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Dynamic Channel Allocation Using Hybrid Genetic Algorithm and Simulated Annealing

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ABSTRACT : With the limited frequency spectrum, the channel assignment problem (CAP) *i.e.*, to assign the calls to the available channels so that the interference is minimized while the demand is met, has become increasingly important. In this paper a hybrid technique of Genetic Algorithm and Simulated Annealing (HGASA) is applied for dynamic channel allocation. With this hybrid algorithm effort is made to reduce the search complexity of channel allocation while satisfying constraints of interference. The concept of Simulated Annealing (SA) is incorporated into Genetic Algorithm (GA) in order to avoid pre-mature convergence of the strings. Experimental results show that the proposed HGASA is a better method than GA and the average call blocking probability of the system decreases.

Keywords: Genetic Algorithm, Simulated Annealing, Dynamic Channel Assignment, GSM Network.

I. INTRODUCTION

With the rapid growth of cellular radio network, wireless mobile communication is developing extraordinarily. The fast growing in the number of users requires a major effort to enhance the performance of wireless communication system. Due to the current development in the communication system is extremely limited by the capacity constraints of the available frequency spectrum, proper utilization of channel allocation techniques which are capable of ensuring efficient channel allocation is essential in solving the channel assignment problem. The channel assignment problem is to allocate channels to each radio cell in cellular radio network. The channel assignment is NP hard problem. The role of a channel allocation scheme is to allocate channels to cells in such a way as to minimize the probability that the incoming calls are blocked. To minimize this call blocking probability, the channel allocation scheme must satisfy electromagnetic compatibility constraints as well as demand of traffic. The electromagnetic compatibility constraints consist of two types soft constraint, hard constraint. The hard constraints are co-channel interference, adjacent channel interference, and co-site interference. The soft constraints are packing condition, resonance, limiting rearrangement. There are three categories into which channel assignment problem is classified, Fixed Channel Assignment (FCA), Dynamic Channel Assignment (DCA) and Hybrid Channel Assignment (HCA). FCA allocated channels to each cell permanently in a manner that maximizes frequency reuse. Hence in an FCA system, the distance between cells using the same channel is the minimum reuse distance for that system. In DCA, channels are allocated dynamically as call arrives and has higher degree of randomness but involves complex algorithms. FCA is simpler and outperforms DCA under heavy load conditions, but FCA does not adapt to changing traffic conditions. HCA scheme combines benefits of both FCA and DCA. In HCA one set of channel is allocated as in FCA and the other set is allocated as in DCA.

II. PREVIOUS WORK

Shinde [1] proposed a hybrid channel allocation model using an evolutionary strategy with an allocation distance to give efficient use of frequency spectrum. The problem of determining an optimal allocation of channels to mobile users that minimizes call blocking and call-dropping probabilities is emphasized. A new hybrid algorithm combining the genetic with the simulated annealing algorithm is introduced in [2] for Selecting the routes and the assignment of link flow in a computer communication networks which is an extremely complex combinatorial optimization problem. Bhattacharjee[3] maximized the channel allocation of the active subscribers within the cognitive radio network(CRN). There are numbers of heuristics approaches being suggested to overcome the channel assignment problems based on fixed reuse distance concept such as neural networks (NNs) in [4], particle swarm optimization (PSO) in [5] and Tabu search (TS) in [6]. These type of algorithms can be used to solve complicated optimization task, such as optimal-local, multi-constrained and NP-complete problems. Lima [7] investigated in his research, the dynamic channel assignment (DCA) in mobile communications systems using genetic algorithm (GA). The performance of the proposed GA was evaluated in a 49 hexagonal cell arrangement operating under uniform and nonuniform traffic distributions.

