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# WSN Optimization Using BEE Colony Optimization

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**ABSTRACT**

*WSN is a network which consists of receiver nodes and converse during radio impression, so that monitor and sense takes position in this physical world. The WSN consists of number of difficulties as WSN development is based on some constraints i.e. energy, power, size, bandwidth and memory. In this paper, an optimization approach is applied for energy optimization in WSN using Bee Colony Optimization. Our problem is to identify the optimize cluster heads which are responsible for the energy optimization and to opt another routing suitable path consists of optimize cluster heads so that the data transmission becomes smoother and energy gets conserved. The whole imitation is taken position in MATLAB environment.*

**Key words:** LEACH, WSN, Bee Colony Optimization (BCO), Bandwidth

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## INTRODUCTION

The main components of WSN consist of sensor nodes, routers and gateways. The clients are also important part of WSN network e.g. laptops, phones etc. There are mainly two standards of the WSN network i.e. IEEE 802.1, 802.15 [1-2] and [4]. A sensor node is very reliable but when one node can no longer operate, the rest of the nodes can still communicate with each other, straight or through one or more middle nodes. In a wireless sensor network, there are several protocols which are used to enhance the performance of the network. Out of those protocols, LEACH Protocol is considered to be suitable for low energy density but sometimes when the efficiency decreases due to the change in node mode from active to sleep the data packets are required to wait at the initial point where the packet has been send and this increases the waiting time of the packets and also the energy spending increase. Our problem is to identify the dead nodes and to opt another routing suitable path so that the data transmission becomes smoother and energy gets conserved. In WSN, the basic components used are as [5-6].

- Sensor Nodes: The devices are surfaced on the process and it can even route the packet on the part of other plans [12-13]. The process and the equipments can be controlled by a variety of character [16] [19] [21-22]. A router never interferes and it doesn't have process control or manage tools
- Entrance Points: The access points or the gateways are responsible for transmission among application of hosts and field tools.
- Network decision-making: it is accountable for network arrangement, devices scheduling communication, routing tables' management and Network's health monitoring and reporting [11].
- Security executive: The Security executive is accountable for the creation, storage and organization of keys.

The IEEE standard pertaining to wireless complex is 802.11. Wireless systems could perhaps be categorized into two categories:

### Infra Type Structure Network

Within commercial infrastructure primarily based network, communication takes place just between the Wi-Fi nodes and also the entry points. The particular communication won't right occur between the Wi-Fi nodes [24] and [27]. The particular communication won't right occur between the Wi-Fi nodes. The following, access point must be used to manage the particular medium entry moreover given it functions while bridge between the Wi-Fi in addition to wired site [28-29]. At the there this kind of network, fixed base locations are utilized. The minute the nodule would probably go above the limit of 1 base location which comes into the particular range of the some other foundation station. The example of infrastructure based network is cell receiver networks. It can be central method that is certainly govern through the controller just like router. The most negative aspect in this method can be that if controller isn't able, whole method may crash.

