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Improvements of PEGASIS Routing Protocol in WSN

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ABSTRACT : *The Wireless Sensor Networks (WSNs) is one of the succeeded technology that being strongly considered in scientific and engineering fields. WSN is an ad-hoc network that consists of small nodes with sensing, computing and communicating wireless abilities. These Sensor nodes are usually have limited lifetime duration due to the sensors that powered by limited exhaustible batteries. The main aim of WSN is to sense all the information from the environment (The environment can be an Information Technological framework, a physical world, or a biological system) based on the kind of application for which is deployed and send this information to it is Base Station (BS). Sensor nodes have to ensure their task with their rigorousenergy budget, this constraint makes theenergy resource the most of critical importance in the WSNs. Sensor Nodes communicate with each other by different Routing Protocols, and Routing Protocols can be classified into different categories in WSNs. This paper will focus on the Hierarchical (cluster based) routing protocols. Also, we will go deeply in PEGASIS protocol backgrounds and improvements,complete description for each stage of improvements, models, and offering a complete vision for these protocols through making a comparison between them by knowing there positive and negative effects on WSN.*

Keywords -*Wireless Sensor Network, Cluster-based routing protocols, LEACH, PEGASIS, EEPB, PEGASIS-ANT, H-PEGASIS, PDCH, IEEPB, MIEEPB, ACO.*

I. INTRODUCTION

Due to the advances in the WSN technology field, it become necessary to explore new ways or new techniques such as improving routing protocols by using many intelligent systems and optimization algorithms to keep abreast of developmentsthat affects in WSN technologies positively. These routing protocols applied on small and cheap sensor nodes to achieve an efficient communication between these sensors nodes in the whole network. The architecture of sensor nodes is showing in the Fig. 1.These sensor nodes are very sensitive in terms of energy that will leads to limited energy supply and in turn will cause a short network lifetime, to recover this issue we have to use efficient routing protocols that will ensure efficient and reliable communication between these nodes. In this paper, author present a simple comparative study about specific protocol, PEGASIS protocol and it is improvements that proposed at recent years [1-2-3-4-5]. The rest of the paper organized as follow. Section 2, describe simply routing protocol and it is classification with focusing on the second type of routing protocol, hierarchal (cluster based) routing protocols. Section 3, describe PEGASIS routing protocol with it is genesis and improvements and show their models. Section 4, comparison and summarize these cluster-based routing protocols, and section 5concludes the paper

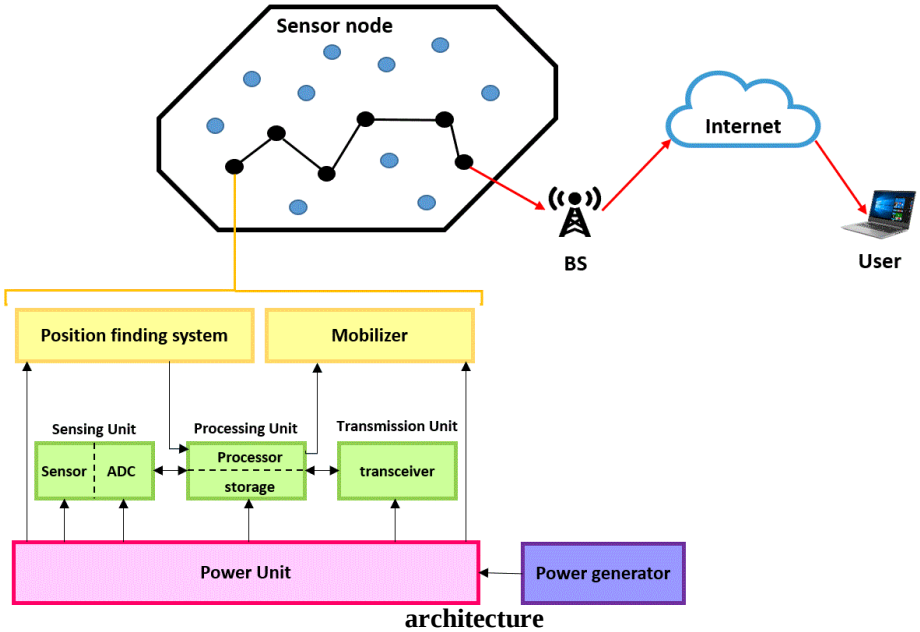

Fig. 1 Sensor node architecture

II. ROUTING PROTOCOLS IN WSN

Routing is a mechanism that initiate a route between a source node and destination node. The main goal of routing protocols is to discover the best route (shortest path) in terms of energy consumption, delay, quality of service and other metrics to make sure to extend the network lifetime by keeping the sensors node alive as can as possible [2]. Therefore WSN routing protocols can be sorted and classified based on different metrics, based on network structure the routing protocols classified into three main categories:

- Flat routing protocols.
- Hierarchal (cluster based) routing protocols.
- Location based protocols.

