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Dipl.-Kfm. Rajnish Tiwari
Dr. Stephan Buse
Prof. Dr. Cornelius Herstatt

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Technische Universität Hamburg-Harburg

Schwarzenbergstr. 95, D-21073 Hamburg-Harburg
Tel.: +49 (0)40 42878-3777; Fax: +49 (0)40 42878-2867

www.tu-harburg.de/tim

THE MOBILE COMMERCE TECHNOLOGIES: GENERATIONS, STANDARDS AND PROTOCOLS

By Rajnish Tiwari[1], Stephan Buse[2] and Cornelius Herstatt[3]

Hamburg University of Technology, Institute of Technology and Innovation Management
Schwarzenbergstrasse 95, 21073 Hamburg, Germany
Tel: +49-40-42878-3951, Fax: +49-40-42878-2867
rajnish.tiwari@tu-harburg.de, stephan.buse@tu-harburg.de, c.herstatt@tu-harburg.de

Abstract

Mobile Commerce has staged a remarkable come-back. Driven by the technological innovations in the field of telecommunications, it is showing signs of a healthy recovery. The collapse of the dot-com boom in 2001/2002 had dealt a severe blow not only to Electronic Commerce but also to Mobile Commerce, which was just about developing at that time. In addition to a general lack of customer demand for mobile, location-based, services, it suffered heavily under the technical deficiencies of end-devices, slow data transmission and unripe technological standards. These factors in turn had a negative impact on the customer acceptance of mobile services and whatever little demand was available, was rendered useless. Many of the environmental conditions have changed since then.

Technology innovations have reduced many barriers to acceptance. Increasing globalization has led to more mobility and therefore to greater demand for mobile, ubiquitios services that can be consumed "anytime, anywhere". This paper examines different telecommunication technologies regarding their suitablilty and defficienecies. It provides an overview over the historical development of mobile technologies while pointing towards the expected future scenario.

Keywords: Mobile Commerce, 1G, 2G, 2.5G, 3G, 4G, EDGE, GSM, GPRS, HSCSD, i-mode,UMTS, WLAN, WAP.

[1] Dipl.-Kfm. Rajnish Tiwari is Research Fellow at the Istitute of Technology & Innovation Management (TIM) of Hamburg University of Technology (TU Hamburg-Harburg).
[2] Dr. Stephan Buse is Assistant Professor at TIM/TU Hamburg-Harburg.
[3] Prof. Dr. Cornelius Herstatt is Director of TIM/TU Hamburg-Harburg.

1. Introduction

Fast, secure and user-friendly mobile telecommunication technologies are a crucial factor for the commercial success of Mobile Commerce, since it is largely dependent on the acceptance of Mobile Commerce applications amongst targeted consumer groups and relevant business firms. This paper provides an overview of technological standards that have either contributed to the development of Mobile Commerce or that can be expected to shape its future.

This paper is structured on the following lines: The various technologies and generations of mobile data transmission (i.e. 1G, 2G, 2.5G and 3G) are introduced in chapter 2. Chapter 3 discusses some complementary technologies, such as WLAN and Bluetooth. Display and programming standards, WAP and i-mode, are dealt with in chapter 4. Chapter 5 introduces expected future trends of 4G. Chapter 6 entails a short summary.

2. Technologies for Mobile Data Transmission

The mobile (wireless) telecommunication systems (networks) are generally categorised in three broad generations of technologies. Between the second and the third generation a "second and half" (2.5) sub-generation is supposed to exist, that bridges the two neighbouring generations (see figure 1). These generations and their technologies are described in the following sections.

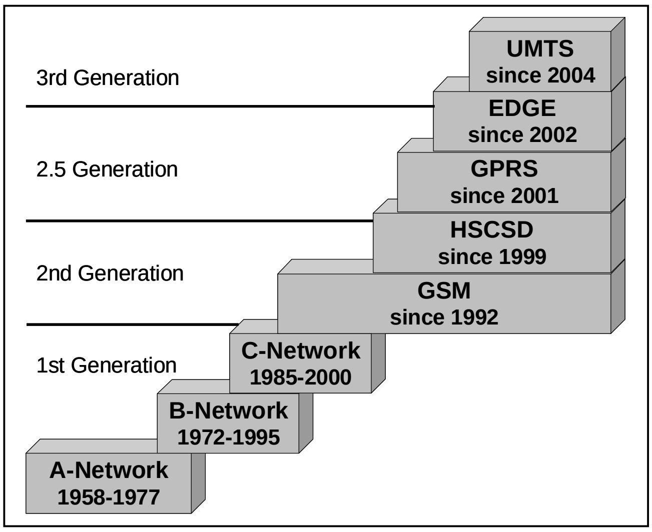

Figure 1: **Generations of mobile telecommunication standards in Germany**

[*Graphic modelled after: Schell, 2002, p. 78*]

2.1 The First Generation (1G)

The beginning of wireless communication in Germany can be traced back to 1926 as the German Railways introduced a wireless telephone service for first-class passengers on its Berlin-Hamburg route [IMZF, 2005a].

