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An Overview of Memetic Approach to Design Problems of Wireless Networks

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Abstract- In this paper, we explore the design problem of wireless network. In wireless cellular network cell to switch assignment is well-known NP-hard problem for location management. Personal communication services (PSC), cellular mobile network and Universal Mobile Telecommunication services share analogous network architecture used for study. Some aspects of cell to switch allocation problemis also discussed. Memetic algorithm is a population-based search and exploiting objective function. The traits are acquired during the learning process, passed from parents to their offspring. GA and neighborhood search technique will result in early findings of the optima. Memetic algorithm performs good to find optimal result of complex problems.

Keywords: BSC and MSC, cell to switch assignment, cellular networks, topological design, Memetic algorithm, personal communication services.

I. INTRODUCTION

Cellular Mobile Network consists of geographical topology of hexagonal structures called Cells. Each cell has one base station connected to MSC. The ultimate goal of every service/designer provider is to reduce the total cost for complete commercialization. Given a cellular network coverage area, service provider have to decide the number of switches should be located in coverage area and where. Which switch should serve which subset of cells (cell to switch allocation problem) and well known switch to switch assignment problem. GA simulates the survival of the fittest among a population of artificial chromosome and it normally stops when the number of generation specified is met or there is no change in maximum fitness value. In this paper Memetic algorithm can be defined as genetic algorithm that include non-genetic local search to improve genotypes. Memetic algorithm can blend the functioning of genetic algorithm with several heuristic search techniques like simulated annealing, tabu search is analysed. The Cellular mobile Network consists of three major layers user level such as mobile phone, access level and network level as shown in table1 [1]. Mobile handset to base station connection is wireless all other connections are linked by cables.

Layers	Components
Network layer	PSTN
Access layer	Cells, BTs, Links, Switch
User layer	Mobile Devices, Telephone

Table 1 Basic layer of cellular mobile network

II. DESIGN OF CELLULAR NETWORK

In the 1^{ST} and 2^{nd} generation wireless networks, the network structure consists of two levels of equipments [2]. First level consists of base stations (BSs) collecting traffic coming from mobile users. The second level consists of switches called MSCs (Mobile Switching Centers) which handle a group of base station via a base station controller. Each BSC reserve radio frequencies handle the handoffs from one BS to another, and perform paging of the mobile terminal. However in order to simplify the assignment problem the BSCs are not usually taken into account, as BS is directly assigned to the MSCs. Therefore cell assignment problems, consists of finding an optimal topology that assigns each BS to an MSC, remains challenging and classified as NP-hard.

The design of Universal Mobile Telecommunications service (UMTS) networks involves optimizing a number of network configuration parameters in order to meet various service and performance requirements. UMTS support third generation services and consists of access network and core network. The access network, called as UMTS terrestrial radio access network, controls the radio resources within the network and can interface with one or more stations (node Bs) [3]. Access network consist node of two types Radio network controller (ENC) and a base station B. the air interface face used between the user equipment and UTRAN is wide-band code division multiple access. The UTRAN communicate with the core network over the Iu interface comprise Iu-PS and Iu CS. Iu PS interface is for Packet Switch services and Iu CS interface is for a circuit Switch services. In the core network, Mobile switching centers are

responsible for the CS location management and also store CS location information, whereas serving general packet radio service (GPRS) support node (SGSN) assume the PS location management [4]. The home location register, a common location information database for both the domains, contains the network subscriber's profiles. The gateway GPRS support node links a UMTS network and a public switched telephone network.

A personal communication services (PCS) network such as a UMTS is a wireless communication network that integrates various services such as voice, video and electric mail, which are accessible from a single mobile terminal and for which subscribers obtain a single invoice[3]. These various services are provided in cover zone

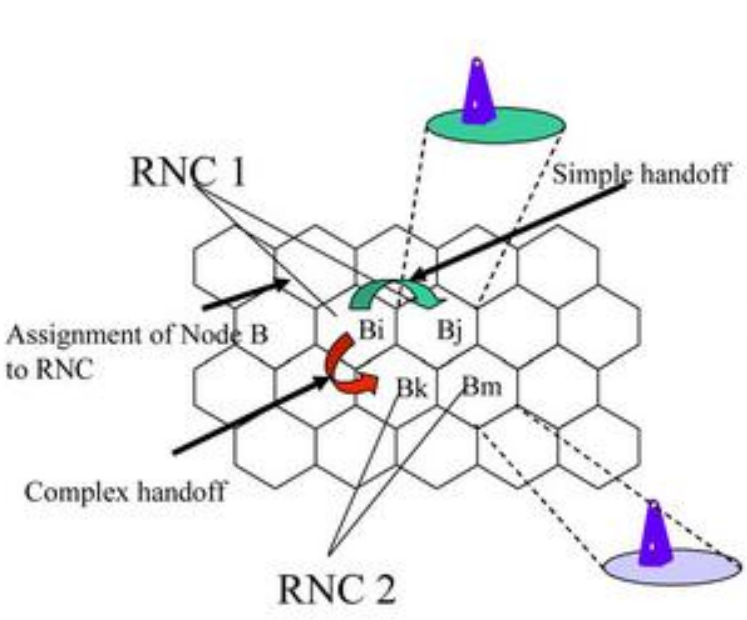

Figure 1 Geographical division in cellular network

areas that are divided in Bs, which manage all the communications within the cell. In the cover zone Bs are connected to special units called RNCs. Mobility of a user is managed by handoff. When a user's communication switches from one node to another, the new node becomes responsible for relaying this communication through the allocation of new radio channel for the user. Supporting the transfer of communication from one node to another is called handoff. This mechanism, which primarily involves the RNCs, occurs when the level of signal received by the user reaches a certain threshold. There are two types of hand off simple and complex as shown in figure 1. A movement where a user moves from node B_i to B_j is referred to as soft handoff because these two nodes are connected to the same RNC [5]. On the other hand, a case where the user moved from B_i to node B_k is considered as a complex handoff. The cost associated to this concept is superior, as both RNCs 1 and 2 remain active during the handoff procedure and the database contains the subscribers information requires an update.

