Localization of BTS using Genetic Algorithm

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Abstract--- Wireless Communication, since the beginning of this century has observed enormous advancement The need for the optimal use of available resources has pushed researchers towards investigation of swarm intelligence based optimization algorithms to support designs and planning decisions. Radio coverage generally is affected by variables such as antenna arrangements, base station performance, and the locations of base stations and users. Bio-inspired evolutionary algorithms are probabilistic search methods that simulate the natural biological evolution or the behavior of biological entities. Such algorithms can be used to obtain near optimal solutions in optimization problems, for which traditional mathematical techniques may fail. Genetic algorithm (GA) has found its usage in telecommunications field because of the challenging factors and parameters involve in radio coverage optimization. This work actually considered how to optimally determine locations of Base Transceiver Station (BTS), such that minimum number of BTS can be installed to cover larger number of subscriber at lesser infrastructural cost.

I. INTRODUCTION

The increasing use of radio communication throughout Europe and subsequent congestion of frequency spectrum resulted in the introduction of the cellular system of communication for commercial operation in 1992 [1]. The cellular network requires that a coverage area be divided into different cells and sectors using the principle of frequency re-use. The many advantages of the cellular network over its land line both for the subscriber and service providers has led to unprecedented patronage and hence increase in mobile phone users, making cellular telephony the economically most important form of wireless communications world-wide.

Optimization of the radio coverage entails operating the network to its optimum (best) output state. Optimization is the process of adjusting the inputs to or characteristics of a device, mathematical process, or experiment to find the minimum or maximum output or result [2]. It is an established fact that an optimized network performs better—and subscribers notice the difference, hence operators have been investing in and upgrading their networks to meet demand, since they realize that their success will be based on a differentiated service quality, attractive services, and a good value proposition [1].

In the increasingly competitive wireless industry, optimization offers the means to achieve good quality solution consistently. While deploying a network, the optimization phase is followed

Immediately after the new frequency plan is introduced. Several teams of field personnel undertake extensive drive testing around each site making a number of calls, concentrating on testing and the handovers between each cell. Each call is investigated and identified problems are resolved by classical methods [3].

Drive-testing methodology is used by most network operators so as to identify the areas within the network for improvement through optimization. This method of network performance
measurement is very important for comparing the performance of network under test with competitor's network [13].The placement of BTSs is a tedious job for network designers, the reason being the frequency channels become increasingly congested and propagation environments become more complex[5]. Suboptimal placement of BTS will result in not only expensive deployment costs, but a reduction in spectrum efficiency due to interference which could be devastating to a service provider considering the cost of spectrum license. In order to cope with the need of rapid wireless systems deployment, significant research efforts have been put into develop advance wireless planning techniques over the past few years [5].

The problem considered in this paper is to determine the optimal locations of BTSs to meet traffic demands. Optimal coverage with minimum number of BTSs is essentially a resource allocation/optimization problem. The received power, path loss and attenuation are main parameters of considerations during the optimization.

II. NETWORK PLANNING

A cell is the area that is covered by base station transmitter which is the basic geographical unit of the cellular system. The cells can be classified according to their sixe such as macro cells range from 1 to 30 Km and that of Pico cell ranging from 10 to 200m. Cell planning address the problem of placing the base station and specifying the parameters for every base station so that the optimal system performance is achieved and the system cost is minimized. The performance and the costs are characterized by:

Coverage: The radio signal coverage must be guaranteed and holes in the coverage area should be avoided.

Capacity: In each cell, a sufficient number of channels must be available in order to meet its traffic demand for new calls and handoffs.

Transmission quality: the ratio of carrier to interference power(C/I) of radio channels must satisfy the requirements of transmission quality.

Cost: The deployment cost that is the cost of putting the required number of base stations cost of transmitting power.

For cell planning, the area to be planned is discretized, the resolution depending on the type of cells being planned.

The cells are drawn for convenience as hexagons. The edges of the hexagons represent the theoretical equal power boundaries between cells assuming that every BTS radiates the same power, propagation is homogenous in every cell and all the BTS are similarly sited in either the centre or at the corner of every cell. However the reality of the coverage pattern will be somewhat different and can fully determine using propagation planning tools coupled with a detailed study of the service area and fields measurement.

III. CLUSTERING MODULE

Clustering is used to categorize or group similar data items together. The problem of cell planning can be modeled as a clustering problem where the aim is to cluster the demand node such that the accord to a certain set of properties. The set of properties being: minimum signal strength should be guaranteed over the whole area and cell capacity should not exceed the maximum capacity of a base station. This modeling enables the application of te standard techniques developed for clustering. There are basically two types of clustering methods: Hierarchical and partitional clustering[7] Hierarchical clustering proceeds by merging small cluster into large one or by splitting large clusters.Partitional clustering on the other hand attempts to decompose the data set into set of disjoint clusters. The cell planning can be modeled in a better way using partitional clustering as we are not only interested in the local structure of the cluster(involving traffic capacity and signal strength aspects) But global structure(involving the transmission quality (C/I) of clusters also.

