Chapter 5
Charging in Mobile Telecommunication Networks

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ABSTRACT
The tariff packages in the mobile telecommunication industry got more and more complex in the last few years. The telecommunication companies have introduced several different services along with different discounts and allowances. The price calculation of the services and the understanding of prices became harder for the subscribers. This chapter describes the basic architecture and the major flows of a billing system in the telecommunication area. It introduces a novel concept for price calculation, which could aid the Advance of Charge and Income Prediction functionalities.

INTRODUCTION
The technological evolution and the market competition of the telecommunication industry lead to the change of approach in the price calculation of the different services in the last decade. At the very beginning, the price of the mobile telecommunication service depended mainly only on the time of the call, the called party and the duration of the call. The latter was a simple linear component in the price calculation. Nowadays, the available tariff packages are much more complex. The new, advanced technologies brought new dimensions in services and in measurable units; volume or quality for example. Currently, the price of the service depends on a lot of parameters, such as the called party, the calling party, the accumulated service consumption in the current billing period, the delivered services, the type of the customer, the duration of the call and many others. Not even mentioning the different allowances and discounts that can be purchased separately or can be bundled with other services. The tariff packages are so complex, that it is actually hard to compare them to one another.

Since the legacy charging systems of the network operators are mostly unable to handle the large variety of new services and discounts,
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these systems need to be updated, revised or exchanged. From the billing system point of view, there are several possible solutions to keep up with the market driven evolution of complexity (Schwartz, 2003). One is to keep the old, legacy billing system and try to squeeze the complex (ever changing) pricing mechanism into it. Another one is to redesign the whole system, and take the new circumstances and the new marketing approaches into consideration. Of course, there are several companies (like Amdocs, Siemens or Ericsson) that are selling their own solutions / products for this problem (Johnson, 2005). These new, off-the-shelf billing systems are quite flexible, and provide the possibility to the mobile network operators to develop almost any marketing driven price calculation with minimal manual work. Sadly, this flexibility does not necessarily come together with a suitable mathematical model, and does not provide the possibility to do extra calculations with the tariff packages.

The huge number of available functions and the standardized interfaces of UMTS give the possibilities to 3rd party providers to use the infrastructure of the telecommunication system, and offer value-added services to the subscribers (UMTS forum, 2002). Because these providers are financially isolated from the network operator, and because of the continuous growth of the number of pre-paid services and subscribers, an accurate and fast (or real-time) charging mechanism is indispensable.

The following sections describe the corresponding standards and the basic architecture and functionalities of a billing system. The main section also introduces a novel, mathematical model for price calculation.

BACKGROUND

Although UMTS introduced lately and the charging protocol hasn’t changed significantly since GPRS (General Packet Radio Service) was introduced somewhere at the end of the 20th century, different phases of the standard are still under development. 3GPP (3rd Generation Partnership Project) specifies guidelines and recommendations for the network elements, and the standards are detailing two different types of charging methods: offline and online charging (3GPP, 2004).

An actual service request might be pre-paid or post-paid, depending on whether the price of the requested service is paid before, or after the consumed service. Most telecommunication company groups their subscribers into two sets. Pre-paid subscribers may only require services in pre-paid mode, so they have to top up some amount of money to their balance, and may only require services until their balance covers the price of those requests. Post-paid users may gain services anytime (at least until their un-paid balance does not exceed a given security threshold), and may pay the prices of those services in predefined periods. However, these subscribers types are straightforward and most common, telecommunication companies may introduce novel subscriber types and may set up or dismiss restrictions regarding the type of services and payment mode. The connection between the payment mode (pre-paid and post-paid) and charging method (offline and online) are detailed later.

During offline charging, the network elements (switches) are sending charging information (Charging Data Record - CDR) to the billing system in a predefined format. The CDRs contain all the necessary information, which is needed to compute the actual price of the requested service. This includes the calling party, called party, type of service, amount of the requested service, quality of service and many others. Because these charging records carry information about the services requested, the functionality of the CDRs extends beyond charging, and it’s possible to analyze service-utilization, and gain statistical information about the services, content and subscribers with them. By archiving the CDRs, the user-complaints can also be easily settled. Since this information