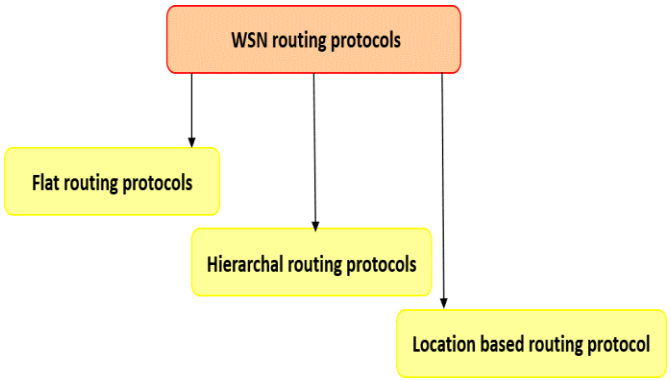

Fig. 2 WSN routing protocols

In this paper we will focus on the routing protocols that classified based on the network structure especially those called hierarchal routing protocols. In flat routing protocol, all the nodes is working together based on the same role in the same manner and because of the limited resources this type is not preferred or not used a lot at large scale networks. In hierarchal routing protocols all the nodes working together but in different scenario by distributed these nodes into groups called cluster heads and each grope execute its own tasks , this will provide many useful and supported features to the network such as scalability, energy efficiency , and increased network lifetime. Finally, the locationbased routing protocol is that path creation between each node will depend on each node position [2-4-6-7].

2.1. Hierarchal routing protocols

Hierarchal routing protocols also called cluster based routing protocols. It is concept is stand for dividing the network into many regions of interconnected nodes these regions called cluster, each cluster contains a node called cluster head which has specific feature that it owned highest energy among all the nodes

in the same region. These clusters also divided in to a layered structure, it is usually contains two layers. The processing idea of sending data or information between nodes in this hierarchal or layering structure based on sending information from the lowest energy nodes to the highest energy nodes. This mean that the nodes those have lowest energy is responsible for sensing and sending information to cluster head while the nodes those have highest energy is using for processing information and send to another cluster head or to base station by using a gateway nodes.This type of routing have many benefits and damages on any ad-hoc network, it is basically minimizes on demand route discovery traffic and routing overhead, reduce route determination delay and increase packet delivery ratio. On other hand, it is negative effect on the network rises when the clusters increases in size because it will increase packets overhead due to it is routing source. Also, increasing packet size because of the operation that happened when every node of the route must be stored in the routed packet so the more route increase the more packet size will increase. That leads us to a bigger problem is the increasing of transmission time because of the two previous negative point. [2-3-6-7-8]

III. STAGES OF BUILDING PEGASIS PROTOCOL AND IMPROVEMENTS

In this section, you will find a complete idea about the hierarchal routing protocols. Especially, that are belongs to the chain cluster based routing protocols. However, each protocol has its own special mechanism of communication and data transmission between their interconnected nodes but the most of these protocols are depending on the first order radio model to make the process of transferring data completed perfectly. Therefore, to transmit number of bits message with a certain distance using this radio model, the radio expends[6]:

$$E_{tx}(k,d) = E_{tx} - elec(k) + E_{tx} - amp(k,d) \quad (1)$$

$$E_{rx}(k) = E_{rx} - elec(k) \quad (2)$$

$$E_{DA}(k) = E_{DA} - elec(k) \quad (3)$$

Where:

- E_{elec} :The energy that consumed by the radio to run the transmitter or receiver circuitry, (equal to50 nJ/bit).
- E_{amp} :The required energy for transmitter amplifier, (equal to 100 $pJ/bit/m^2$).
- k : Number of bits.
- d : Distance.
- E_{DA} : The energy that consumed by Transmitter circuitry to aggregate the data received by the child nodes, (equal to 50 nJ/bit).

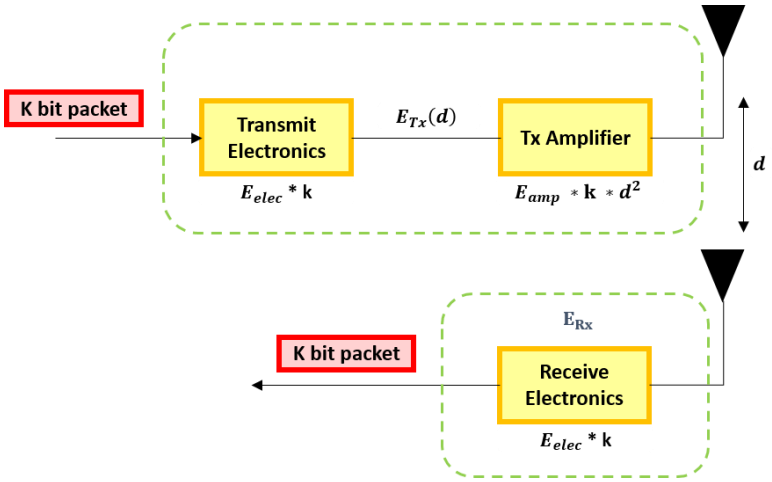

Fig.3 first order radio model (free space)

Or can be expressed such as:

$$E_{tx}(k,d) = k \times E_{elec} + k \times E_{amp} \times d^2 when \ (d < d_0) \quad (4)$$

Or

$$E_{tx}(k,d) = k \times E_{elec} + k \times E_{mp} \times d^4 when \ (d \geq d_0) \quad (5)$$

$$E_{rx}(k) = k \times E_{elec} \quad (6)$$

Where:

