Prolong the lifetime of the MANET based on Genetic algorithm and simulated annealing optimization

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Abstract— The MANET mainly intends to minimize the power used by the devices. The higher data transmission is the main reason which affects the throughput, packet overhead, energy consumption, network performance and end to end delay. The node is responsible for sensing the data movement. The improvement in the algorithm is the need of the hour to enhance the network lifetime. The routing protocol necessary to obtain the less usage of the energy is applied and enhancing the network lifetime. The research paper is an attempt to enhance the network lifetime by the Genetic Algorithm comparing the result with the LEACH protocol.

Keywords— Energy consumption, Clustering, Network lifetime, Simulated Annealing, Fitness function

I. INTRODUCTION

Mobile Ad-hoc networks organize on their own and decentralized. The shortest path to send that data packet needs to found by routing algorithm. The topology and the selection of optimal path define the MANET routing [1].

The MANET nodes without the need of the base station establish the connectivity. Each node along with the routing function is communicated by sending the packets through midway nodes. The MANET establishes easy deployment along with the free movement in the network. In order to rise the life time of network the power consumption needs to be reduced. Several researchers have developed heuristic algorithms for the energy efficient multicast tress based on the source [2].

The MANET characteristic topology dynamics is due to the conservation of the energy along with the node movement leading to dynamic load balanced clustering problem (DLBCP).In the MANETT the nodes moving freely may not be regularly connected in the communication link. The key parameters like energy difference as well processing difference caused the load imbalance of the nodes. The overloaded nodes and the idle nodes load sharing are necessary. Due to the node mobility as well as the dynamic changing topology scalability is important. The research prime concern is to find the cluster efficient structure to get topology control, energy efficiency and load balancing. The dynamic genetic algorithm is important in finding the solution for dynamic clustering problem. It finds the best clusters to cover the minimum node set in the MANET network [3].

The performance of the MANET is analyzed based on the measurement of parameters like throughput, energy consumption, routing overhead, packet delivery ratio and end to end delay. From the literature survey the author propose to improvise the Genetic algorithm with simulated annealing to increase the life time of network and for drawing minimum energy.

II. RELATED WORK

The best used clustering algorithm in the WSN is LEACH [4]. This algorithm allowed different researchers for carrying out the work in enhancing the algorithm and to come out with novel algorithm to save the energy in MANET. It is the basic adaptive hierarchical -clustering routing protocol. The cluster is organized by the LEACH where every cluster contains a CH used as native routers for the base station. Every node activity is to send the data to the nearest CH. For every cluster once the data is received the CH does the aggregation action and sends the combined data to the base station via a single hop relay so that the information sent to the base station is minimized.

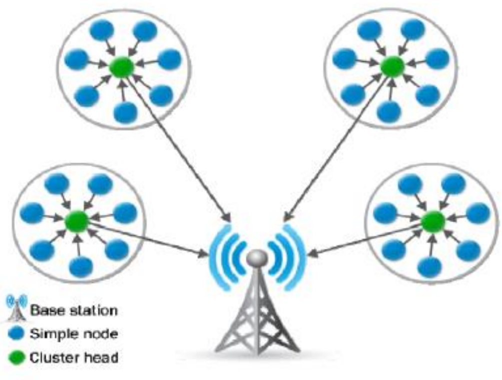

Figure 1: Leach structure

LEACH contains of two steps like the set-up step, and the steady state step. In the setup step, limited nodes are nominated arbitrarily as cluster heads besides nodes get prearranged into clusters then in steady step, the time-slot arrangement is forming and the data communication toward the BS occurs.

The CH is required to take more energy in comparison to the different nodes for balancing the network energy, where LEACH operates is different rounds with both set-up as well as steady-state step.

In the set-up step one node is designated as CH built on the threshold T(i) specified by equation 1 then the created random number. The threshold T(i) is given in[4]:

$$T(n)=p/(1-p*(r \bmod (1)/p)) \; ; \quad \text{If } n \in G \qquad (1)$$

In which p =probability of cluster head, G = node set which is not present in the CH in the last 1/p rounds then r is present round [6].

