SIMULATED ANNEALING APPLIED TO THE FREQUENCY ASSIGNMENT PROBLEM USING NONBINARY CONSTRAINTS,

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Abstract:

In the last years there has been a tremendous increase in the demand of mobile radio communication services. The third generation (3G) mobile systems with the capability to transfer voice, data, video, etc. are being deployed and will operate simultaneously with the previous 2G and 2.5G systems. The radio access network (RAN) of 3G systems will be completely different to previous mobile systems such as GSM, which is based on TDMA. However, the GSM RAN will be in use and under development even after the introduction of 3G systems [1]. This means that there will be a common core network (CN) but two independent radio access networks for 3G and for GSM systems. In order to accommodate this increasing demand of spectrum in GSM systems, a better frequency assignment (FA) planning is required. The frequency assignment problem (FAP) is usually represented as a constraint satisfaction problem (CSP) assuming a regular hexagonal network layout and binary constraints between pairs of transmitters (TXs) that have the following form:(1)where and are the frequencies assigned to TXs i and j, respectively, and g is a positive integer. However, it has been demonstrated that binary constraints might lose important elements of the original problem, which produces solutions that are not necessarily the best ones [2]. The use of nonbinary constraints such as maximizing the carrier-to-interference ratio (CIR) over all points of the coverage region is a more appropriate representation of the FAP that produces better results. This approach was used to solve the FAP using a heuristic sequential algorithm in [3].
Nevertheless, sequential algorithms assume the existence of an infinite set of available channels to minimize the assignment span, i.e. the difference between the lowest and highest used channels. But in the problem of already operating systems we deal with a fixed number of available channels, and one should satisfy all the channel requirements even if an excess of interference must be tolerated. In order to provide FA plans with a fixed spectrum minimizing the excessive interference that might arise, we propose a metaheuristic algorithm based on simulated annealing (SA). This algorithm minimizes a cost function that has the following form: (2) where , , and  account for cosite, cochannel, and adjacent channel interference, respectively, and a, b, and c are weighting coefficients. This algorithm defines an initial configuration of N base stations, each one with m number of channel requirements that might be assigned from a total number of M available channels. The algorithm changes systematically this configuration and evaluates the cost function in every change until it reaches its minimum value or a predefined criterion halts the process. For the evaluation of interference we take into account real urban propagation phenomena and the fact that the cells might have different sizes and even irregular shape, which is closer to real operating systems. The final paper version and the presentation will include detailed explanations of the implementation and operation of the SA algorithm, the representation

of different configurations, and the computation of the cost function as well as the interference models we used. Finally, a practical example using a real GSM system will be presented.

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