The mobile telecommunication gained currency, however, only with the introduction of the A-Network in 1958, which was followed by a more advanced B-Network in 1972. A country-wide coverage was provided later by the C-Network[4] in 1985 [IMZF, 2005b].[5] In the United States of America (USA) a comparable system called the Advanced Mobile Phone System (AMPS) was introduced in 1983. Some more standards that belong to 1G are the Total Access Communications System (TACS), the Nordic Mobile Telephone (NMT) system and the Japan Digital Cellular (JDC) network system [Elliot and Phillips, 2004; Toh, 2002].

The first generation systems were voice-oriented analogue mobile and cordless telephones [Krishnamurthy and Pahlavan, 2002]. Such systems are not suitable for modern Mobile Commerce services on account of low quality of transmission and their exclusive voice-orientation, i.e. the inability to transmit non-voice data [Geer and Gross, 2001]. 1G is hence not relevant for this paper.

2.2 The Second Generation (2G)

The second generation (2G) systems are based on the digital multiple access technology,[6] e.g. the Time Division Multiple Access (TDMA)[7] and the Code Division Multiple Access (CDMA)[8], and currently worldwide in use They use digital encoding and support transmission of not only voice but also of other data, e.g. fax and SMS. They make use of encryption techniques to enhance confidentiality of the transmitted data. Such features are prerequisites for mobile services. Examples of 2G systems are the Global System for Mobile Communication (GSM), Personal Access Communication Systems (PACS) and Digital European Cordless Telephone (DECT) [Toh, 2002].

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4 There are A-, B-, C-, D- and E-Networks. No explanation is found in the literature about why the networks were named like this. An explanation could be Analogue (A-) and Digital (D-) Networks. That however does not explain the B-, C- and E-Networks.

5 For historical development of 1G systems in Germany see [IZMF, 2005a].

6 For technical details see [Krishnamurthy / Pahlavan, 2002]

7 TDMA is a technique for multiplexing multiple users onto a single channel on a single carrier by splitting the carrier into time-slots and allocating these on *as-needed* basis, so that three calls can share a single frequency channel without interfering with one another [GSM Glossary, 2005; Ericsson Glossary, 2004].

8 CDMA is a digital technology that utilises a singe frequency band for all traffic, differentiating the individual transmissions by assigning them unique codes before transmission [GSM Glossary, 2005; Ericsson Glossary, 2004].

Since GSM has become "the" dominating standard in the world in general and in Europe in particular, this paper explains GSM and one of its off-shoot, the High Speed Circuit Switched Data (HSCSD), in some details.[9]

2.2.1 Global System for Mobile Communication (GSM)

GSM, first introduced in 1991, is an open, non-proprietary and digital system of second generation [GSM Glossary, 2005; Ericsson Glossary, 2004]. Originally developed as a European standard,[10] it has come to be the most widely deployed global standard.[11] Some of its basic features are [Schell, 2002]:

i) A broad offer on voice and data communication services;

ii) Compatibility with fixed-line networks, e.g. Analogue and Integrated Service Digital Networks (ISDN) due to standardised interfaces;

iii) Automatic roaming[12] and handover[13] procedures;

iv) Support for various types of mobile devices, e.g. hand-held devices and devices mounted in vehicles;

v) Independent of device manufacturers.

The first GSM-based digital network (D-Network) was launched in Germany in 1992 on the frequency of 900 Megahertz (MHz) by two network carriers, namely the *Deutsche Telekom AG* (launched as D1) and by the *Mannesmann AG*[14] (launched as D2). In 1994 a new GSM-based digital network (E-Network) was launched by the *E-Plus Service GmbH & Co. KG* (launched as E1). The E-Network is based on the Digital Cellular System (DCS) standard that utilises the frequencies of 1800 MHz. In 1998 one more network *Viag Intercom*[15] launched its services as E2. Meanwhile D1 and D2 have also begun using the E-Network to expand their network capacities [At-mix.de, 2005].

9 The number of subscribers of GSM-enabled mobile phones is estimated to be over 1.5 billion worldwide. This is an 85% share amongst all subscribers [Jenkins, 2004].