III. PROBLEM STATEMENT

Channel assignment scheme helps to increase the networks capacity by efficiently distributing channels across the network There are three types of interference namely co-channel constraint (CCC), adjacent channel constraint (ACC), and co-site channel constraint (CSC). CCC is due to the allocation of the same channel to certain pair of the cells within the BTS distance or reuse distance simultaneously. ACC is caused by the allocation of the adjacent channels to certain pairs of the cells simultaneously and CSC is due to the separation is less than some minimum spectral distance when channels are allocated in the same cell. These EMC constraints are known as hard constraints. There are soft constraints to help in reducing the call blocking probabilities besides the hard constraints. They are the resonance condition, packing condition, and the limitation of reallocation. The resonance condition maximizes the use of channels within the same reuse scheme by allowing the same channels to be assigned to cells that belong to the same reuse scheme. This would greatly reduce the call blocking probabilities. On the other hand, the packing condition allows the use of minimum number of channels each time upon new call requests. The channels assigned in different cells need to be separated by a reuse distance which is sufficient enough to reduce the CCC interference to a tolerable level. This ensures that each channel can be reused many times without affected by the CCC interference. The reuse distance is the minimum distance required between the centers of two cells which are using the same channel to maintain the desired signal quality.

IV. PROPOSED MODEL

A. HGASA scheme

GAs search by simulating evolution, starting from an initial set of solutions or hypotheses, and generating successive "generations" of solutions. GA is a useful approach in searching for an optimum solution in the channel assignment problem. GAs are search techniques for global

optimization in a complex search spaceThe performance of GA can be improved by introducing more diversity among the strings so that pre-mature convergence can be eliminated. This can be achieved by replacing weaker strings *i.e.* the strings having low fitness value with better strings *i.e.* strings having higher fitness value. Simulated annealing is a branch of iterative improvement algorithms in which the basic idea is to start with an initial configuration (solution) and make modifications to improve its quality. Thus, the SA aims to achieve a global optimum by slowly convergence to a final solution, making downwards moves with occasional upwards moves and thus hopefully ending up in a global optimum.First of all, if we take a cell, say first and find its channel requirement by calculation the difference of allotted channel and previously assigned channel. if this cell requires a channel then we use HGASA to find the most appropriate channel that must be assigned to this cell.

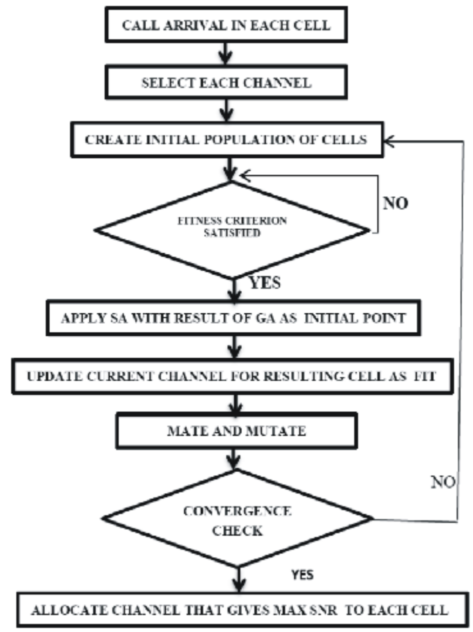

Fig. 1. Flowchart of HGASA.

B. Optimization through Genetic Algorithm

(*i*) *Initial Population :* The algorithm starts by randomly generating an initial population of possible solutions. For our problem, the population is the randomly generated cells. We can select a cell, say cell one and if this cell requires a channel, we start from channel one to last and search for the best to allocate.

(*ii*) *Evaluation phase :* The quality measure to decide how fit one individual is among the whole generation is called the fitness. In our application, we can compare the frequency reuse distance and SNR of all the cells created in initial population. The fitness function is the value of both distance and SNR to maintain least interference between co channel cells.

(*iii*) *Selection phase :* The chromosome with better fitness will be selected, and the others will be eliminated. This will help improve the total fitness of the population. After this we sort the other cells that satisfy the condition of allocation of channel one, on the basis of highest SNR.

(*iv*) *Crossover phase :* After the selection step, the eliminated individuals are added by applying crossover to the selected individual. The selected cells can be used to create another cells having better fitness criterion.

(*v*) *Mutation phase :* The mutation process is carried out by changing a random bit of the new genes. These new genes (cells) now become the next candidate to be assigned with channel one but only if they satisfy the fitness criterion. The cycle goes on until all the channels are scanned and the channel requirement of the cell is fulfilled.

C. Optimization through Simulated Annealing

(*i*) Initialize temperature *T* to a particular value.