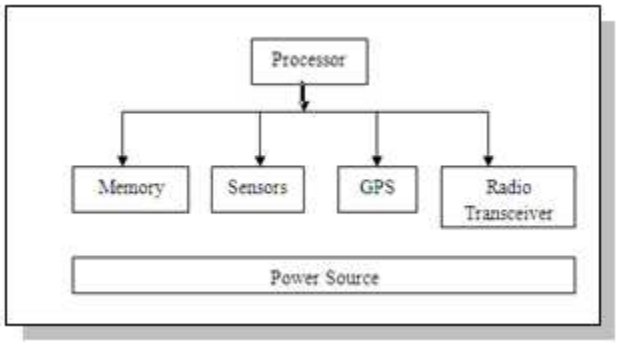


**Fig. 1 Block Diagram of WSN [32]**

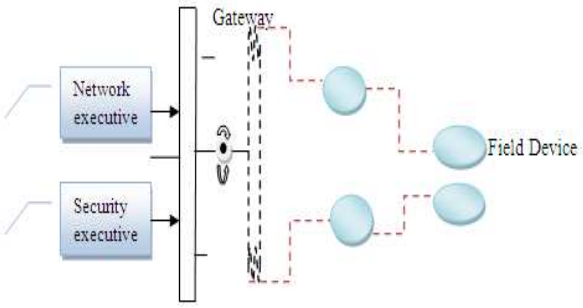


**Fig.2 WSN Architecture [33]**

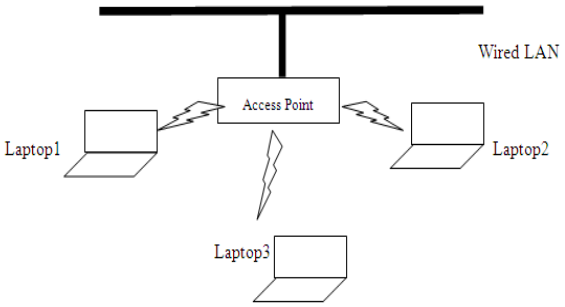


**Fig.3 Infrastructure Network [36]**

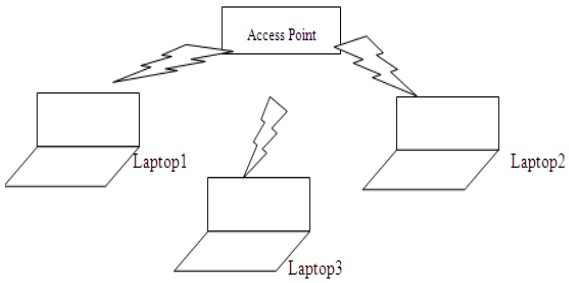


**Fig 4 Infrastructure-less Network [37]**

**Infrastructure-Less Networks**

The particular infrastructure less network won't need any kind of commercial communications to think. In this community, every join will converse right using distinct nodes. Therefore, in this community, not any entry purpose should be applied pertaining to dominating average entry. In this society, all the nodes had got to behave as routers in addition to each one nodes are efficient at movements and could get in touch dynamically in an energetic fashion.

A Wireless Sensor System (WSN) includes a gang of nodes connected with typically low functionality. They vocation with others cooperatively to execute realizing tasks during granted environments [30-31]. An invisible detector population might comprise one particular or many drain nodes (Base Stations) to collect understood know-how in addition to exchange that to a central procedure in addition to storage freedom technique. Any detector node is typically power-driven by means of battery pack and could end up being split into 3 primary functioned products: the realizing unit, the communication unit and also a processor unit. The latest advances in micro-electro-mechanical systems technology, Wi-Fi devices in addition to digital physics possess increased the big event connected with detector nodes. This produces the particular blossoming prospect connected with WSNs into practical feasibleness.

## LEACH PROTOCOL IN CONTRAST TO WSN

Low-Energy Adaptive Clustering Hierarchy (LEACH) is a typical clustering routing in WSN [3]. In our research, we have deployed LEACH, which is a clustering based protocol that lessens the energy indulgence in sensor networks. The key points that are to be keeping in mind while initializing LEACH are [12] [14-15]:

- Cluster set up control and operation and coordination localization.
- To reduce the global communication, consider local compression.
- 'Base stations' or 'group heads' and correspondent clusters arbitrary rotation.

LEACH protocol appropriation with respect to WSNs is as under:

- Every senor nodes are stagnant, equal and charged by the similar quantity of original power. The nodes take energy at the similar rate and are capable of knowing their remaining energy and manage broadcast control and distance.
- All nodes can straight commune among each node as well as the sink node.
- The Sink node is permanent and is distant from the wireless network. Consequently, the energy obsessive by the sink node can be ignored.
- In every time frame, every node has a data to transfer that can be fused.

The leach operation can be divided into two rounds. The beginning of the each round is through Set up phase [17-18]. The association of the clusters that is followed by stable stage. What time data is being transport from the nodes towards the cluster head and under the Base Station is the Start up phase [20].

The clustered heads are selected by the sensor nodes by threshold T (n). The rate of threshold depends on the predictable percentage so that it came as cluster head in 1/p rounds as G.

$$T(n) = \begin{pmatrix} \frac{p}{i - p(rmode\frac{1}{p}} & n \in G \\ 0 & otherwise \end{pmatrix}$$

The value of the cluster node should be among 0 and 1.if the charge is not between the threshold values or is less than the value then the value would become the cluster head for the existing round. With the cluster's strength basis, the clusters can be joined by the non clusters head nodes. In the below fig.5, CM are the cluster members and the CH are the cluster heads [23-24].