- d^2 : Represent power loss in free space with d 2 and with d 4 power loss.
- d^4 : Represent power loss in multipath fading

- d_0 : Represent threshold

Also, as mention previously:

- E_{elec} *:* The energy that consumed by the radio to run the transmitter or receiver circuitry, (equal to$50\ nJ/bit$).
- E_{amp} **:** The required energy for *transmitter amplifier in free space, (equal to 100* $\mathrm{pJ/bit/m^2}$ *).*
- E_{DA} *: The energy that consumed by Transmitter circuitry toaggregate the data received by the child nodes, (equal to* $50\ nJ/bit$*).*
- E_{mp} *:* The required energy for transmitter amplifier in multipath model

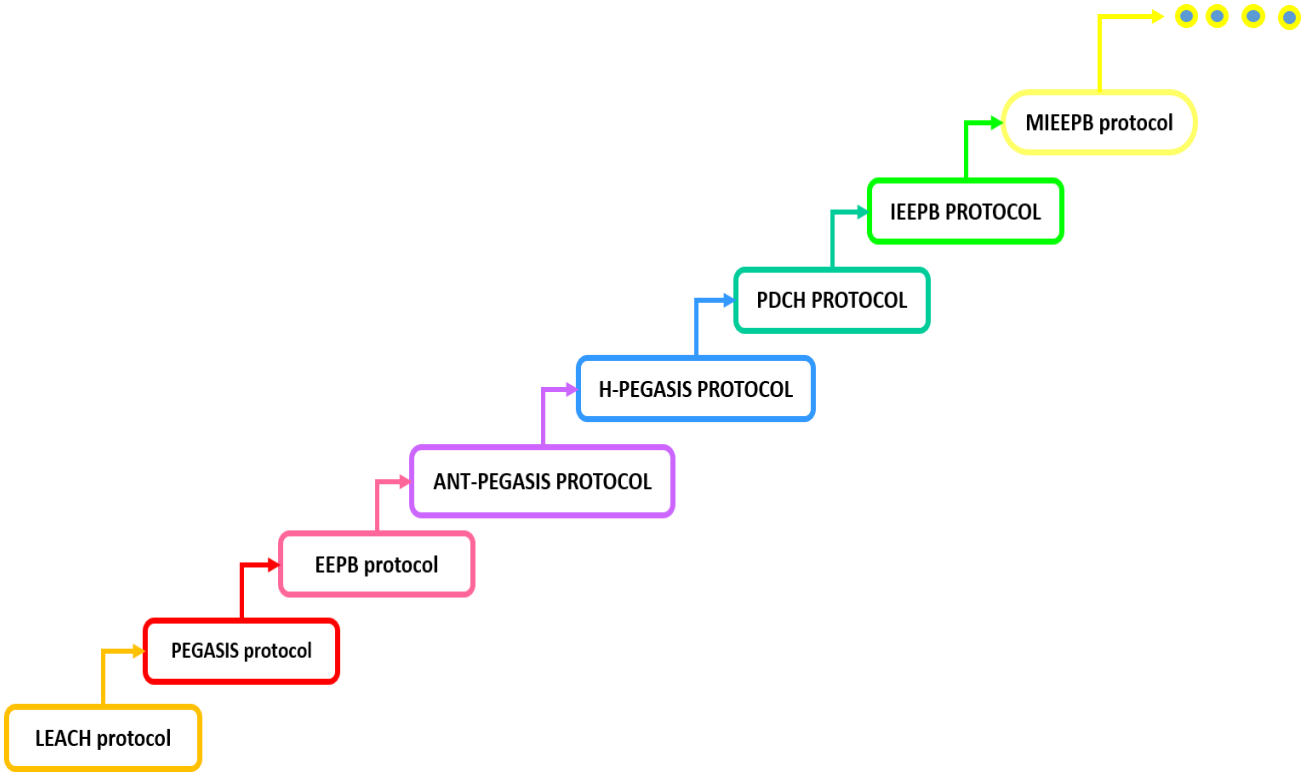

Fig.4 PEGASIS improvement stages

3.1 LEACH protocol (Low-Energy Adaptive Clustering Hierarchy)

It is one of the most popular routing protocol. This protocol is block cluster based routing protocol, leach protocol architecture based on a distributed clustering algorithm, all sensors nodes communicating together using the first order radio model continues in negotiation between each other throughout the work period about who will take the place to be the chosen cluster head. The cluster head selection process will be divided into rounds, in each round the process will be done with 1/p probability for each sensor node to become the next cluster. The decision of selecting a node to be the next cluster head is depend on the node number chooses between 0 and 1. If the number is less than a threshold T (n), the node becomes a cluster-head for the current round otherwise it will be consider as a regular node. The threshold represented below:

$$T(n) = \begin{cases} \frac{P}{1-P*\left(r \bmod \frac{1}{P}\right)} & if \quad n \in G \\ 0 & otherwise \end{cases} \quad (7)$$

Where:

- P: The desired percentage of cluster heads.
- r : the current round
- G *:* is the set of nodes that have not been cluster-heads in the last rounds.

as a result, each node will be a cluster head for a once this in turn will save energy consuming and increase the network lifetime because of the changeable cluster head node process that will consumed the node energy [9-10-11]. Leach protocol is a self-organized protocol that choose the cluster head randomly or based on some metrics such as the energy. The cluster head will be responsible for collecting information from the nodes, aggregate this information and forward it to the base station [2-5-12-13].