IV. GENETIC ALGORITHM

Genetic algorithm sophisticated nature has made it an efficient searching tool as it found application in complicated problems in business ,pattern recognition, scheduling etc[8].The application of Genetic algorithm in solving the telecommunications Challenges can be justified by the fact that challenges optimal services are generic in nature;

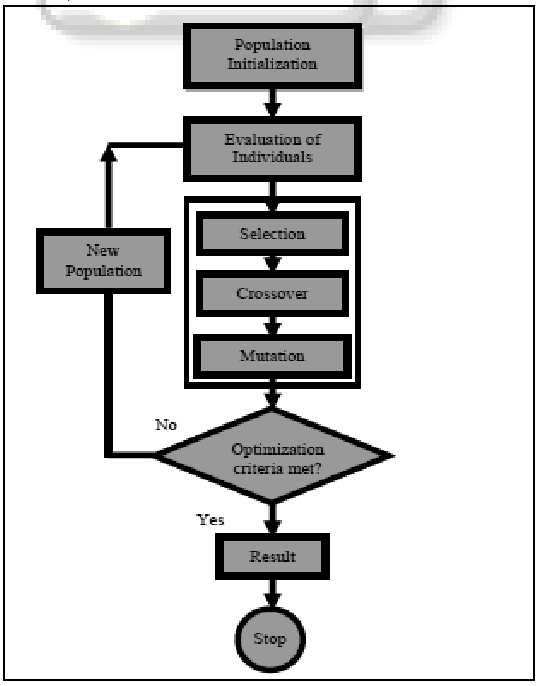

Fig. 1: Flow Chart

GA is an optimization tool capable of giving optimum results in situations where there are many conflicting options, this is because it has capability to search large spaces efficiently without the need for derivative information. They operate on a population of potential solutions applying the principle of survival of the fittest to produce, hopefully, better and better approximation to solution. They produce high quality solution because they are independent of the choice of the initial configuration [9][11].

Algorithm flow chart:

A. Initialization

Initially many individual solutions are randomly generated to form an initial population covering the entire range of possible solution.

B. Genetic Operators/Reproduction

The reproduction process of the algorithm follows a sequence of selection, cross over and mutation, reproduction defines the rules for generating the gene sequence of offspring from the parents chromosome.

Selection

The selection process is analogous to the survival of the fittest in the natural world [10], in the GA operation, based on the fitness value allocated to each chromosome, selection is done to select parents for crossover, and the system is expected to choose the more fit individuals in the population while still preserving the population diversity. Several means of selecting a population exist with their advantages and disadvantages,

In the Facility placement problems reviewed mention is made of rank-based, roulette wheel and tournament selections methods. Researchers have compared these three selection methods and from results based on fitness cost indicated that tournament selection utilizes a more efficient method of choosing fitter parents for mutation though choice could be problem dependant.

C. Cross over

Cross over is the process of inter linking two chromosomes where genes are exchanged resulting in new chromosomes carrying the features of both parents. It is analogous to combination of genes in biology resulting in a haploid, it can be referred to as the sexual combination with relation to life and evolution. It involves the introduction of sub solutions on different chromosome resulting in an entire new chromosome or generation. Cross over is done to accelerate search; the basic cross over methods include single point cross over, multipoint and uniform cross over.

D. Mutation

This is a term used to describe a genetic operation that is carried out in other to make adjustment on the population, this operation is employed in an attempt to allow the algorithm to search every possible space and arrive at a global optima. For a binary GA this involves randomly changing a 1 to 0 and vice versa. Mutation can be referred to as random when the solution is allowed to explore every possible search space with no problem specific knowledge, while the use of problem specific knowledge in other to fine tune a solution is called guided mutation. Mutation probability is advice to be low to the tune of 0.1% to avoid premature convergence and at most 1% as the case may be.

E. Ending Criteria

The complete process from population initialization to mutation resulting in the production of a new set of “candidate solution” can be referred to as one generation. The GA is run over several generations in order to determine the best set of solutions and typically ended at the best convergence; that is when the best fit converges to the average. There are however other stopping criteria which include

1) Fixed number of generations reached
2) Budgeting: allocated computation time/money used up
3) An individual is found that satisfies minimum criteria
4) The highest ranking individual's fitness is reaching or has reached a plateau such that successive iterations are not producing better results anymore.
5) Manual inspection. May require start-and-stop ability
6) Combinations of the above

Usually GA is ended with an output display of both data and graphs of best solutions to the facility placement. One that will give best coverage and minimum number of facilities while takings environmental and safety constraints into consideration[13].

Code:

- Choose initial population Repeat
- Evaluate the individual fitness of a certain proportion of the population
- Select pairs of best ranking individuals to reproduce.
- Breed new generation through crossover and mutation.
- Continue until terminating condition.