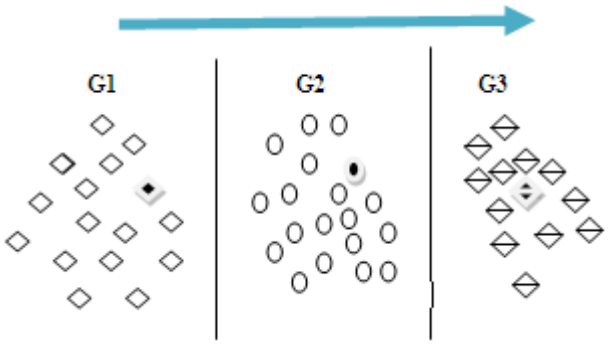


**Fig.5 Cluster heads selection**

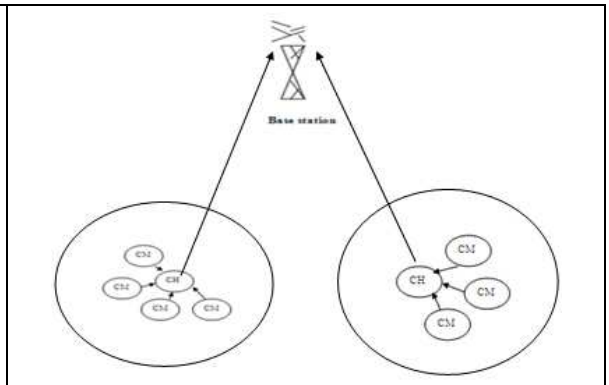


**Fig. 6 LEACH Protocol [34]**

The division of operation is into frames in steady state phase as shown in fig.6. The statistics is being sent by the nodes and they propel their data toward the cluster head on mainly one time for every frame throughout their owed transmission period. The period of every slot inside which a node send data is stable, as a result the instance toward sending a frame of data depends lying on the numeral of nodes in the cluster.

The energy indulgence of cluster head and member node in every frame is described as follows:

$E_{ch,steady-stage}$= the energy pleasure while a single outline of a cluster is:

$$E_{ch,steady-stage} = \left(\frac{N}{K} - 1\right).l.E_{elec} + \frac{N}{K}.l.E_{DA} + l.E_{elec} + l.Emp.d^4 to\ SINK$$

$E_{non-ch,steady-stage}$: The energy indulgence of a member node through an s frame is

$$E_{non-ch,steady-stage} = l.E_{elec} + l.\in fs.d^2 toch = l.E_{elec} + l.\in fs.\frac{1}{2\pi}.\frac{M^2}{K}$$

If there are n frames in the stable phase, then the power extravagance for this round is:

$$E_{Cluster,steady-stage} = n.E_{\ ch}, stedy - stage + \left(\frac{N}{K} - 1\right).n.E_{non-ch,steady-stage}$$

$$= n.[\left(\frac{N}{K} - 1\right).l.E_{elec} + \frac{N}{K}.l.E_{DA} + l.Emp.d^4\ to\ SINK + \left(\frac{N}{K} - 1\right).n.(l.E_{elec} + l.Efs.\frac{!}{2\pi}.\frac{M^2}{k}$$

For every extravagance of energy, the cluster in every round is given below:

$$e = E_{ch,set-up} + \frac{N}{k} - 1.E_{non-ch,set-up}$$

$$= \left(2\frac{N}{K} -\right).p.E_{elec} + \frac{N}{K}.p.\varepsilon_{fs}\left(2\frac{N}{K} -\right).p.E_{elec} + \frac{N}{K}.p.\varepsilon_{fs}.\frac{1}{2\pi}.\frac{M^2}{k} + \left(\frac{N}{K} - 1\right).\left(3p.E_{elec} + p.\varepsilon_{fs}.\frac{1}{2\pi}.\frac{M^2}{k}\right)$$

$$+n.[\left(\frac{N}{N} - 1\right).l.Eelec + \frac{N}{K}.l.E_{DA} + l.E_{elec} + l.\varepsilon mp.d^4\ to\ SINK + \frac{N}{K} - 1.n.(l.Eelec + l.\varepsilon fs.\frac{1}{2\pi}.\frac{M^2}{k})$$