III. DESIGN PROBLEMS

The pressure to reduce costs adds new urgency to the search for optimized networks which can minimize the cost of required facilities while satisfying a set of predetermined constraints. Typically, the design of cellular networks requires:

- the analysis of radio-wave propagation and/or the field topology to identify a set of optimal base stations (BSC) locations;
- the subset of locations (network nodes) as hubs having minimum-cost where the traffic is to be aggregated and switched[5];
- the cell-to-switch assignment while taking into account a certain number of constraints including capacity constraints, routing-diversity to assure reliability, handoffs frequency, and so on;
- the selection of the type of links between the nodes or network elements (BTS, BSC, MSC).

  Hybrid search strategy basicly composed of three phases: 1) constraint satisfaction method with an embedded problem specific goal to guide the search for an acceptable initial solution; 2) an optimization phase using local search algorithm such as tabu search,SA [6]; 3) a post optimization phase to improve the solution generated by second phase.

IV. GENETIC APPROACH

A. Basic principle of genetic algorithm

An optimization problem can usually also be modelled as a search problem, since searching for the optimum solution from among the solution space [7]. Without any loss of generality, assuming that our optimization problems are of the

minimization category. Genetic algorithm (GA) refers to a technique of parameter search based on the procedure of natural genetics in order to find solution to optimization and search problem. It combines the principle of the survival of the fittest, with a random, yet structured information exchange among a population of artificial chromosomes [8]. A chromosome contains a group of numbers that completely specifies a candidate solution during the optimization process. The individuals with higher fitness values will survive and will be selected to produce a better generation, while the individuals with lower fitness values will be eliminated. Therefore, GA simulates the survival of the fittest among a population of artificial chromosome and it normally stops when the number of generation specified is met or there is no change in maximum fitness value.

B. Memetic approach

Procedure for memetic algorithm is same as simple genetic algorithm except that a local search method is implemented in one of the operation to exploit the search space [9]. Simple GA represents an intelligent exploration, having a random search confined within a defined search space for solving a problem optimally. Diversity helps in finding the optimal solution. The time needed to reach the global optimum can be reduced if local search methods and local knowledge are used to accelerate locating the most promising region in addition to locating the global optimum starting within basin of attraction [10]. Meta heuristic search mechanism in the memetic algorithm offers the speed and quality of convergence. Due to the similarities in the role of the local search within the genetic search and the role of learning within the evolution process, the local search is usually viewed as a learning process. According to the hybrid theory, solving an optimization problem and reaching a solution of desired quality can be attained in one of two ways. 1) the global search method alone reaches the solution 2) the global search method guides the search to the basin of attraction from where the local search method can continue to lead to the desired solution.

A move operation would probably shuffle a couple of positions in the original solution.To avoid getting stuck in local minima we adopt a random-restart hill-climbing. Random initial states are generated, running each until it halts or makes no discernible progress. The best result is then chosen. Hill climbing is often used when a good heuristic function is available for evaluating states but when no other useful knowledge is available [11]. It produces a better result than other algorithms when the amount of time available to perform a search is limited, such as with real-time systems. These improvements accumulate over all the generations, resulting in a larger improvement in the total performance. Genetic algorithm and local search have complementary properties [12], which helps in optimization of objective function with fast convergence.

In assignment problem, the objective function is minimization of link cost between a cell and a switch [13], which is prelude by two ingredients. First, whether the cells are connected to single or dual switch. In single homed network of cells, each communicating cell is connected to only one switch whereas in dual homed network the each cell is connected to two different switches. Second, whether simple or complex call handoff [4]. Optimization problems arising during the various phases of network life cycle differ not only in their objectives but also in the set of design parameters and the level of details with which they deal. Mean site to site distances, site locations, sectorization, antenna type and antenna heights are usually addressed in dimensioning phase.

V. Conclusion and Future work

GAs is robust search techniques based on Darwin's concept of natural selection and genetic mechanisms. The memetic algorithm ability depends on the way of utilizing the information from both the searching mechanism i.e. genetic algorithm and local search. Simulated annealing is efficiently used to solve the problem in second generation and also estimate the solution of very large combinatorial optimization problems. After executing the Memetic algorithm on cellular network problems, it was concluded that it gives better result in terms of accuracy as compare to SA and Tabu search. Presence of many local optima makes the GA slower but steepest desent methods have unlikely ability of escaping from local minima. Although SA delivers accurate result in medium size problems. Memetic algorithm can somehow reduce its greediness by either not using elitist replacement strategies or by exploiting operators that can lead to deteriorated points from which progress can be achieved at a later stage of the search.

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