In LEACH every node turns out to be a cluster head merely

for a particular time for rounds. In the opening of every round each node goes to G produces an identical arbitrary number in the interval [0, 1]. The nomination of a node as a cluster head to present round is done if the random number is smaller than T(i) or else the node remains anticipated to link the nearby cluster head in its vicinity.

2.1 LEACH protocol deficiencies:

The LEACH protocol possess some deficiencies even though it network lifetime is higher than the remaining protocol like multipath routing. The sink is directly connected by the CH generating some problems. When the distance of the sink is away from the CH, the interconnection becomes difficult. Even though the sink is accessible with the CH, the data transfer energy gets higher. So the network consumes more energy and its lifetime is affected.

III. PROPOSED PROTOCOL

A. GENETIC ALGORITHM (GA)

The research paper details about the algorithm based on genetic with simulated annealing. The proposed combined algorithm minimizes the consumption of the energy for enhancing the lifetime of network then data number is increased for sending to the sink.

Holland first introduced the Genetic Algorithm which is basically a method to search grounded on the natural selection principle as well as genetics [5, 6].It is similar to the selection and evolution of Darwin. The optimization problem is solved by the object function f(x) where x = [1, 2,…,] is the N dimensional vector of optimization parameters. It is efficient, powerful and effective universal optimization algorithm. The chromosomes and genes are the basically the building blocks of binary GA. The parameters of optimization are encoded through the conventional binary into the binary code string. To develop solutions and perform the natural selection, a particular parameter is necessary to differentiate the worse and better solution [7]. The measure to function objectively and a computer simulation model founded on the maths or based on the subjectivity in which user can select the better path and solution [8]. GA is dependent on the candidate solution population. The population size is found by the user which affects the performance and scalability of GA. The GA gets eligibility to know the best solution when the encoding problem of chromosomes as well as after selecting a parameter of fitness which separate the bad and good solution. The steps to know the best possible solution are Initialization, Evaluation, Selection, Recombination, Mutation, Replacement and repeating all the steps. [9, 10]:

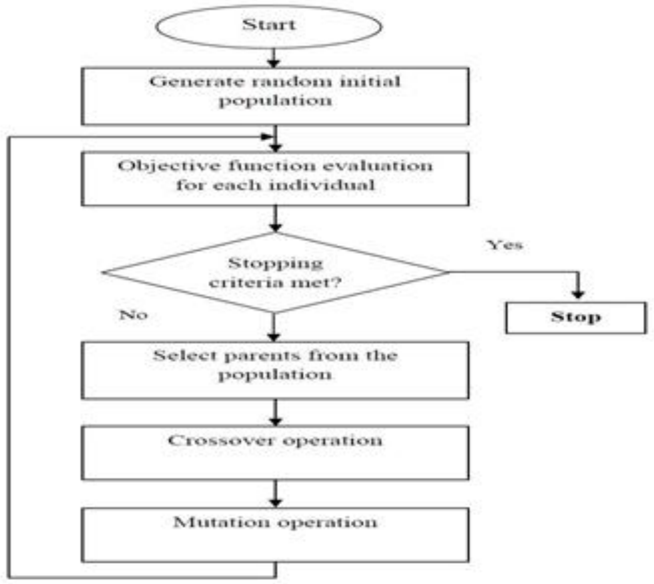

Figure 2: Flowchart of the main step of GA [11]

B. Simulated annealing

The annealing is a process in which the solid low energy is achieved by cooling. The heating of the solid and its melting at high temperature makes the particle to move randomly. The gradual cooling of the solid place in their base form with less energy state. In order to evade the defects crystal the cooling time should be slow [12].

In the SA, neighborhood structure and generation method gives the best solution. The selection by neighborhood gives the solution set, Ss. The generation method is to select the novel solution after the neighborhood S, of the solutions. In the method of SA, a novel solution is obtained with a neighborhood arrangement then a generation method. The neighborhood arrangement gives a solution set, Ss. It is near to the current solution, s. The method of generation means selecting a new solution after the neighborhood S, of the solutions.