To decrease energy usage, every non cluster head node use power manages toward put the quantity of broadcast control based on the established power of the cluster head advertisement. Also, the radio of every cluster member node is twisted off in anticipation of its owed transmission instance. The cluster head node has to remain its receiver on to get the data as of the nodes in the gather. After the data has been recognized, the cluster head node sends it towards the base station LEACH gives a balancing of energy procedure through casual revolution of cluster heads. The algorithm is too prepared in such a way that data fusion be able to be used to decrease the amount of data transmission. LEACH (Low Energy Adaptive Clustering Hierarchy) is a hierarchical-based routing protocol which uses random rotation of the nodes required to be the cluster-heads to evenly distribute energy consumption in the network.

The board of multi-ho route table collect head can be maintained as under [25] [26]:

$$m_i.route = \{m_j : dist(n_j, sink) < dist(m_{j,}sink) \& neigbor(m_i, m_{j)}\}$$

The route for $m_i$ is to select the node residue energy in route node set and sink node minimum distance. The energy inspired by cluster head when the M bytes send by the cluster's node. Therefore, the energy devoted by cluster head as:

$$E_{internala} = MF_{elec} + NMF_{DA}$$

$F_{elec}$ Shows the energy consumption of $F_{DA}$ is the energy consumed by data. N is the number of nodes in the cluster. The energy consumed by $m_i$ and $m_j$ is shown in below fig.7.

