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Cell size determination in WCDMA systems using an evolutionary programming approach☆

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Abstract

This paper deals with the problem of the cell size determination in WCDMA-based mobile networks, in multiservice environments. The objective is to obtain the maximum cell size, given a set of services with their corresponding constraints, in terms of quality of service (QoS), binary rate, etc. To achieve this, we have to find the optimal services' load factors which maximizes the cell radius of the system under traffic criteria. We apply an evolutionary programming algorithm to solve the problem, which codifies and evolves the services' load factors. We have compared our approach with an existing algorithm in several multiservice scenarios, improving its solutions in terms of cell size.

Keywords: Mobile networks; Dimensioning; WCDMA systems; Evolutionary programming

1. Introduction

A classical problem in mobile network dimensioning is cell size determination [1]. It is a critical issue in mobile network strategic planning policies, since an underestimation of the cell size may result in a cost increment (more base stations are needed for covering a given area), whereas an overestimation of the cell radius may produce a lack of coverage, with the corresponding dissatisfaction of customers.

In most of second generation (2G) mobile networks, like GSM, IS-54 or JDC, cell radius is mainly limited by the coverage, due to the *hard blocking* feature of these systems [2]. Furthermore, capacity planning in 2G mobile networks is performed considering mainly the voice service. However, due to new packet technology like general packet radio system (GPRS), multiservice traffic capacity studies in 2G mobile networks are getting larger relevance [3]. Anyway, in 2G mobile systems, capacity planning can be considered as independent from the coverage planning, and the capacity of the system can be increased by adding more equipment in the base station.

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In 3G mobile networks, the situation is different. In these networks there is a tight relation between coverage and capacity planning (cell size determination), mainly in systems based on code division multiple access (CDMA) or wideband code division multiple access (WCDMA) [1]. Moreover, 3G networks are designed as multiservice systems, which increase the planning complexity. Thus, the calculation of the cell size in 3G (WCDMA) mobile networks is a much more complex problem than in 2G.

Cell size calculation in WCDMA systems has been studied before [4–6]. Most of the models considered in these approaches only consider a single service, which may result in a non-accurate estimation of the cell radius in multiservice environments. In addition, the studies of multiservice environments are usually based on simulation [7]. Simulation-based methods have several disadvantages when are used in strategic mobile network dimensioning. First, they require a large number of data for a given area, that sometimes is not available. Secondly, they are focused in the study of a particular small area, whereas strategic mobile network planning needs the study of large regions. Thus, it would be interesting to have an algorithm which can be applied to mobile network dimensioning. A nature-inspired or emerging algorithm can be a good option to solve this problem.

We propose an evolutionary approach to the cell size determination problem. Our approach uses an encoding of the capacity assignment for each service, which is evolved using the cell size as objective function to be maximize. The objective is therefore to obtain the optimal capacity assignment for each service, which provides the maximum cell size. The cell size determination problem includes a main constraint: the total capacity of the system (calculated as the sum of the capacity assignments for each service) must be less than a parameter $\eta < 1$. The parameter η is known as the *total load factor* of the system. This constraint makes that the classical evolutionary programming (EP) approach [8,9] is not directly applicable to solve the problem. In this paper we propose several modifications to the EP in order to solve the cell size determination problem in WCDMA multiservices scenarios.

The rest of the paper is structured as follows: next section defines the cell size determination problem in WCDMA networks. In Section 3 we propose the evolutionary heuristic for solving the problem, and in Section 5 we show the performance of the proposed algorithm by solving some experiments in WCDMA multiservice scenarios. Section 6 concludes the paper giving some final remarks.

2. Cell size determination in WCDMA networks

Let us consider a 3G mobile access network based on WCDMA technology (Fig. 1) where the mobile operator provides a set of S services (voice, data 16 kbs, data 64 kbs, etc.) each one defined by a set of parameters P (binary rate, user density, quality of service, etc.). The operator must be provided with a first estimation of the number of base stations (cells) required to provide coverage in the area under study. In order to obtain this, a good estimation of the cell size of each cell must be achieved.

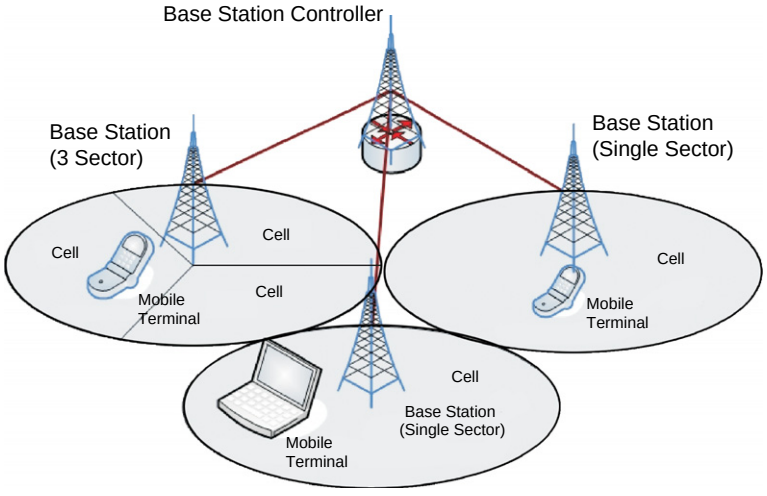

Fig. 1. Example of the architecture of the access network.