The SA operation given below:

Step 1: Initialization: Initialize the repetition count is k = 0, the temperature T0 selected sufficiently high.
Step 2: Reiterate for every temperature Tk: Complete Steps 2–4 till an equilibrium condition is fulfilled.
Step 3: Neighborhood solution: Create a trial solution xk+1 in the region of the current solution xk.
Step 4: Acceptance condition: Let Δ = f(xk+1) + f(xk) then r is a arbitrary number regularly spread over [0, 1]. If Δ < 0,the trial solution is accepted Otherwise, the trial result is recognized with the possibility exp(–Δ/Tk) > r.

4. Blending of Genetic and simulated annealing algorithms

In order to obtain the best performance the genetic and simulated annealing algorithm is blended in comparison to the LEACH algorithm. The GA has higher capacity to find the solution for MANET performance concerned problems. The higher combinational optimization problems solution can be obtained with the blend of GA and SA. The GA has problems like the pre maturity with lesser convergence rate, local optimum, and lesser local search capacity [13]. The SA has high local search capability and high maturity. The combination of the GA and SA makes it better approach to increase the efficiency.

To hybridize GA with SA, the SA algorithm is used along with the GA. The GA-SA algorithm is given in the figure 3. The main population is P(t), the crossover population is Q(t) then mutation population is R(t).The combination of Q(t) with R(t) products S(t).

The sorted population is given by S′(t) which is better solution. The npop() are elements number in P(t), npop() elements are chosen to the S′(t) top populations and labelled as S″(t).

Later P(t) with S″(t) is compared grounded on the SA rule is required. The new generation population is created at this stage [14].

Algorithm 1- Simulated Annealing algorithm in pseudo-code

1: Choose an initial solution S0= {X10,X20…………… Xn0}
2: Choose an initial temperature T > 0;
3: Set temperature variation counter t=0;
4: Set repetition counter n=0;
5: While (Tn>Tf)
6: for i=1 to g
7: for j=1 to N/2
8: S2 = Generate a neighbour of the S1.
9: Generate two children using crossover and mutation operator.
10: Evaluate the cost function Δ E= Cost (S2) – Cost (S1)
11: If (Δ E < 0) then S2 = S1
12: Else if random (0, 1) <exp (-Δ E/Tn) then S1 = S2;
13: Decrease T
14: S t+1= {X1t+1,X2t+1…………… Xnt+1}
15: t = t +1
16: Until T n+1 = α (Tn)
17: n = n+1
18: Until meet the stopping criterion true.