$$E_{m_i=}MF_{elec} + M\varepsilon_{fs}distance(m_i, m_j)$$

$$E_{n_j-external=}2MF_{elec} + M\varepsilon_{fs}distance(m_j, sink)$$

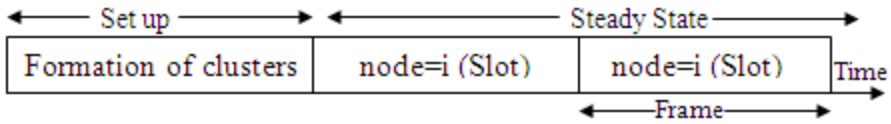


**Fig.7(a) Setup phase and Steady phase of LEACH**

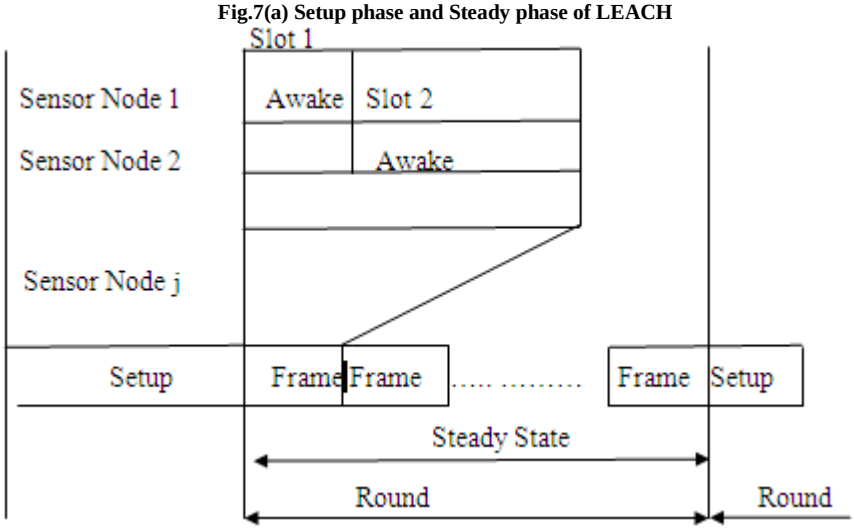


**Fig.7(b) LEACH operation [35]**

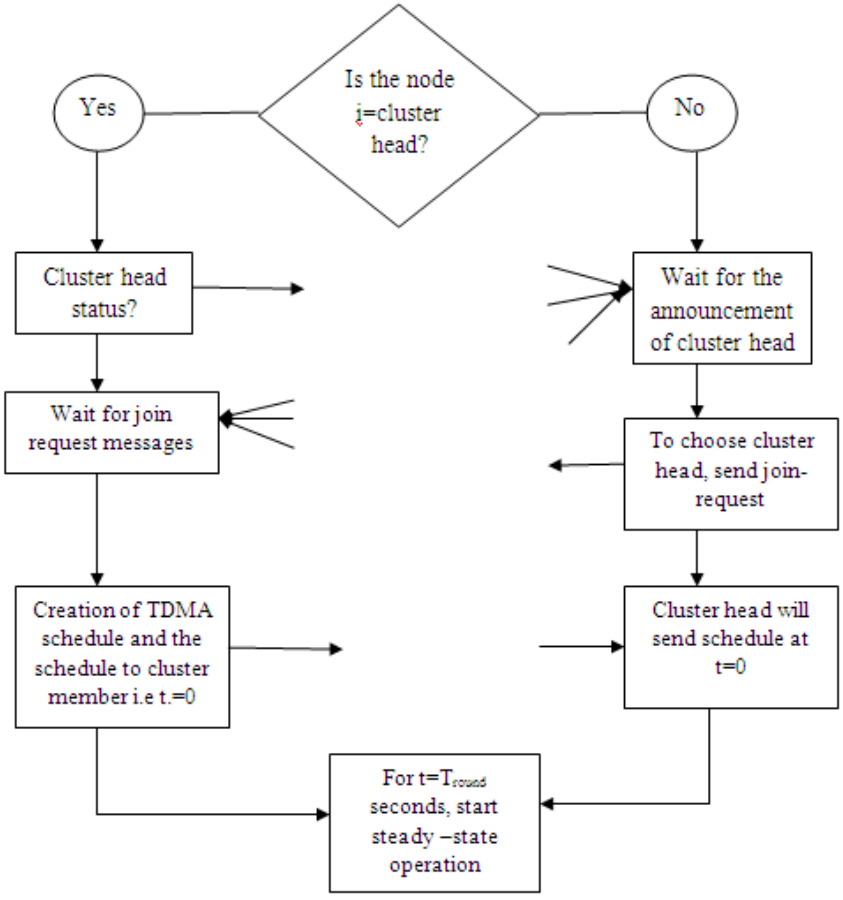


**Fig.8 LEACH Flowchart**

**Procedure BCO** (**in** B, IT, NP, NC, **out** S)
**For** i = I **to** B **do**
Determine an initial solution for the i-th bee.
Evaluate the solution of the i-th bee.
S← the best solution of the bees.
**For** j = I **to** IT **do**
**For** i = I **to** B **do**
The bee i — set an initial solution.
**For** k = 1 **to** NP **do**
**For** i = I **to** B **do**
**For** r = 1 **to** NC **do**
Evaluate modified solutions generated by possible changes of the i-th bee solution.
By roulette wheel selection choose one of the modified solutions.
**For** i = I **to** B **do**
Evaluate solution of the i-th bee.
**For** i = I **to** B **do**
Make a decision whether the i-th bee is loyal.
**For** i = I **to** B **do**
**if** the bee i doesn't loyal **then**
Choice one of the loyal bees to be followed by the i-th bee.
**if** the best solution of the bees **better** then solution S
S ← the best bee's solution.
End

## BEE COLONY OPTIMIZATION (BCO) ALGORITHM

The normal notion of creating Bee Colony Optimization is always in the direction of writing the particular multi-agent method (gathering involving artificial bees) which may hunt for great answers involving numerous combinatorial optimization issues [4] [7]. These bees examine a particular ideologies utilized through honey bees designed for your phase of nectar series method [8-9]. To put it differently, BCO principles usually are gathered through healthy techniques [10].

Artificial bees examine with the look for space, seeking the particular probable answers. To discover far better in addition to far better answer, artificial bees work jointly in addition to trade data. By way of collective knowledge in addition to revealing data amongst on their own, artificial bee's focus on more guarantee locations, in addition to slowly discard answers in the less guaranteeing people. Slowly and gradually, artificial bees along create and/or improve his or her answers. This BCO look for is managing inside iterations till a few pre defined halting criteria is satisfied. Human population involving agents (artificial bees) composed of T bees collaboratively looks for the optimal remedy. Every artificial bee generates just one treatment for the problem.