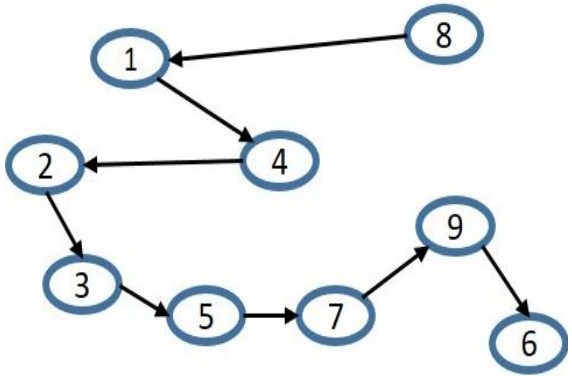

Fig. 5 LEACH protocol

3.2 PEGASIS protocol (Power-Efficient Gathering in Sensor Information Systems)
A proposed protocol by [14] that present an improvement over leach protocol. This protocol is a chain cluster based routing protocol that present a different mechanism of actions than the Leach protocol. The nodes that under the law of PEGASIS protocol is also communicating with each other depending on the first order radio model, equations (1)(2)(3) that been mentioned previously in this paper.There is some steps that should be follow when using PEGASIS protocol and can be classify into two phase:

- **Chain formation**

The process of building a chain based on greedy algorithm between sensor nodes to guaranty the communication between each sensor node with it is nearest neighbor, then send the data that been collected and gathered in the end of the chain to the leader node or to the node that is the closet to the base station. The construct of the chain always begins from the furthest node [8-10-11-15].

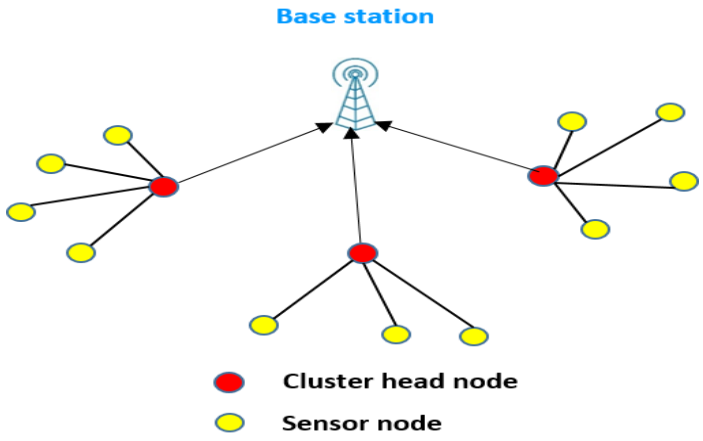

Fig.6 PEGASIS protocol chain

- **Data collecting and gathering**

In second phase, each node will take the data of it is neighbor and emerge it with it is data then forward the gathered data to next node as a cumulative process. The leader will be responsible for sending this data to the base station. In addition, in each round there is different leader node in different location is chosen randomly and used [8-10-11-14].

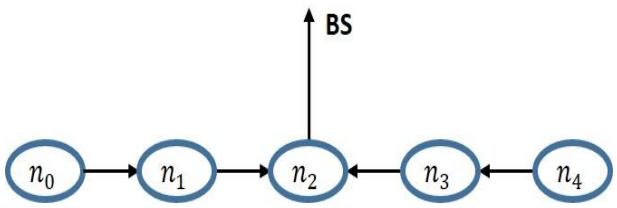

Fig.7Control token passing approach in PEGASIS

In a certain round, the leader will build control token passing approach to get the gathered data from the further node to the nearest one and forward it to the base station. In the fig.7 the leader node is n2 so the first token will be pass from n0 through n1 and reach the leader node n2 then the second token will be pass from n4 through n3 and also reach the leader node n2. All the data from the two direction will be gather in n2 then forward to the base station. [8-10-11-14-16]

3.3 EEPB (Energy Efficient PEGASIS based algorithm)

It is an improved protocol over PEGASIS protocol. The aim of EEPB is to overcome the shortcomings in the PEGASIS protocol by solving the problem of long links of chains because of the long distance between nodes that is occur on account of greedy algorithm which been used in PEGASIS protocoland in turn will cause high energy consumption and fast node death [17].EEPB protocol handle this problem by initiate a distance threshold that will applied on the average distance of formatted chain to decrease the problem of long link initialization as shown in next equations :

$$D_{average} = \sum_{p=1}^{h} \left(\frac{D_p}{h}\right) \qquad (8)$$

Where:

- $D_{average}$: is the average distance in the formed chain.
- h: is the hop number of the formed chain.
- D_p : is the distance of every segment in the formed chain, where (p=1, 2, 3 …h).
- If the distance between an end node in a formed chain and a new requested node to join with that formed chain of nodes is longer than $D_{threshold}$ then the possibility of creating LL problem will be high.

$$D_{threshold} = \alpha * D_{average} \qquad (9)$$

Where:

- $D_{threshold}$: is the threshold distance.
- α: is a user defined constant.

