4 Framework of UMTS Network Dimensioning

This chapter provides an overview of dimensioning issues in the UMTS radio access network, which arises in planning and operation of UMTS networks. At first, the main objectives of the UMTS network dimensioning are defined. Then various important aspects which need to be particularly considered in the dimensioning process are addressed. Based on that, a general framework for UMTS network dimensioning is proposed in this thesis and the corresponding dimensioning procedure is presented. At last an overview of the dimensioning approaches used in this thesis is given.

4.1 Objectives of UMTS Network Dimensioning

In order to perform network dimensioning, a clear objective is necessary. In the framework of this thesis, cost and quality of service are the main objectives for dimensioning processes within the context of network planning and operation. The ultimate goal of network dimensioning is to minimize the cost while maximizing QoS. However, these two factors are usually negatively correlated, and thereby the service provider has to find a right balance and tradeoff between them.

4.1.1 Network Costs

Normally the network costs have two main categories: the expenditures associated with building a network and with running it. In this thesis, the network cost only considers the cost for leasing link bandwidths. For a given transport technology, usually the higher the link capacity, the higher is the network cost.

4.1.2 Quality of Service

The European Telecommunications Standards Institute (ETSI) and the International Telecommunications Union (ITU) define QoS as the quality perceived by the end user [ITU93]. The IETF network working group provides a more concrete definition where QoS is defined as the service requirements that need to be met by the network while transporting a traffic flow [CNRS98]. In this thesis, the term quality of service (QoS) is used based on the
latter definition by the IETF. In the framework of this thesis, various QoS measures are taken into consideration for the UMTS network dimensioning and they are categorized into flow-based and network-based QoS measures. For further reference, they are called user-relevant QoS and network-relevant QoS (also called network performance) throughout this thesis. In the following paragraphs, the relevant measures for the quality perceived by the user as well as for network performance are presented.

4.1.2.1 User-Relevant QoS

User-relevant QoS refers to the QoS related to the individual user flow. From a user’s perspective, typically user-relevant QoS criteria are application delay, throughput and delay jitter. If Connection Admission Control (CAC) algorithms are applied in the network, connection reject ratio (also referred to as blocking probability) is another important QoS aspect.

**Application Delay** The end-to-end application delay is defined as the total time of transferring a file (the data transaction is completed only after the last packet is received) or an individual application packet like a voice packet from the source to the destination. In addition to the delay for transmitting the entire data from the source to the destination, it may also include the extra time for setting up and releasing the transport connection, the possible retransmissions due to packet losses, and the delays caused by traffic shaping, flow control or congestion control from transport protocols like TCP or network functions.

**Application Throughput** Application throughput indicates the transaction speed, i.e. how long it takes to transfer a certain amount of data. It is directly related to the application delay and the volume of corresponding data transaction. The throughput is usually measured in bit per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

**Application Delay Jitter** Application delay jitter refers to the variance of individual delay values. It is measured as the difference between the largest and smallest end-to-end delay. This QoS is mainly important for real-time traffic such as streaming audio or video.

**Connection Reject Ratio** As introduced in section 3.3.4.3, CAC algorithms are used to decide whether an incoming connection request should be accepted or rejected in a network in order to maintain the guaranteed QoS for the end users and networks. Connection reject ratio refers to the ratio of rejected connections to the total number of requested connections in the system. It is mainly used for reservation based services.

In the outline of this thesis, the user-relevant QoS is regarded as the main objective for the UMTS network dimensioning. The considered user-relevant QoS is the end-to-end application delay or throughput for the elastic traffic and connection reject ratio for the circuit-switched traffic.