## METHODOLOGY

In this paper we have proposed a new model that solves the optimization issue with the nature enthused algorithm. a variety of parameters like throughput, energy, collect nodes etc have been used. The optimization process of WSN has been done using Bee Colony Optimization Algorithm. Leach protocol is a procedure in which all the data gets transmit through the Centre beginning In real time scenario, the possibility of placing node is one as one cannot predict the exact position of the centre nodes and the prospect of defining a node as the cluster head is also one. The cluster head transmit the data to the channel which is called packet to channel. The difficulty occurs when a sub node castoffs the acceptance of a data packet from one end to another. In such a condition dynamic routing would be optimized using optimization algorithm as mentioned above.

The proposed work would work as follows:

- To realize LEACH protocol for wireless sensor network.
- To recognize the dead nodes of the LEACH protocol
- To produce dynamic routing using BCO
- To compare it with other routing protocols

In this expansion, power is the only factor which has been taken for optimization. There is no such optimization method defined which can clearly identify both the parameters namely power and time. In this future approach, we have used BCO to optimize the network route on the base of the time as well as energy to create a sophisticated approach of routing.

Start
Initialize WSN network
Initialize LEACH protocol
Search dead nodes.
If dead nodes = TRUE
DO Bee Colony Optimization Application
Set I =1
The, Do forward pass
Select node = active
Move forward
DO backward pass
Best solutions = Share
Compare all generated solutions
Best feasible solution is chosen
Delete all other chosen paths.
Output= best path.
Stop

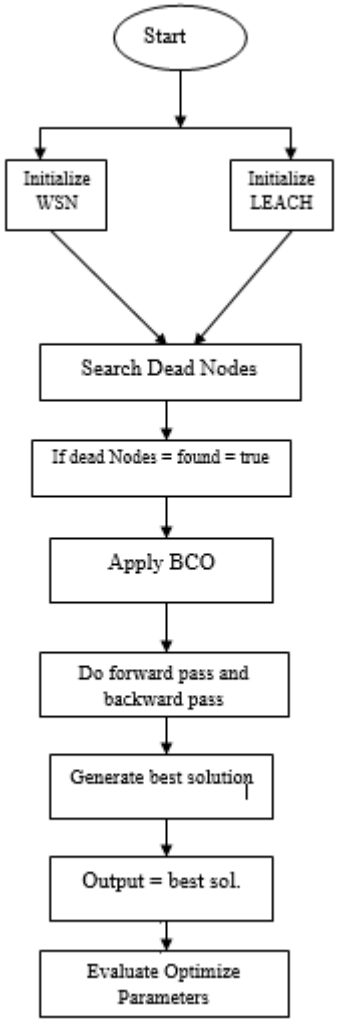


**Fig.9 Methodology flowchart**

## RESULTS AND DISCUSSION

In this section, we evaluate the performance of our proposed algorithm through the simulation. The whole simulation is taken place in MATLAB environment. The following parameters have been used:

- energy_nodes(i)=100*rand; % taking energy as random
- energy_blocks(i)=1000*rand; % energy of each block
- avg_movements=avg_movements/300;
- failed_node_block=round(25*rand);% failed block
- error_rate(mp)=5*rand; % generating the error rate
- energy_consumed(i)=energy_per_block(path(i))+extra_error_energy(path i));
- snr_range=10*log(1:throughput);
- ber=throughput(1:100)/estimated_errors;

The above figure shows the Leach network with number of clusters having cluster heads with the deployment of other nodes in the network. The whole network is divided into 25 clusters and each cluster is having 12 nodes and the network consists of the 300 nodes. The network is careful in 1000*1000 in meters. The above figure shows the meaning box when one cluster head fails to transmit the packets from source to the destination and shows that there is requirement for optimization using BCO. The above figure shows the finalized path after applying Bee colony optimization and shows that this optimize path of the cluster heads through which the packets will be transferred from source to the destination. The above figure show the bit error rate which is 3.3 db with respect to the signal to noise ratio and this measure should be less for the efficient network.