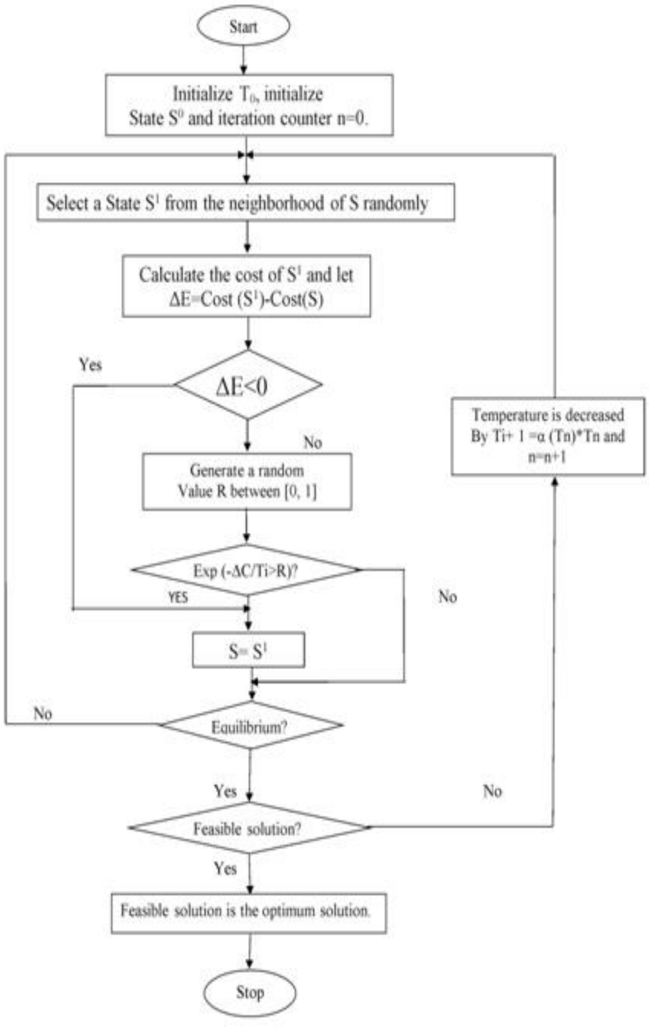

Figure 3: working flow of Genetic with simulated annealing algorithm

Three processes generates a new generation of system configuration. The processes are crossover, mutation and Boltzmann trial. The three processes are reiterated N/2 times for generating N original system configurations of the succeeding generation St+1.

From the earlier population (Pt) the two system configurations are selected as parents, which are not replaced. By the use of crossover as well as mutation operators of GA, two children's are produced by two parents. The Boltzmann trial is defined as the competition amongst the system costs for a parent and a child. Two Boltzmann trials are conducted.

The probability of winning is exp (-Δ E/Tn) by the parent. T0 is the high initial temperature value is applied guarantee that parent and child both are similarly winning the trial even if child is a suitable solution in terms of lower cost than a parent, Cost (S2) Cost (S1). This makes an uphill move within the space of decision to permit for escape after local optimal solutions.

The trial winner is chosen for practice as a parent of the subsequent generation. After evolved generations G, the temperature is minimized by the SA temperature update function Tn+1 = α (Tn). With Tn+1 reduced, uphill changes become more challenging. When temperature is low, the cost is increased in a system configuration and possesses very less chance for winning the Boltzmann trial since probability if less. The SAGA stopping criterion is a final temperature Tf. When the temperature Tf is passed the algorithm ruminates.

IV. SIMULATION RESULTS

The simulation parameters for the evaluation of the energy efficient cluster head selection shown in table I. fixed network size is 1000 X 1000 m2 and 10,25,50,75,100,150 nodes created. The initial energy of every node was set to 10 Joules. Energy for data aggregation is 2nJ. The data packet size is 812 bits and data transmission time is 50ms.

TABLE 1: SIMULATION PARAMETERS FOR SELECTING THE ENERGY EFFICIENT CLUSTER HEAD

Parameter	Value
propagation	Two ray ground
Field size	1000m X 1000m
Number of nodes	75
Channel Type	Wireless Channel
Antenna Type	Omni
Link Type	LL
Initial energy of MANET node	10J
Data packet size	812
Simulation time	50
Transmission time	10,15,20,25,30
Routing protocol	SAGA
Observation Parameters	End to End Delay, Throughput, Energy Consumption

a) End to end delay

The simulation results for end to end delay parameter are shown in the figure 4.1 with respect to the number of nodes. In the beginning the end to end delay is less in both the protocols as number of nodes increases the delay also increased up to certain nodes then remains same as in both the cases.

TABLE 2: MEASURE OF END TO END DELAY LEACH VS GASA PROTOCOL

Time of simulation end	End to End Delay	
	Leach	GASA
10	24.04	27.294
15	39.421	35.263
20	59.892	38.967
25	64.829	50.939
30	64.829	52.548

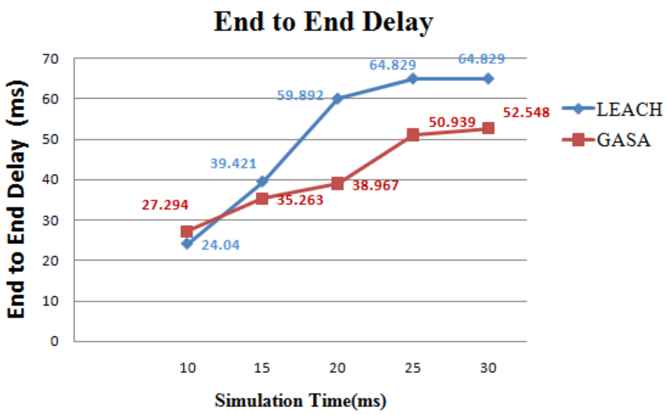

Figure 4.1: End to end delay vs Number of Nodes

Even though GASA protocol performs better compared to LEACH protocol with an improvement of 18.94% end to end delay. This factor again improves the performance of network with respect to consumption of energy and life time of the network due to reduce in end to end delay.

