Abstract

This thesis studies the dimensioning for UMTS Radio Access Networks. In this thesis, dimensioning is investigated with specific focus on the transport network of the Iub interface, which connects the Node B with the RNC. This interface is considered as one of the most important economic factors for the UMTS network dimensioning. In order to cover large urban and rural areas, a large number of Node Bs are required and thus the transport resources for the Iub interface become considerably costly. The ultimate goal of this thesis is to investigate important aspects related to the UMTS radio access network dimensioning, and to propose novel analytical methods to provide suitable estimations on the required transport capacity for the UMTS radio access network in order to achieve maximum utilization of the transport resources.

In order to provide a comprehensive investigation on the dimensioning of the Iub interface, various traffic types, different evolutions of UMTS radio access networks as well as different transport solutions, QoS mechanisms and network topologies are studied in this thesis. In the framework of this thesis, UMTS Rel99 is considered as the basic UMTS network. Furthermore, evolved UMTS networks such as HSDPA and HSUPA, and the evolved transport from ATM to IP are investigated. For each evolution of the UMTS radio access network, its specific protocol stacks, important features, its specific traffic- and resource control functions and their impacts on the Iub dimensioning are studied.

For the dimensioning process, two basic types of traffic are distinguished, elastic and circuit-switched traffic. They are associated with non real time data applications and delay-sensitive real time services, which are identified as the two main traffic classes served in the current UMTS networks. The fundamental property of elastic traffic is its rate adaptability, which is caused by the feedback mechanism of TCP. In this thesis, the theory of processor sharing is applied to the dimensioning of the Iub interface for elastic traffic for satisfying its desired end-to-end application QoS. To consider the specific UMTS functions and network structures, the basic processor sharing model has been significantly extended in this thesis to dimension the radio access networks under various scenarios of traffic, QoS framework, resource control functions, different transport technologies and network structures. In case of circuit-switched traffic, which needs to meet a guaranteed blocking probability, the classical Erlang models are applied. In addition, a number of queuing models are proposed in this thesis to dimension the Iub link for guaranteeing a required transport network QoS.

For validating the developed analytical models as well as for performance evaluation, several simulation models were developed in this thesis to model different UMTS radio

access networks. By performing extensive simulations and analysis of the simulation results, important dimensioning rules are derived and the proposed analytical dimensioning models are demonstrated. Through validating with simulation results, it is demonstrated that the proposed analytical models in this thesis are able to capture relevant characteristics and provide accurate dimensioning results, and thus can be applied for UMTS radio access network dimensioning. At the end, a dimensioning tool is developped in this thesis, containing all developed analytical models. This tool can perform dimensioning for various traffic scenarios, transport solutions, QoS mechanisms and network topologies for different UMTS radio access networks. Overall, the investigations and the analytical dimensioning models presented in this thesis can help network service providers to optimize their network infrastructure to reduce costs while still being able to provide the desired quality of service.