Chapter 1
Planning and Dimensioning of the 3G UMTS Core Networks

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ABSTRACT
The current literature provides many practical tools or theoretical methods to design, plan, and dimension Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) radio networks, but overlooks the algorithms of the network planning and dimensioning for core networks of GSM, UMTS, and IP Multimedia Subsystem (IMS). This chapter introduces an algorithm for traffic, bandwidth, and throughput dimensioning of the network entities in the UMTS core network. The analysis is based on the traffic and throughput generated or absorbed in the interfaces of the network entities in the UMTS core network. Finally a case study is provided to verify the algorithms created for UMTS core network. This chapter is aimed at helping UMTS network operators dimension an optimum network size and build an optimum network structure to deliver an optimum quality of service for users. The algorithms developed in the chapter have been successfully applied in dimensioning a nationwide UMTS network in North Africa and adopted in an optimization tool by a mobile operator in the United States in 2008-09.

INTRODUCTION OF THE UMTS NETWORKS
Rapid changes in mobile telecommunications have always been evolutionary, and the deployment of UMTS to Long Term Evolution (LTE) will be the same. It will be a transition from third generation (3G) to 4G over a period of several years, as is the case still with the transition from 2G to 3G. As a result, mobile operators must find algorithms and rules that will dimension their emerging 3G networks, while addressing their potential 4G deployment requirements and will not require a “forklift” upgrade.

Radio access solutions are a primary concern of the UMTS deployment strategy, as it impacts the
mobile operators’ most valued asset: spectrum. As an equally important part of this equation, the core network will play an essential role in enhancing mobility, service control, efficient use of network resources and a seamless migration from 2G/3G to 4G. Hence, the network evolution calls for a transition to a “flat,” all-IP core network with a simplified architecture and open interfaces.

As mobile operators evolve their networks to UMTS or even LTE, they will try to minimize cost and maximize subscriber usage. Therefore, a new problem appears: how to correctly plan and dimension the emerging UMTS Core Networks (CN) with a new flat and all-IP structure to avoid configuring unnecessary network resources and maintaining high Quality of Service (QoS) to subscribers? Meanwhile, the dimensioning algorithms for UMTS CN should be significantly differentiated from the traditional design philosophy for Circuit Switched (CS) and Time Division Multiplexing (TDM) networks such as 2G GSM and CDMA networks.

In order to accurately plan, design, and dimension the UMTS CN, this paper will develop the algorithms of traffic and throughput for the UMTS CN Network Entities (NEs) described in Section 3. The analysis will be based on the live traffic and throughput generated or absorbed in the interfaces of CN NEs. Our approach provides the mobile operators with a capability to assess and plan their capacity requirements independent of any particular vendor product. This vendor neutrality is further discussed later in the paper. A case study is provided to verify the algorithms created for UMTS CN. This paper is aimed at helping UMTS network operators dimension an optimum network size and build an optimum network structure to deliver an optimum quality of service for users.

In addition, the network optimization and expansion is the further effort for the mobile operator after the rolling out of mobile networks. To minimize the CAPEX/OPEX and maintain the QoS of mobile core networks, we propose that the impact of cell site re-homing on the mobile core should be studied. It is believed that the appropriate cell site re-homing in radio domain, via correct algorithms applied, not only optimizes the radio network but also helps improve the QoS of the core network and minimize the mobile operator’s CAPEX/OPEX investment in their core networks.

The rest of the article is organized as follows: Section 2 summarizes the literature in the related area and the challenges in dimensioning core networks. Section 3 introduces the architecture of the UMTS network and in particular the key network entities in UMTS. Section 4 which is the core of the paper discusses the algorithms for traffic and throughput in those interfaces of UMTS CN networks such as Iu-CS, Iu-PS, Nb, Mc, and Me interface. Section 5 provides two case studies to illustrate application of the algorithms created in Section 4 for Iu-CS and Iu-PS interfaces. Section 6 is the conclusion to the paper.

**LITERATURE REVIEW**

The current literature provides many practical tools or theoretical methods to design, plan and dimension GSM and UMTS radio networks but overlooks the algorithms for planning and dimensioning of core networks of GSM, UMTS and IMS. No previous literature provides a unified approach to calculate the throughput or traffic of the UMTS core network. Very few studies have addressed the mobile core network planning and dimensioning topic. This is because that the core network in either logical or physical structure is more complicated than the radio access network and the internal throughput or traffic may vary from different vendors’ NEs.

Neruda, M. and Bestak, R. (2008) summarizes the evolution path from GSM, UMTS to IMS from the aspect of network entities so that service providers will be able to progressively migrate from GSM to UMTS and IMS. Shalak, R. et al (2004) make a qualitative study of the
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