Extended Cell Planning for Capacity Expansion and Power Optimization by Using MEMETIC Algorithm

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ABSTRACT

In the current era of cellular world, cell planning plays an important role to achieve better performance of the cellular network. Capacity expansion and cost optimization of a newly activated base station by placing it at an optimized location is one of the primary objectives of the current manuscript. The locations of the new as well as the existing base stations are directly correlated to the required capacity demand and the power of the received signal at the base station which becomes the sensitive parameter for the cell planning. Therefore, cell planning is to be modeled to optimize the location of the base stations in the form of a linear programming problem. Further, the MEMETIC algorithm has to be used for the optimization of the multi-objectives of the scenario. The simulated results show that there is a significant enhancement in the capacity of the base stations (1% to 5%) as compared with the orientation of base stations achieved by random deployment.

Keywords: Capacity Expansion, Cell Placement, Cell Planning, Linear Programming, MEMETIC Algorithm (MA), Power Optimization

INTRODUCTION

In today’s era of dense cellular devices mobility is not the constraints as they are free to move not only in plains but also in topographical terrains or the areas where the situations are not favorable for the signal processing. In such type of conditions there might be different problems like Path Loss, Shadowing, and Reduced Cellular Coverage Area. To overcome such problems it is required to formulate cell planning for better performance. Cell Planning in a network of

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base stations to provide the required coverage of the service area with respect to current and future traffic requirements, available capacities, interference, and the desired QoS.

Surface-level path loss has been studied by (Chong & Daeyoung, 2013) and explained it by the fading effects of spatial small-scale area as a Rician Distribution with a distance-dependent K-factor. They also proposed a semi-empirical path loss model for outdoor surface-level wireless sensor networks called the Surface-Level Irregular Terrain (SLIT) model.

Several nonlinear optimization algorithms are discussed to enhance the coverage area in heavy capacity demand with small number of base stations. Optimization methods are discussed by (Wright, 1998) for base station placement in wireless applications by direct search methods to handle the nonlinearity of the system behavior. Abdulla and Shayan (2009) derived a generic close-form expression for the path-loss distribution density between a base-station and a mobile. Phaiboon and Somkuarmpanit (2006) investigated how tree density affected path loss-distance and the fast fading characteristic depends on base tree size and base station antenna height in a range of 3, 4, and 5 m above ground. Erceg, Greenstein, Tjandra, Parkoff, Gupta, Kulic, Julius, and Bianchi (1999) presented a statistical path loss model for 1.9-GHz wireless systems in suburban environments and conclude that the path loss it predicts can be either the local mean (time-averaged) value for a mobile system or the broadband (frequency-averaged) value for a fixed system. Ohira, Hirai, Tomisato, and Hata (2012) proposed a mobile path loss estimation models for small cell area on a sloping terrain and compared with some of the already established models. Sadek, Zhu Han, and Liu (2007) proposed a bandwidth efficient cooperation protocol which uses a BS-controlled relay-assignment algorithm to assign cooperating users to extend coverage area in cellular networks.

In most of the optimization the location of the base station is considered as an important factor to be enhanced but they consider that all the base stations are activated at the same time which leads for more power consumption. In the current manuscript two different types of base stations are to be considered, first those are in active phase and second, those are in passive phase and likely to be activated as the capacity demand is going to be increased. In this way the base stations can be having a mechanism to change their phase as per the demand and save the power as the passive base stations will consume less power. As the base stations are changing the phases hence the location will become the significant one for the coverage area and capacity. Therefore, the coverage area and capacity of the newly active base station with its optimized location has to be determined.

Rest of the paper is further organized into six more sections. The next section is devoted to understand the behavior of the base station with respect to its capacity and power. The section following discussed the detail modeling of the linear programming model for cell planning by the authors. The section after that provides the overview about the multi-objective optimization algorithm i.e. MEMETIC algorithm. Following that is a section which shows the proposed usage of MEMETIC algorithm for cell planning and the last section provides the simulated results of the whole work.

BEHAVIOR OF BASE STATION WRT CAPACITY AND POWER

In the cellular world the major problem is of frequency reuse and it is handled by restricting the radio range of Base Station (transmitter) up to a specific area known as coverage area of it. The cellular network works with the principle of coverage area with cell reuse pattern (cluster). In the cluster there are n (4, 7, 9 etc.) number of cells and each of them works on a different frequency. Beyond the cluster these frequencies can be reused and leads to increase the capacity in terms to handle more number of simultaneous calls. Most of the currently deployed cells are hexagonal shape and the base station is to be located in the middle. The radius of cell is governed by power of Base Station and hence increasing the power increases geographical

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