10 The term GSM originally stood for "*Groupe Speciale Mobile*", i.e. for the workgroup that developed this standard on behalf of the "*Conférence Européenne des Administration des Postes et des Télécommunications*" (CEPT), a body of European Post and Telecommunication authorities [GSM Glossary, 2005].

11 For a comprehensive study of GSM see [Jenkins, 2004].

12 Roaming is defined as the ability of a mobile telephone subscriber to automatically make and receive voice calls, send and receive data or access other services when travelling outside the geographical coverage area of the home network by means of using a visited network [GSM Glossary, 2005].

13 Handover occurs when a call is passed from one network cell to another, even as the user moves between cells [UMTS World, 2004].

14 The *Mannesmann AG* was taken over by the *Vodafone Group Plc* of Great Britain in the year 2000. The D2-Network is now run by the *Vodafone D2 GmbH*.

15 Since 2002 Viag Intercom is known as O_2 (Germany) GmbH & Co. KG.

Although GSM is a relatively advanced technology, it is not free of drawbacks. One major problem is that of low actual data-transmission rates. Though GSM is theoretically capable of a transmission rate of 22.8 kilobits per second (kbps), the actual rate of data-transmission is reduced to as low as 9.6 kbps as a safety-measure against possible transmission errors [Steimer et al., 2001].

Another problem is that GSM is a circuit-switched technology. That means a channel is assigned for the transmission of data for the complete duration of usage. For example, if a user calls a Wireless Application Protocol (WAP) page on his mobile phone, a channel is assigned to this process. This channel is kept allocated until the process is cancelled, even when all the data has been transmitted and displayed on the screen. The user is billed for the utilised channel-time and not for the volume of the actually transmitted data [Ahlke, 2002].

Both these factors – low actual transmission rates combined with the circuit-switched technology – result in disproportionately high costs for the user and discourage the usage of data services offered. Low transmission rates are also problematic for data-intensive applications, e.g. mobile videos. Such drawbacks make GSM technology sub-optimal for promoting attractive mobile services.

2.2.2 High Speed Circuit Switched Data (HSCSD)

HSCSD is an enhancement of data-services based on GSM to enable higher rates by using multiple channels. With a transmission rate of 28.8 kbps HSCSD allows three times faster access to non-voice (data) services.[16]

The bundling of channels requires functions that may dissect and consolidate data on and from various channels without compromising the integrity of data. This requires costly and extensive modification in the hardware of mobile devices [Steimer et al., 2001]. There are currently few subscribers with voice terminals that support HSCSD. The other alternative is using a special portable computer card that has a built-in GSM phone. This card turns laptops and other portable devices into a high-speed mobile office with the ability to make voice-calls and carry out data transfer. This facility is particularly interesting for subscribers who wish to access the Internet, or their office Intranet, while on the move, by using a mobile device [GSM World, 2005a].

The main drawback of HSCSD lies in the circuit-switched technology that makes its usage very expensive, considering that the user has to pay for multiple channels [Steimer et al.,

[16] Some upgraded networks can even reach transmission rates of up to 43.2 kbps.

2002]. HSCSD seems to be more interesting and suitable for a laptop than for a mobile phone [Müller-Veerse, 2000].

2.3 The 2.5 Generation (2.5G)

The transit between 2G and 3G is known as 2.5G. The General Packet Radio Service (GPRS), main standard of this phase, even though based on GSM distinguishes itself from other circuit-switched 2G technologies, in that it is a packet-switched[17] technology [Toh, 2002]. Another standard that arguably belongs to both 2.5G as well as to 3G and builds on GPRS is the Enhanced Data-rates for Global Evolution (EDGE).

2.3.1 General Packet Radio Service (GPRS):

GPRS is a non-voice service that allows speedy transmission of data [Buckingham, 2000a]. It is a packet-switched technology, which means that the data to be sent is broken up into small packets, which are "routed by the network between different destinations based on addressing data within each packet. Use of network resources is optimized as the resources are needed only during the handling of each packet" [Toh, 2002]. GPRS offers following advantages:

i) **Speed**: By using all eight time-slots simultaneously GPRS can theoretically achieve transmission rates of up to 115.2 kbps, about two times faster than ISDN and ten times faster than other circuit-switched GSM standards [Buckingham, 2000a].

ii) **Immediacy**: GPRS enabled mobile devices are, subject to network coverage of the geographic area, always connected to the network ("Always-on, Always-connected" feature). The user does not have to dial up a connection to receive information [Buckingham, 2000a; Ahlke, 2002].

iii) **Innovative services**: GPRS can offer services that were hitherto not possible due to low transmission rates. It facilitates creation of WAP-pages similar to Internet-based web-pages and provides access to many other services, e.g. the Internet, e-mail, music and office applications [Buckingham, 2000a; Gneiting, 2000].

iv) **Costs advantage**: The subscriber pays for the volume of the transmitted data and not the time required in the process [Toh, 2002].

