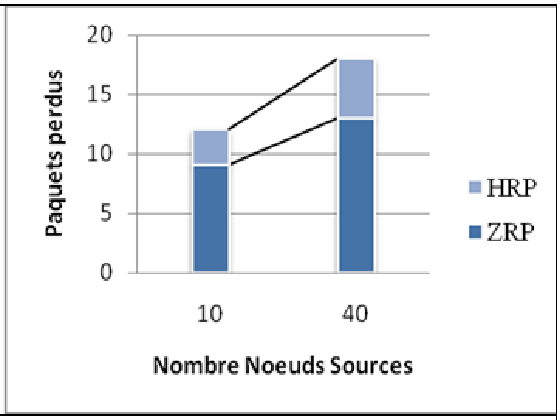

Figure 5-18: Ratio Packet loss with mobility

Following the two curves we note the difference between the two Protocols. On the first curve ZRP this is number 1 in the lost packets, but with a difference negligible compared to E-HRP is that in the case where the mobility is zero.

At the level of the second illustration we note that the rate of lost packets increases in the case where the nodes are mobile, especially with the increase of the Nodes sources. ZRP loses more packets per report to E-HRP.

4.3End-To-End Delay

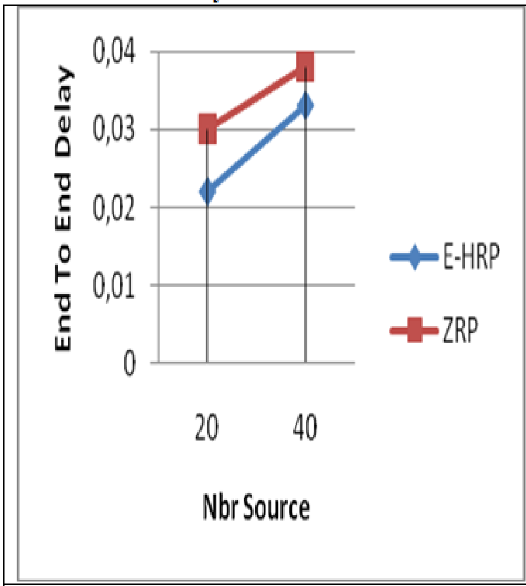

Figure 5-19: End-To-End Delay With Mobility

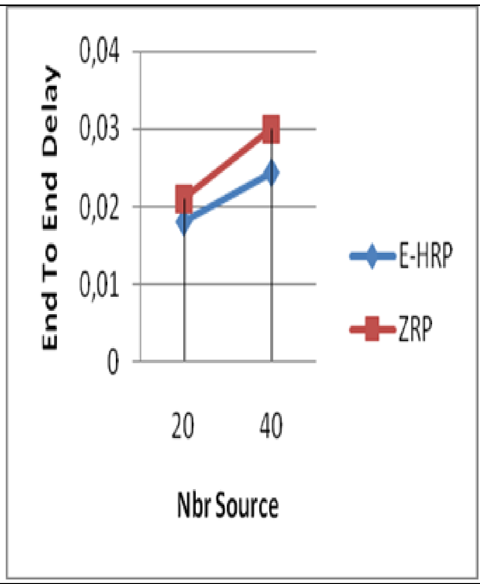

Figure 5-20: End-To-End Delay Without Mobility

Figures 5-19 and 5-20 illustrate the variation of period of end-to-end of two protocols hybrids to know E-HRP and ZRP in the case fixed and with mobility, in function of the number of nodes sources.

According to the results obtained we note that the Protocol E-HRP request less than temp that ZRP to route the information to the destination, which is logical since it calculates in advance the shortest path to the cluster head which supports the transmission of data to the base station.

VI. Conclusion

In this chapter we describe our algorithm energy minimization, deadlines and rate of packets lost. An algorithm that is based on the selection of the clusterhead by the Gateway it taking it consideration the mobility, the energy and the distance.

After a simulation of E-HRP on NS2 in different scenario (with or without the mobilities also a number of variable sources), there has been a significant reduction in relation to the Hybrid protocol ZRP at the level of the deadlines for the end-to-end and this due to the calculates the shortest path to the cluster-head in advance, also a minimization of the consumption of energy in the case fixed and mobile This is logical since the algorithm reduces the number control packets and not sending that the useful data to the destination.

For the third parameter which is the rate of packets lost, we note a significant reduction in the level of our protocol in the different scenarios, a reduction due to the sending and the useful packets to the destination

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