V. PROBLEM STATEMENT

Main objective of the paper is to optimally locate BTS covering maximum area with minimum interference. This problem can be stated as given a colony size with potential subscriber density distribution, identify the optimal cell geometry and location of BTSs. Our problem is to optimize location of BTS with respect to each MS using Genetic algorithm.Genetic algorithm is used to localize BTS so as to cover maximum number of subscriber. The fitness of solution is selected on the basis of three parameters: (a) Power received, P_r (b) Path loss, L_p (c) Attenuation A[12].

$Lp = 66055 + (26.16)\log_{10} f_c - 13.82\log_{10} h_b - 3.2\log_{10}11.75 h_m + 44.9 - 6.55\log_{10} h_b \log_{10} d$

Attenuation $(A) = 42.6 + 20\log_{10}f + 26 \log_{10} d$

$P_r = 10\log_{10}(Pt) - \text{abs}(L_p)$.

VI. RESULTS & SIMULATIONS

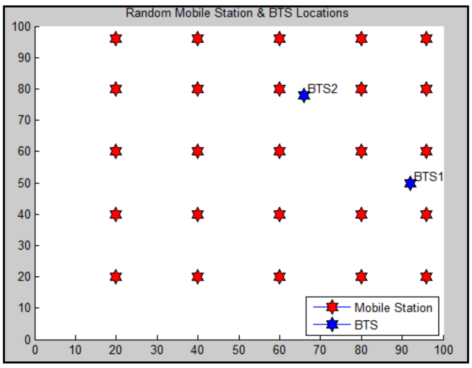

Fig. 2 : Random Location of MS & BTS

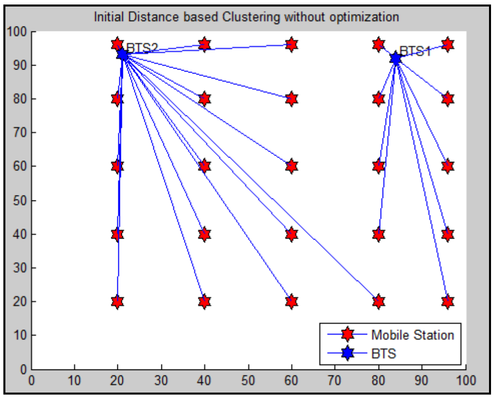

Fig. 3 : Cluster formation

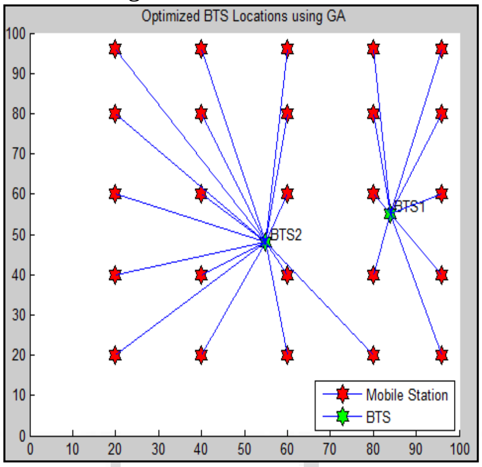

Fig. 4 : Optimized BTS Using GA

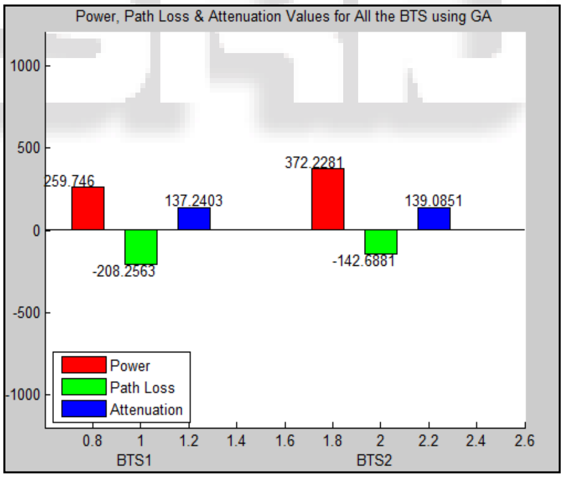

Fig. 5: Power,Path Loss & attenuation for all BTS

VII. CONCLUSION

The main aim of this paper is to optimize the location of BTS using Evolutionary algorithm.

Parameters	BTS1	BTS2
Power	259.746	372.2281
Path Loss	-208.2563	-142.6881
Attenuation	137.2403	139.6651

This technique helps in providing effective way for optimal placement of BTS with maximum coverage and minimum number of BTS.The optimization is done using certain parameters like power, path loss and attenuation which help in determining performance of BTS at optimal position and from the table it is clear that BTS is optimally placed as optimal values of received power and path loss are obtained. In future work can be done in reducing attenuation or some other technique can be used to provide 100 % coverage.

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