In addition, the leader node selected by EEPB according to two factors: the residual energy of node with the distance between nodes and base station. Once the chain is created, the data transmission Stage begin by collecting and gathering the data from each node in accumulative way until it reach the leader node that will be responsible for sending these data to the base station. As a result the power will be saved and balanced between nodes [16-17-18].

3.4 PEGASIS-Ant

PEGASIS improvement in this protocol is present by using ant colony optimization algorithm (ACO) instead of greedy algorithm in order to form the chain. This in turn will lead to a global optimization. ACO is an intelligent algorithm that based on the real ant behaviour. Ants depend on the chemicals were spread byants that precede them which pass through a specific route, these chemicals called pheromones [19]. Ants will choose to follow trails that have pheromone in it is higher levels than trails with lower pheromones levels. Therefore, as more ants use a certain path, the pheromones trail raised stronger and will have higher probability to be chosen by ants. Leader node selection will depend on the distance between node and BS. Therefore, the nearest node from the base station is the leader node [20-21-22]. The ACO algorithm construct the chain of nodes to get the best path based on ant communicationwhich Accredited on selection the lesser number of nodes, this help tomaintain more energy and balance energy consumption between nodes [16-23-24-25-26-27].

The general idea of ant colony algorithm is shown in the figure.8 in four steps:

- **First step: exploring**
  To discover the surrounding area by sending different individual ants from the nest into different direction to search for a food.
- **Second step: Pheromone trail:**
  When the individual ant go into a certain direction, a pheromone trail will be created in the yellow colour as it shown fig.8.
- **Third step: additional node:**
  A new node is add into the trail because of the exploratory nature of ants.
- **Fourth step: shortest path:** after several times of trying to search and discover new path , the shortest path is found and ants swarm is head for the same direction that have the highest pheromones level and this will ensure to the other ants that this path is the shortest path to reach to food .

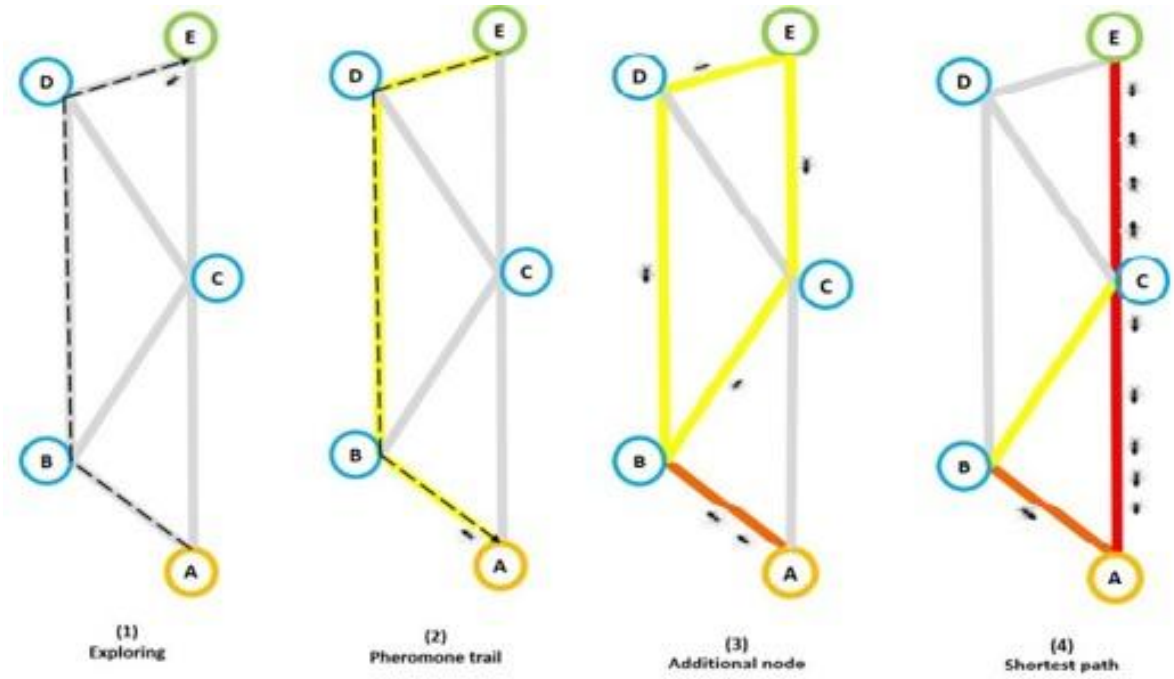

Fig. 8 Ant colony optimization algorithm

The next equations is represent mathematically the previous process [19-20]:

$$P^{k}_{(i,j)}(t) = \frac{\left([\tau_{ij}(t)]^{\alpha} \cdot [\eta_{ij}]^{\beta}\right)}{\left(\sum_{k \in J_k} [\tau_{ij}(t)]^{\alpha} \cdot [\eta_{ij}]^{\beta}\right)} \qquad (10)$$

Where:

- $P_{(i,j)}$: The traveling from node i to node j probability.
- J_k : The nodes that the antPass through it in advance and travel to from node i.
- η_{ij} : The visibility between node i and node j.
- $\tau_{ij}(t)$: The quantity of un-evaporated pheromone between node i and node j at time t.
- α and β : control the effect of τij(t) and ηi j .
- Where if α >β then the searching behavior of ant is more depending on pheromone.
  And if β > α then the searching behavior of ant is depending on its visibility or knowledge.

