A Dimensioning Study for UMTS Core Networks

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ABSTRACT

Current literature provides many practical tools and 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 network planning and dimensioning for core networks of GSM, UMTS and IP Multimedia Subsystem (IMS). This paper introduces an algorithm for traffic, bandwidth and throughput dimensioning of the network entities in the UMTS core network, based on the traffic and throughput generated or absorbed in the interfaces of the network entities. A case study is provided to verify the algorithms created for UMTS core network. This paper helps UMTS network operators dimension and build an optimum network to deliver the best quality of service for users. The algorithms developed in the paper 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 2008-2009.

Keywords: Circuit Switch, Core Network, Network Dimension, Network Plan, Network Throughput, Packet Switch, UMTS

INTRODUCTION

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

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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). 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: the literature in the related area and the challenges in dimensioning core networks are summarized. The architecture of the UMTS network and in particular the key network entities in UMTS is then introduced. The core of the paper discusses the algorithms for traffic and throughput in those interfaces of UMTS CN networks like Iu-CS, Iu-PS, Nb, Mc, and Mc interface. Two case studies are given to illustrate application of the algorithms created for Iu-CS and Iu-PS interfaces.

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 and Bestak (2008) summarize 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 et al. (2004) make a qualitative study of the performance of UMTS core network, in which equipment of multiple vendors of UMTS CN is compared. Harmatos (2002) proposes a model to plan UMTS core network based on the requirements for the radio access network. The model also considers the premise of planning work in cost minimization, which helps mobile operators minimize Capital Expenditure (CAPEX). Because of the complexity of these networks, Harmatos (2002) divided the problem into two parts. First, he finds the location of Media Gateways and a reasonable topology using a linear cost function. In the second part, he uses the real cost function (step function) in order to reduce the cost of the network. Britvic (2004) specifies the strategic steps to plan and deploy the UMTS radio network, the core network, and the access transport network. Previous studies have provided many solutions to plan, dimen-
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