17 The packet-switched technologies are explained later in this section.

These advantages make GPRS the first technology that can not only enable but also promote mobile applications. But also GPRS has certain shortcomings, which are described in the following:

i) **Low actual transmission rates**: The theoretically possible rates of data transmission are not achieved, because all the eight time-slots are seldom, if ever, available simultaneously [Buckingham, 2000a]. The actual rates of data-transmission via GPRS is reported be a meagre 14 kbps while sending and between 28 and 64 kbps while receiving [GSM World, 2005b].

ii) **Priority for Voice-transmission**: The packet-switched GPRS is used only as a secondary network channel along with the circuit-switched GSM network for voice-transmission that has a higher priority. If the capacities are being utilised for a voice-call, then the data-transmission has to take a back seat [Schell, 2002].

These factors handicap the development of data-intensive and/or time-critical Mobile Commerce applications based on GPRS.

2.3.2 Enhanced Data-rates for Global Evolution (EDGE)

EDGE is a 2.5G technology that is based on GPRS and can be used to offer personalised multimedia services similar to 3G technologies [Toh, 2002]. It can be used to transmit both voice and data. It however is just an add-on to GPRS and can not work alone [Ericsson, 2003]. EDGE allows subscribers to access the Internet and to send and receive data, e.g. digital images and videos, with a broadband like transmission speed of 384 kbps that is about three times faster than an ordinary GPRS network [Ericsson Glossary, 2004].
This speed is sufficient even for video-transmissions and in that sense it rivals the 3G Universal Mobile Telecommunications System (UMTS) technology [Ahlke, 2002]. EDGE is reputed to possess high potential and a growing importance in many regions of the world, e.g. the Americas, Australia and India, where it is reported to be gaining market rapidly [Menon, 2005]. The main advantage of EDGE is that it could allow network carriers to offer 3G-like services without having to actually acquire a 3G license. Implementing EDGE is relatively simple, as it works with the existing GSM/GPRS structure [Toh, 2002]. It may also be used with laptops with the help of a card [Menon, 2005].
EDGE however does not seem to have very bright prospects in Europe for a practical reason: Most of the network carriers in Europe have invested heavily in the expensive UMTS licenses

and building a UMTS network [Wallbaum / Pils, 2002].[18] Their priority lies in amortisation of these investments.

2.4 The Third Generation (3G)

The 3G technology aims to provide a broad range of services, e.g. interactive multimedia services, video telephony and high speed internet access, in addition to voice communication. The European 3G standard is called UMTS[19] and is based on a radio access technology called Wideband Code Division Multiple Access (WCDMA)[20]. The high speed of data transmission makes it suitable for real-time and time-critical applications [Wallbaum and Pils, 2002].[21] UMTS works with a hierarchical cell structure consisting of different cell types [Schell, 2002; Toh, 2002].

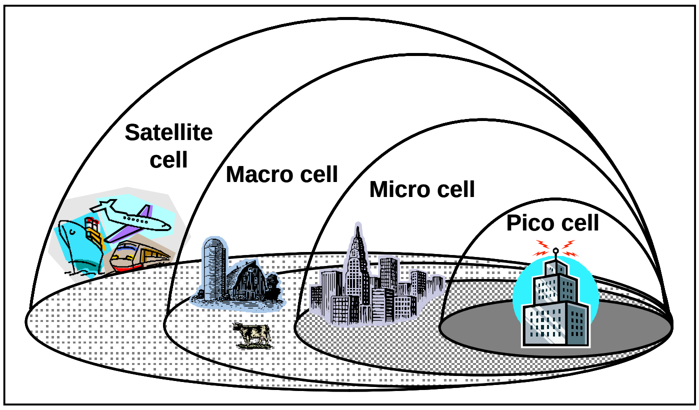

Figure 2: Hierarchical cell structure of UMTS

[*Graphic modelled after: Wallbaum and Pils, 2002; Schell, 2002*]

i) **Pico cells**: The speed of data transmission in Pico cells, i.e. at *low mobility*, is up to 2048 kbps, provided the device remains within a geographic range not exceeding 50 metres, e.g. in a building.

ii) **Micro cells**: The rate of data transmission in urban areas is 384 kbps at *limited mobility*, within a geographic range of 50 to 350 metres.

18 The network carriers in Germany alone are reported to have invested €100 billion for this purpose [Göttgens and Zweigle, 2001, p. 2].

