Basic Concepts of Mobile Radio Technologies

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INTRODUCTION

Mobile radio technologies have seen a rapid growth in recent years. Sales numbers and market penetration of mobile handsets have reached new heights worldwide. With almost two billion GSM users in June 2006, and 74.7 million users of third generation devices, there is a large basis for business and product concepts in mobile commerce (GSM Association, 2006). Penetration rates average 80%, even surpassing 100% in some European countries (NetSize, 2006).

The technical development laid the foundation for an increasing number of mobile service users with high mobile Web penetrations. The highest is seen in Germany and Italy (34% for each), followed by France with 28%, while in the U.S., 19% account for mobile internet usage (ComScore, 2006). One of the largest growing services is mobile games, with 59.9 million downloaded in 2006 (Telephia, 2006).

Compared to the overall availability of handsets, the continuing high complexity and dynamic of mobile technologies accounts for limited mobile service adoption rates and business models in data services. Therefore, particular aspects of mobile technologies as a basis of promising business concepts within mobile commerce are illustrated in the following on three different levels: First on the network level, whereas available technology alternatives for the generation of digital radio networks need to be considered; second, on the service level, in order to compare different transfer standards for the development of mobile information services; third, on the business level, in order to identify valuable application scenarios from the customer point of view.

DIGITAL RADIO NETWORKS

In the past, the analysis of mobile radio technology has often been limited to established technology standards, as well as their development in the context of wide-area communication networks. Thus, in the following four chapters, alternatives of architecture and technology are represented.

General Basics of Mobile Radio Technology

Generally connections within mobile radio networks can be established between mobile and immobile stations (infrastructure networks), or between mobile stations (ad-hoc networks) only (Müller, Eymann, & Kreutzer, 2003). Within the mobile radio network, the immobile transfer line is displaced by an unadjusted radio channel. In contrast to analogous radio networks where the communication signal is directly transferred as a continuing signal wave, within the digital radio network, the initial signal is coded in series of bits and bytes by the end terminal and decoded by the receiver.

The economically usable frequency spectrum is limited by the way of usage, as well as by the actual stage of technology, and therefore represents a shortage for mobile radio transmissions. Via so called "multiplexing," a medium can be provided to different users by the division of access area, time, frequency, or code (Müller et al., 2003; Schiller, 2003).

In contrast to fixed-wire networks, within radio networks, the signal spread takes place directly similar to light waves. Objects within the transfer area can interfere with the signal spread—that is why there is the danger of a signal deletion within wireless transmission processes. In order to reduce such signal faults, spread spectrum techniques distribute the initial transmission bandwidth of a signal onto a higher bandwidth (Schiller, 2003). The resulting limitation of available frequency can be minimized by the combination of spread spectrum techniques with multiple access techniques. Those forms of combination are represented, for example, by the *Frequency Hopping Spread Spectrum* (FHSS), where each transmitter changes the transfer frequency according to a given hopping sequence, or the *Direct Sequence Spread Spectrum* (DSSS), where the initial signal spread is coded by a predetermined pseudo random number.

Wireless Local Area Networks (IEEE 802.11)

The developers of the 802.11 standards have aimed at establishing application and protocol transparency, seamless fixed network integration, and a worldwide operation ability within the license-free ISM (Industrial, Scientific, and Medical) radio bands (Schiller, 2003). The initial 802.11 standard of 1997 describes three broadcast variants: One infrared variant uses light waves with wave-lengths of 850-950 nm, and two radio variants within the frequency band of 2.4 GHz, which are economically more important (Schiller, 2003). Within the designated spectrum of the transfer power between a minimum of 1mW and a maximum of 100mW, in Europe, the radio variants can achieve a channel capacity of 1-2 Mbit/s. Following the 802.3 (Ethernet) and 802.4 (Token Ring) standards for fixed-wire networks, the 802.11 standard specifies two service classes (IEEE, 2001): an asynchronous service as a standard case analogous to the 802.3 standard and an optional, and temporally limited synchronous service. Typically, WLANs operate within the infrastructure modus whereby the whole communication of a client takes place via an access point. The access point supplies every client within its reach or serves as a radio gateway for adjoining access points.

Developments of the initial standards are mainly concentrated on the area of the transfer layer (Schiller, 2003): Within the 802.11a standard, the initial 2.4 GHz band is displaced by the 5 GHz band, allowing a capacity of up to 54 Mbit/s. In contrast to this, the presently most popular standard 802.11b uses the encoded spread spectrum technique DSSS. It achieves a capacity up to 11 Mbit/s operating within the 2.4 GHz band.

Wireless Personal Area Networks (Bluetooth)

In 1998, Ericsson, Nokia, IBM, Toshiba and Intel founded a "Special Interest Group" (SIG) for radio networks for the close-up range named Bluetooth (SIG, 2004). Like WLAN networks, Bluetooth devices transfer within the 2.4 GHz ISM bands, which is why interferences may occur between both network technologies. In general, 79 channels are available within Bluetooth networks. FHSS is implemented with 100 hops per second, as spread spectrum technique (Bakker &McMichael, 2002). Devices with identical hop sequences constitute a so-called "pico-network." Within this network, two service categories are specified: a synchronous, circuit-switched method, and an asynchronous method. Within the maximum transfer power of 10mW, Bluetooth devices can reach a transfer radius of 10m, up to a maximum of 100m, and a data capacity of up to 723Kbit/s (Müller et al., 2003).

The main application areas of Bluetooth technologies are the connection of peripheral devices such as headphones, automotive electronics, or the gateway function between different network types, like the cross linking of fixed-wire networks and mobile radio devices (Diederich, Lerner, Lindemann, & Vehlen, 2001). Generally, Bluetooth networks are therefore linked together as ad-hoc networks. Ad-hoc networks do not require decided access points; mobile devices communicate equally and directly with devices within reach. Among a network of a total maximum of eight terminals, exactly one terminal serves as a master station for the specification and synchronization of the hop frequency (Jaap/Haartsen, 2000; Nokia, 2003). Bluetooth devices can be involved in different pico-networks at the same time, but are not able to communicate actively within more than one of these networks at a particular point in time. These overlapping network structures are called scatter-networks.

Network Standards for Wide-Area Communication Networks

In 1982, the European conference of post and communication administration founded a consortium for the coordination and standardization of a future pan-European telephone network called "Global System for Mobile Communications" (GSM) (Schiller, 2003). At the present, there are three GSM-based mobile

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