However, each ant has a list of nodes location than been visited by ant previously to ban the ants from going to another time. The following equation is used to express the depositing pheromone process [19-20]:

$$\Delta\tau^{k}_{ij}(t) = \begin{cases} \frac{Q}{L_k}(t) \\ 0 \end{cases} \qquad (11)$$

Where:

- Q: is a constant.
- L:. The length of the generated path.
- t: is the iteration number.
- K: represents the ants number.
- $\Delta\tau^{k}_{ij}(t)$: Represents the pheromone rate between node i and node j that the ant visited in iteration t.
- The pheromone deposition value is zero for a path that is not selected previously.

Thefollowing equation is using to utilize the pheromone evaporation rate:

$$\tau_{ij}(t+1) = (1-p)\,.\,\tau_{(i,j)(t)} + \sum_{(k=1)}^{m} [\Delta\,\tau^{k}_{(i,j)}(t)] \qquad (12)$$

Where:

- m: represents the number of ants in the system.
- p : represents the pheromone evaporation rate or decay factor.

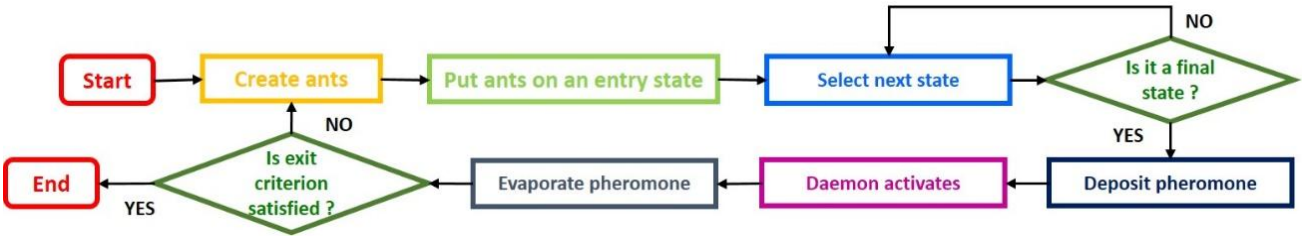

Fig.9AntColony Algorithm Flowchart

3.5 H- PEGASIS (hierarchal PEGASIS)

It is a beneficial extension, which add to the PEGASIS protocol. This extension based on parallel processing between nodes. In other word, this technique allow to transfer data simultaneously from different nodes to other different ones in a parallel way by send the data from the lower layer to the upper layer up to the base station as hierarchal structure. In addition, a signal coding technique will be use such as CDMA to avert any collisions of data that will result an interference. This solve the problem of delay by depending on multiple chains in the same time instead of single chain and using a signal coding technique. Therefore, the problem of energy consumption also will be solve smoothly [16]. This extension will be obvious in MIEEPB protocol that will be describe later in this paper.

3.6 PDCH (PEGASIS Double Cluster Head)

The technique of increasing the cluster head by doubled it will affect the whole network positively by decreasing the traffic and in turn avoiding high delays. Normally PEGASIS protocol uses one CH that communicates with the BS. Nowadays, using double cluster head is being preferred more than using single cluster head. The technique of add more cluster head is based on the mechanism of communicating between cluster heads of each layer in a hierarchal form [16-18-28-29]. After chains formation stage is completed, the stage of cluster head selection is begin by choosing the nodes as a primary cluster head or secondary cluster head or either a regular node based on it is weights, the weights Q of nodes can be found or calculated by dividing it is residual energy with it is distance from the BS. The network decide to choose the node that have the highest weight as a primary cluster head. After choosing the primary CH, each node in the chain computes it is distance with the parent nodethat was assumed as p1, and compare it with the distance to sink node p2. If the distanceof p2 > p1then the node will be consider as a secondary CH otherwise it will be consider as a regular node participating in the chain.

$$Q_i = \frac{E_i}{D_i} \quad (13)$$

Where:

- $E_i$indicate the residual energy of sensor node ***i***
- D_iIndicate the distance between sensor node ***i***and sink.

This will provide many availssuch as decreasing the delay in transmission and receiving process between nodes by giving the responsibility of collecting data from the nodes in a certain layer by their cluster head so a cluster head will present in a form of main cluster head and secondary cluster head as shown in fig.10 As a result, this provide balancing the load of each node and increase network lifetime [18-21-28-29-30-31].