(*ii*) Initialize the iteration parameter (*n*) equal to 1 to be iterated till *M*.

(*iii*) Create two random channels and find their *SNR*.

(*iv*) Select the channel whose difference of *SNR* from the previous channel selected by *GA* is higher.

(*v*) Find the minimum difference SNR value (best) among the *M* best channels.

(*vi*) If best channel is not changed over a period of time, find a new channel using temperature.

(*vii*) Accept the new channel as best with probability as exp-($\Delta E/T$), even though current position is worse. Here ΔE is the difference between current best channel's *SNR* and new channel's *SNR* value.

(*viii*) Reduce *T*.

(*ix*) Terminate if the maximum number of iterations is reached or optimal value is obtained.

(*x*) The resultant channel is allocated to the desired cell for which we wanted the channel. The algorithm repeats for all the cells that require a channel.

V. SIMULATION

A. Cellular Model Assumptions

There are 70 channels available in this model to be allocated for incoming calls. The cellular topological model consists of 64 hexagonal cells, with equal number of cells along both axes. The simulation call traffic distribution can be either uniform or nonuniform distribution. Uniform cellular traffic distribution indicates that every cell has the same traffic load or demand. On the other hand, nonuniform cellular traffic distribution indicates that there is different traffic load in each cell. In our model non uniform traffic is implemented as shown in fig.2. Each of the value represents the average call arrival rate per minute for the corresponding cell. The average call holding time is 180 seconds. mating iterations are taken 25,mutation iterations are 2 and simulated annealing iterations are taken 25. The simulation is performed on MATLAB 7.10.0.499(R2010a). Channels are allocated to the cells satisfying the CCC constraints as shown in Fig. .3 and Fig. 4.

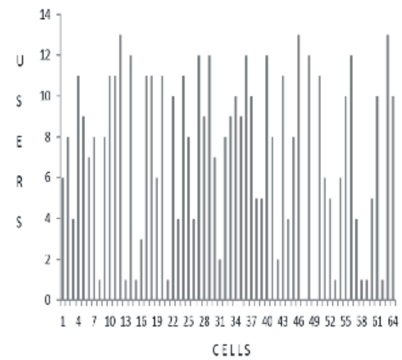

Fig. 2. Non Uniform Traffic Distribution.

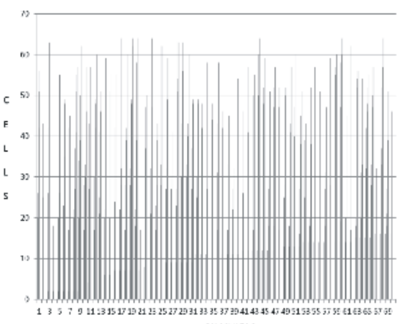

Fig. 3. Channels Allocated to cells. Each channel is allocated in five to six cells that are far apart satisfying the constraints.

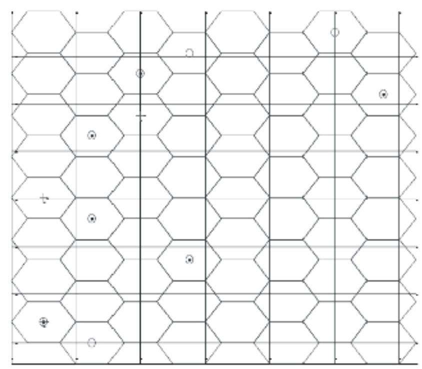

Fig. 4. Channels Allocated in Hexagonal Structure .Four Channels are taken in the figure to demonstrate the frequency reuse concept as one channel appear once only in a cluster.

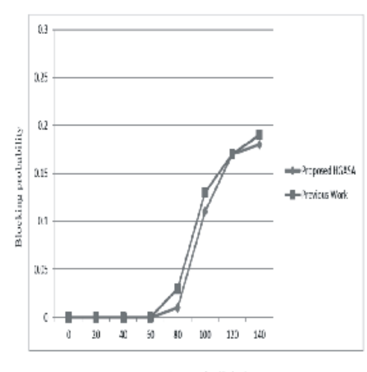

Fig. 5. Comparison of the proposed HGASA algorithm in terms of blocking probability with previous work [1].

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