The above fig.9 shows the Bit error rate comparison with attack and without attack and shows that the bit error is high with attack than the network in the absence of the attack as a result of which network performance degrades.

The above outline shows the bit error rate with respect to the throughput of the network and shows that bit error rate with attack and bit error rate after applying Bee colony optimization. The bit error is coming less as the throughput of the network increases for the efficient network lifetime. The above fig.15 shows the throughput of the network with respect to the signal to noise ratio and shows that the network is gaining high throughput as the SNR increases which is sufficient to increase the lifetime of the network. The fig. 16 explains the throughput performance in the presence of attack and after prevention with bee colony optimization. The above fig.17 shows the accuracy plot with respect to the number of clusters and shows that the proposed system is gaining high accuracy after applying optimization.

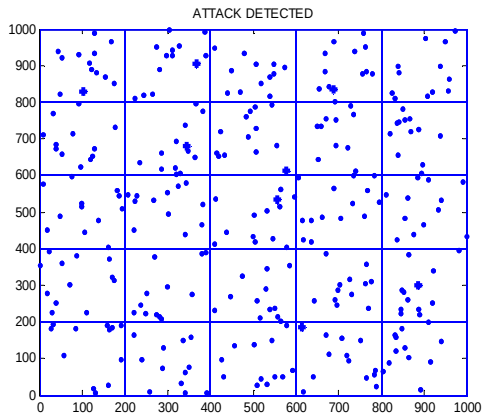


**Fig.10 Network Configuration**

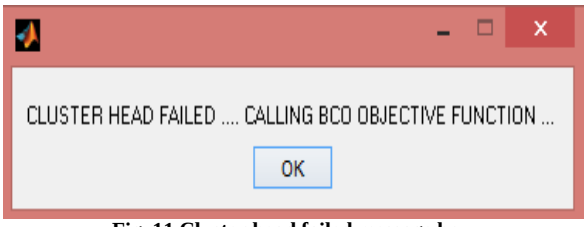


**Fig. 11 Cluster head failed message box**

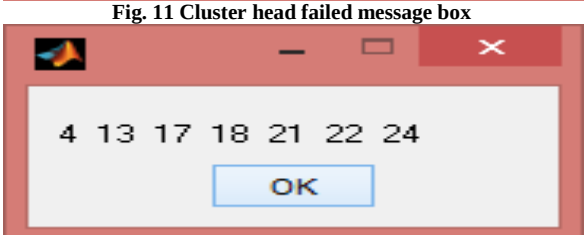


**Fig 12 Finalized path**

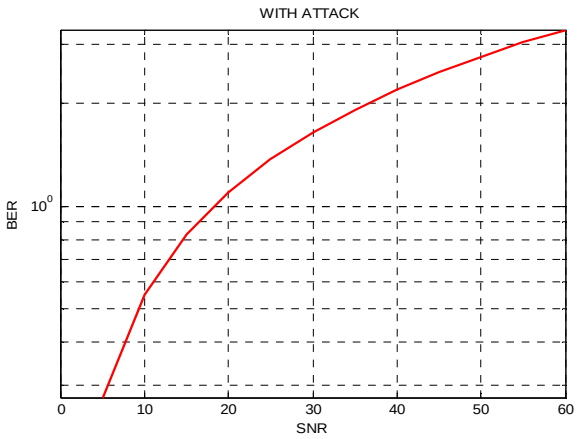


**Fig. 13 Bit Error Rate Vs SNR**

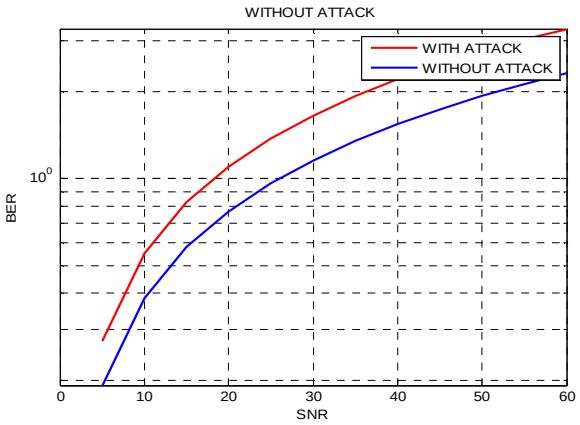


**Fig.14 BER with attack performance**

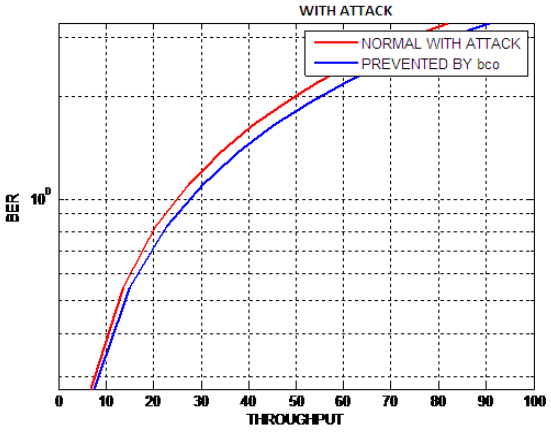


**Fig. 15 Bit Error rate Vs Throughput**

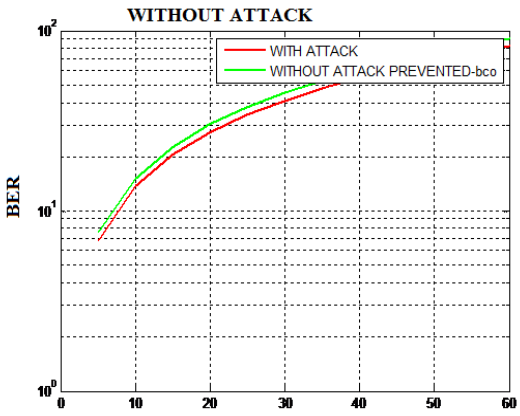


**Fig. 16 Throughput Vs SNR**

**Table- 1 Values of parameters with and without Attack**

| | With Attack | Without Attack |
|---|---|---|
| BER Vs SNR | 0.7 | 0.38 |
| | 1.2 | 0.53 |
| | 1.8 | 1.12 |
| | 2.0 | 1.80 |
| BER Vs Throughput | 0.15 | 0.8 |