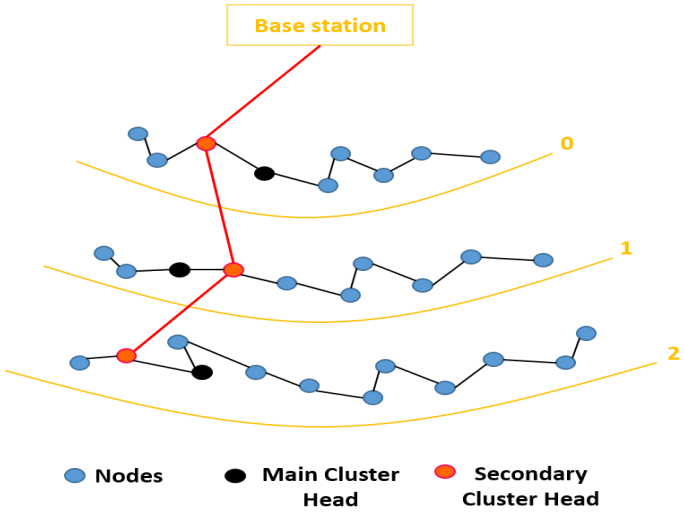

Fig.10 Double cluster head chain

3.7 IEEPB (Improved Energy Efficient PEGASIS based algorithm)

EEPB overcomes several problems over PEGASIS but still has some deficiencies such as the long link (LL) phenomena and weakness in the mechanism of selecting the leader node, which will be mentioned with more details in the next few pages. IEEPB is an improved protocol over EEPB protocol. This protocol deal with the issues that faced us with EEPB through reducing the construction of long link (LL) in chain by using threshold [17-18].]. In IEEPB, threshold process is to calculate and compares the distance between nodes double time, finds the shortest path to link the two adjacent nodes. Also, by selecting the appropriate leader node based on the weighting algorithm. Weighting algorithm works by taking into account each node energy with the distance between each node and base station then distribute the weight coefficients on the leader node as shown in the following equations:

$$D_{bs} = d_{To\ BS} / \mathbb{d}_{ave} \qquad (14)$$

Where:

- $d_{To\ BS}$: Distance between sensor node and BS.
- $\mathbb{d}_{ave}$: Average distance between sensor nodes and BS.

$$E_p = E_{init} / E_i \qquad (15)$$

Where:

- E_p : Portion energy.
- E_{init} **:** Initial energy of node ***i***.
- E_i **:** residual energy of node ***i***for round ***n***

$$W_i = w_1 E_p + w_2 D_{bs} \qquad (16)$$

$$w_1 + w_2 = 1 \qquad (17)$$

Where:

- W_i : combined weight of each node.
- w_1, w_2 : Coefficient of weight factors.
- If $w_1 > w_2$ then means that the most effecting factor to select the leader node is the residual energy.
- If $w_1 < w_2$ then means that the most effecting factor to select the leader node is the distance between the node and BS.

Finally, the node that have the smallest weight will be chosen to be the leader node [16-17-18].

3.8 MIEEPB (Mobile sink improved energy-efficient PEGASIS-based routing protocol)

After EEPB problems been solved by the next emerged version IEEPB, IEEPB removes various deficiencies in EEPB; however, it still has some shortcomings such as major load on the single chain leader, large delay in data delivery, sparse nodes in the network that facing instability periods. MIEEPB is an improvement over IEEPB that present the sink mobility in a multi-chain model, therefore construct and applying smaller chains decreasing load on the leader nodes [32]. MIEEPB mechanism is the same of previous protocol IEEPB by using the first order radio model to ensure an efficient communication between sensor nodes. Also by using token passing

approach to transmit the data between nodes. In the [32] used MIEEPB and insert both extensions of multi-chain and double cluster head as shown in fig11. DCH also selected by using the weighting algorithm to specify the primary and secondary cluster head. Finally, in MIEEPB a mobile sink is been used by specify the sojourn time and sojourn location. Mobile sink node divide WSN area into more than one region as in the [32 divided into 4 regions and consider that in each round the sink node will complete one course around the 4 sojourn locations as follows

$$T_s = \sum_{i=1}^{4}(\tau_i) \quad (18)$$

Subject to :

$$x_{ij} = \begin{cases} & Dif i = j \\ 0 & otherwise \end{cases} \quad (19)$$

Where:

T_s : Total sojourn time of one course.

x_{ij} : The number of bits transmitted between chain leaders and the sink.

i, j : sink potential locations were i=1, j=4.

D : Total data transferred between chain leaders and the sink in sojourn time.

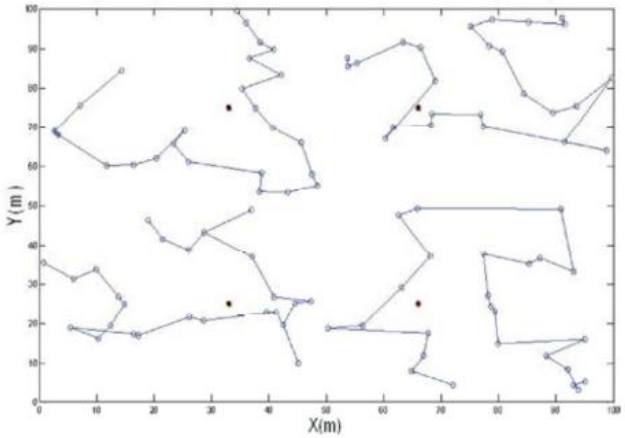

Fig.11 MIEEPB multi-chains and multi cluster head in WSN

In other words, MIEEPB is a multi-chain model with continuesfixed path mobility of sink node and limited potential locations, this achieve proficient energy utilization of wireless sensors and to ensure maximizing of network lifetime [27-32]

IV. COMPARISON

Table-1 summarizes the comparison between LEACH, PEGASIS, and the popular improvements protocols of PEGASIS protocol on the basis of it is advantages and disadvantages on the WSN.

