Chapter 1

MODELLING
FEASIBLE NETWORK CONFIGURATIONS
FOR UMTS *

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Abstract  Telecommunications operators worldwide are facing the challenge of deploying UMTS. These networks have to meet consumers’ expectations, tight budget constraints and governmental regulations. The careful dimensioning of the radio access infrastructure plays an essential role in achieving these goals.

This paper presents an optimisation model for selecting well-tuned base station locations and configurations. The mixed integer programming model reflects the overall design problem fairly accurately. The interference limitations for successful up- and downlink transmissions, the need for sufficiently strong (cell) pilot signals, the limited downlink code capacity in each cell and the potential gain for mobiles from being in soft(er) hand-over are taken into account. This comprehensive model can be used as a core for refined UMTS planning tools.

Keywords: UMTS, radio interface, network planning, configuration, perfect power control, mixed integer programming, MOMENTUM, IST-2000-28088

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1. Introduction

Dimensioning the radio interface between the users' mobile equipment and the network operator's fixed infrastructure is a key step during the initial deployment of an UMTS network and its subsequent expansions. The careful configuration of this interface is of vital importance to the network operator. The radio interface determines the coverage and capacity of the provided services, and it accounts for a major portion of the total network installation and maintenance costs. The layout decisions for the UMTS radio interface are driven by the capabilities of the mobile services that an operator intends to offer. The challenge of finding a suitable layout for the UMTS base stations can be phrased as follows: select locations for the base stations from the set of possible sites and determine the configuration of the cells hosted at each location such that the desired services can be offered and the budget restrictions are met.

The project "Models and Simulations for Network Planning and Control of UMTS" (MOMENTUM, cf. http://momentum.zib.de) addresses this challenge at several levels. MOMENTUM characterises new services UMTS is going to deliver, builds usage profiles and planning scenarios to model the future demands, develops flexible models, algorithms, and new simulation as well as evaluation approaches for the optimised configuration of the new wireless telecommunication infrastructure. The project is performed within the fifth European Framework Programme focusing on Information Society Technologies (IST). This article introduces a rather comprehensive mixed integer linear programming model for optimising the layout of an UMTS radio network.

The article is organised as follows. The next section introduces several of the challenges embodied in UMTS radio network planning and explains how the mathematical programming model can help to face them. This is followed by an extensive survey on (mostly) Operations Research literature dealing with UMTS radio network planning in a broad sense. Sections 4, 5 and 6 develop the model, starting from the input parameters over a comprehensive set of limiting constraints to the objective function. The concluding Section 7 contains a roadmap for further developments on the way to implementing this model in UMTS planning practice.

2. Model Scope

We describe a mathematical programming model for the automatic planning and optimisation of the radio network interface. The focus is on the "static" installation of radio base stations. The following questions are addressed:

- which of the candidate sites shall be used to erect base stations
- what sectorisation shall be used at each selected site