| | 0.72 | 1.19 |
| | 1.2 | 1.25 |
| | 1.87 | 1.64 |

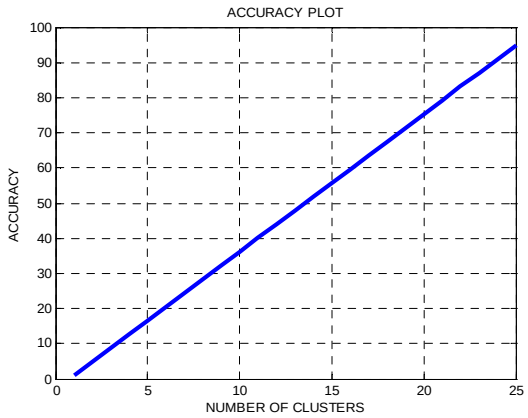


**Fig. 17 Accuracy Vs total clusters**

## CONCLUSION

In this work, we have implemented an advanced optimizes BCO algorithm to enhance network lifetime when LEACH protocol is used. Main concept behind the wireless sensors network is to save energy more and more so that it works last long enough. This is due to fact that the size of a sensor node is expected to be small and this leads to constraints on size of its components i. e. battery size, processors, data storing memory, all are needed to be small. So any optimization in these networks should focus on optimizing energy consumption to enhance WSN life time. In our proposed method the energy consumption is more balanced as compared to the other optimization algorithms. The simulation result shows that the network lifetime is improved in case of proposed scheme. As from the imitation results, it has been also concluded that the nodes are balanced in the network so the energy is.

The Future scope includes the use of enhanced LEACH protocols, as still there are many drawbacks in the basic LEACH protocol. The procedure can be improved for dealing with mobility of bunch head nodes. Even attempt can be made to decide the number of clusters dynamically and this may give better scalability to the protocol for dealing with very large wireless sensor networks. Also For future work, a model with heterogeneous wireless sensor nodes with its topology to have good energy efficient and increasing lifetime network may be investigated in different future requirements and deals with the secure sending data algorithms with various encryption algorithms like Advanced Encryption Scheme and RSA algorithm.

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