Table-1 Advantages and disadvantages of hierarchal routing protocols

Algorithms	Advantages	Disadvantages
LEACH [2-5-9-10-11-12-13]	• Leach uses TDMA, this prevent CHs from any collisions. • Balancing energy dissipation of each node by giving each node an equal probability t become a cluster head. • Outmatches conventional routing protocols. • Completely distributes so no need for control.	• Useless on a large regions network deployments. • Extra overhead on CH nodes due to the dynamic clustering process. • Wasting lots of energy because of the fixed initial amount of energy capacity for all nodes in each round.

PEGASIS [8-10-11-14-15-16-33]	• Better than leach in energy distribution throughout the network. • Saving energy duo to the shorter distance between nodes. So, the process of transmitting and gathering data will have consumed less energy than it consumed with leach protocol. • Saving energy better than leach due to the amount of messages that received by leader node. in Pegasis, leader node only receives two messages while in leach received 20 messages assuming 20 nodes per cluster in a network with 100 nodes. • Minimize the number of messages, last node in a chain is sending the Final message as only one message to the BS, whilst in leach is more than one message from different nodes at the same time is received by BS.	• High delays caused by long communication distance between each node.as a result, this will consume more energy. • Low scalability. • Useless for time varying topology.
EEPB [16-17-18]	• Keep the network far from the phenomena of long link that raised previously in PEGASIS protocol by using a distance threshold.	• Uncertainty of the distance threshold that will have caused once again the problem of long links. • Unappropriated leader selection, dose not taking into account the residual energy of nodes and the distance between them when selecting the leader node.
PEGASIS-ANT [16-20-21-22-23-24-25-26-27]	• Ant colony is smoothly acclimatized to the PEGASIS chains construction either as static, dynamic or mobile environments. • form an optimal routing path from node to other node that ultimately: ❖ To alleviate the problemof long link in PEGASIS protocol. ❖ Improves energy efficiency. ❖ Improves energy consumption. ❖ Decrease delay.	• Encourage doldrums periods and hotspot problem among sensor nodes that will cause rapid drain with the energy rate of a certain sensor nodes. This will also lead to dead node that can minimize the network lifetime • Adequate memory is needed to store all information between hops.
H-PEGASIS [16]	• Minimize the delay of transmission packets to the BS • Avoid collisions. • Avoid signal interference.	• Only spatially separated nodes are allowed transmit data at the same time as a parallel processing.
PDCH [16-18-21-28-29-30-31]	• outperforms PEGASIS and EEPB by: ❖ extinguish the overhead of dynamic cluster formation ❖ reducing distance of non-cluster heads that must transmit ❖ Restricting the number of transmissions and receives among all nodes, and using only one transmission to the BS per round. • Distributing the energy load among the nodes that will lead to increase the lifetime and quality of the network.	• Time delay and unbalanced load distribution is occurring when the location of the double cluster head is: ❖ First cluster head location is far away from the second cluster head and in different directions. ❖ When the double cluster head location is far away from the base station.
IEEPB [16-17-18]	• Avoids problem of consistence long links. • Efficient leader node selection by considers two factors residual energy and	• High loads on the single chains due to the distance between sink node and the chain. • Large delays.

	the distance between nodes to execute the process of giving a weight coefficient for each node.	• Long distance between nodes effect negatively on the rest nodes.
MIEEPB [27-32]	• Appropriate for delay intolerant applications. • Multi-chain concept decreases the network overhead. • Using multi-chain concept reduce the distance between nodes • Sink mobility use the technique of secondary chains head. As a result, this will mitigate the loads on the nodes that is nearest from the sink node • Multi- chain concept decreases the delay of delivering data. • Multi- chain concept decrease the load on the leader node in a single chain as in IEEPB	• Sink mobility not appropriate for randomly nodes with motion in the network to communicate with, this will increase delay, congestion, and overhead.

V. CONCLUSIONAND FUTUER WORK

In this paper, we describe the importance of WSN technology to use in several fieldsthat serve the human needs with this Accelerated World. Routing protocols of WSN Plays a pivotal role in improvements of networksin general, as reviewed in this paper before. A hierarchal routing protocols get all the attention in this work especially those who are specified in chain cluster based routing protocols. It is described based on the protocols that represent the history of PEGASIS protocol and the improvements that raised after, describe there mechanism and models. Then, these protocol is summarized in a detailed comparison table that represent advantages and disadvantages. Therefore this table will lead us to conclude the effect of the improvements that been established on the PEGASIS protocol to become more efficient and this in turn will minimize the energy consumption by overcome the LLs problem and enhance the performance of the protocol to maximize the network lifetime.

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