Chapter II
Radio Resource Management Strategies for HSDPA–Enhanced UMTS Networks

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ABSTRACT

This chapter gives an overview of the background and functionality of the high speed downlink packet access (HSDPA), and provides insights into the radio resource management of integrated UMTS/HSDPA networks. The high speed downlink packet access (HSDPA) is part of the evolution of the universal mobile telecommunication system (UMTS). It is often referred to as 3.5G system, in contrast to UMTS, which is a third generation system. The authors introduce aspects of radio resource management specific to the HSDPA like channel-aware scheduling and radio resource sharing strategies. Furthermore, the impact of radio resource management on the quality of service is analyzed and it is shown that the selection of an RRM strategy is an integral part of the network planning and deployment process

INTRODUCTION TO THE HIGH SPEED DOWNLINK PACKET ACCESS

The high speed downlink packet access (HSDPA) is part of the evolution of the universal mobile telecommunication system (UMTS). It is often referred to as 3.5G system, in contrast to UMTS, which is a third generation (3G) system. This chapter gives an overview of the background and functionality of HSDPA, and provides insights into the radio resource management (RRM) of integrated UMTS/HSDPA networks. The general goal of RRM is to provide the user with a certain quality of service (QoS), and selecting an RRM

strategy is thus an integral part of the network planning and deployment process.

Background

The development of HSDPA was initiated as response to an increasing demand for high-speed mobile Internet access. In standard UMTS (as in Release '99), Internet access is realized by using dedicated channels (DCH). However, DCH radio bearers have limitations in data rate, packet latency, and resource efficiency. The maximum data rate of a DCH connection in macro-cells is 384 kbps with a one-way latency from UE to the gateway GPRS support node (GGSN), which is the gateway to the Internet, of about 100 ms (Cano-Garcia, Gonzalez-Parada, & Casilari, 2006). HSDPA enables data rates of several megabits per seconds with packet latencies of 60 to 70 ms. From the viewpoint of the providers the use of 384 kbps DCH radio bearers is problematic since they require a large amount of code resources, such that at maximum only seven 384 kbps bearers are possible in one sector if no other connections are present. With HSDPA, this limitation is avoided by using a shared channel for all HSDPA users per sector. Figure 1 illustrates the code occupancy time for "bursty" data traffic like web browsing where short times of activity are alternating with

long "idle" times, the so-called reading time. DCH connections occupy the channelization code during the lifetime of the DCH radio bearer, which is terminated only if the release timer expires--which is normally set to several tens of seconds. With HSDPA, the channelization codes are occupied only during the user activity phases.

HSDPA was first specified by the 3rd Generation Partnership Program (3GPP) in March 2002 with UMTS Release 5. Four years later at the beginning of 2006 the first HSDPA-enhanced UMTS networks were launched. The specifications define several expansion stages, which are reflected by the capabilities of the terminals. In the first deployment phase, the maximum throughput is 1.8 Mbps and 3.6 Mbps, which corresponds to UE category 11 with QPSK modulation and UE category 3 with 16QAM and a minimum scheduling interval of 2 TTIs (frames). In later phases up to 12.8 Mbps with 16 QAM will be possible, although such high bitrates require good radio conditions.

Early HSDPA-capable terminals (or user equipments (UE) in 3GPP-terminology) were mostly data cards intended for laptops, but now a wide variety of terminals are available, from small smart phones to stationary devices built as substitute for DSL modems. The increasing number of HSDPA terminals and networks is an

Figure 1. Channelization code occupation with DCH and HSDPA
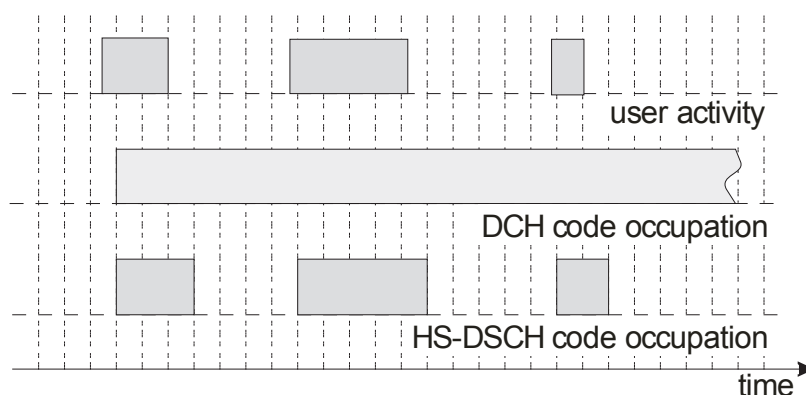
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