b) Throughput

TABLE 3: MEASURE OF THROUGHPUT LEACH VS GASA PROTOCOL

Time of simulation end	Throughput	
	Leach	Genetic algorithm
10	154.20	131.35
15	239.62	253.15
20	281.77	378.73
25	375.84	472.80
30	469.03	574.63

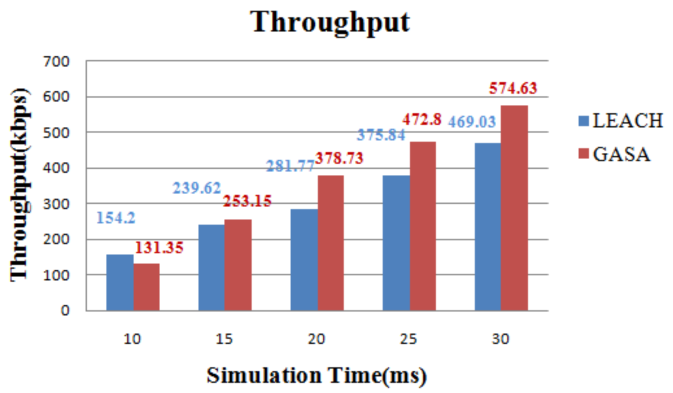

Figure 4.2: Throughput vs Number of Nodes

Figure 4.2 shows simulation results obtained for throughput using NS2 tool from 10 to 150 numbers of nodes. Initially throughput remains till 75 numbers of nodes beyond that the throughput drastically increases by an averages of 18.37% in the proposed GASA protocol compared to LEACH protocol.

c) Energy Consumption

TABLE 4: MEASURE OF ENERGY CONSUMPTION LEACH VS GASA PROTOCOL

Time of simulation end	Energy Consumption Using	
	Leach	GASA
10	58.1382	58.7806
15	86.3866	87.2162
20	114.568	115.727
25	143.202	144.222
30	171.85	172.787

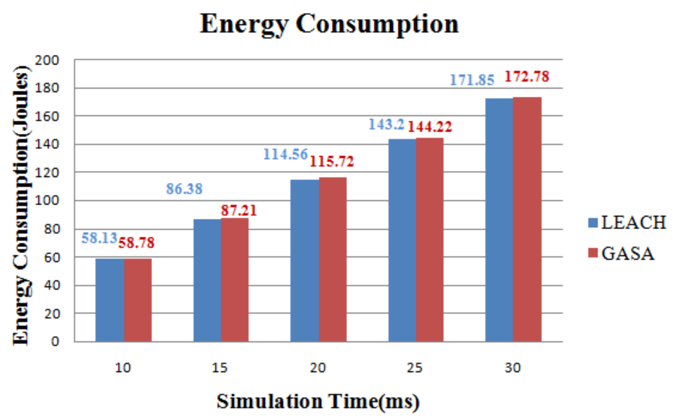

Figure 4.3: Energy consumption vs Number of Nodes

The simulation results of energy consumption using NS2 tool from 10 to 100 numbers of nodes are shown in figure 4.3. Initially energy consumption gradually increases as the number of nodes increases from 10 to 150. The results show that energy consumption is improved in this proposed GASA protocol by 5.38% compared to LEACH protocol.

V. CONCLUSION

The simulation result for GASA shows better in performance compared to the LEACH protocol. The GASA improved the end to end delay by 18.94% which enhances the network performance with energy consumed and network lifetime. The throughput in GASA drastically increases by an average of 18.37% in the compared to LEACH protocol. The simulation results show that energy consumption is enriched in this proposed GASA protocol by 5.38% compared to LEACH protocol. The GASA algorithm in future could be improved for different parameter to increase the network lifetime.

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