19 The terms "3G" and "UMTS" are used interchangeably in Europe, see e.g. EU Legal Notice: *Third generation mobile communications*, dated 31.10.2002, online available: http://www.europa.eu.int/scadplus/printversion/en/lvb/124202a.htm, as on 11.01.2005.

20 WCDMA is a variant of CDMA.

21 For further information on UMTS, see Toh [2002] or IZMF [2005b].

iii) **Macro cells**: Data transmission rates of up to 144 kbps at ***full-mobility*** in suburban areas and countryside within a range of 350 metres to 20 kilometres depending on the area's topology and population density.

iv) **Satellite cells:** UMTS supports universal roaming and provides global coverage. For this purpose it uses – in addition to terrestrial systems – also satellite systems [Toh, 2002]. The data transmission rate in the satellite cell is 9.6 kbps [UMTS FAQ, 2002].

UMTS uses frequencies in the bandwidth of 1,920 and 2,170 MHz [IZMF, 2005b]. This necessitates new mobile devices that are UMTS-capable. On the other hand these devices must be backward compatible with the GSM/GPRS standards because UMTS is initially available only in metropolitan areas whereas a UMTS subscriber must be able to use "normal" mobile services while on the move outside of big cities.

UMTS services are being offered in Germany in nearly all metropolitan cities since 2004.[22] The *Vodafone D2 GmbH* (Vodafone) and the *T-Mobile Deutschland GmbH* (T-Mobile) launched their services in May, 2004, the other two carriers, the ***e-plus 3G Luxemburg S.à.r.l.*** (E-Plus) and the *O_2 (Germany) GmbH und Co OHG* (O_2) in June 2004 [UMTS Forum, 2005b]. There are several UMTS services being offered, e.g. *Vodafone* has been showing a complete movie on its UMTS network that was running in cinema houses [Vodafone, 2005]. At the end of the year 2004 there were approximately 75 models of UMTS capable mobile telephones [Gfaller, 2004, p. 1]. There are some 16 million UMTS subscribers worldwide, of which 6.5 million in Europe [FAZ, 2005a, p.15]; but only around 0.25 million in Germany [BITKOM, 2005, p. 1]. The customer response so far seems to have been less than enthusiastic on account of high costs for UMTS services [FAZ, 2004, p. 15].

Having discussed different generations of mobile telecommunication standards, it would be useful to have a look at technologies that are sometimes considered to be a potential threat to the success of 3G technologies.

3. Complementary Technologies of Data Transmission

This chapter describes two standards of data transmission that – unlike standards discussed above – are not used exclusively for mobile data transmission but can nevertheless be used to a certain extent for this purpose.

[22] For a brief overview of offered services see chapter 5.

3.1 Wireless Local Area Network (WLAN)

The WLAN technology is employed for wireless communication with Local Area Networks (LAN) and theoretically provides data transfer rates of up to 54 megabits per second (mbps)[23], which is much higher than UMTS [Krishnamurthy and Pahlavan, 2002]. In practice, WLAN permits data transfer with a speed of up to 2 mbps [Swisscom, 2004].

Most of the WLAN systems are based on the standard developed by the US based Institute of Electrical and Electronics Engineers (IEEE) and work on the free-to-use, unlicensed 2.4 GHz frequency.[24] The interface to mobile devices, e.g. laptops, is provided by Access Points (popularly known as Hotspots), which are connected to LAN. WLAN usually has a range of 100 meters in buildings and up to 300 meters on open ground.

WLAN has gained tremendous popularity in past few years. In Germany there were 109 Hotspots at year-end 2002. Within one year their number increased to 525 [Mobilmedia, 2004]. The number however jumped dramatically in the following years. 9354 Hotspots were reported to be in operation in Germany by July 2006. These Hotspots were spread across 1035 cities and towns. Over 93% of them were commercially run. The biggest provider was ***Deutsche Telekom***, whose subsidiaries ***T-Com*** and ***T-Mobile*** controlled the Top-2 places with a market share of 50% and 13% respectively.[25]

WLAN is expected to grow in the same manner in coming years. Network carriers such as *Vodafone* and O_2 are cooperating to share their WLAN infrastructure, particularly Hotspots at places such as airports and hotels [Vodafone, 2004].

However, there are currently no mobile telephones available, which can communicate via WLAN. The biggest handicap of WLAN is that the handover of a network connection between two Access Points is not possible. It means that the connection (and every data transfer process) is broken, when the user leaves one WLAN range and enters another one.

On account of this handicap WLAN can not be really seen as a viable alternative to mobile telecommunication standards, e.g. UMTS. On the contrary it seems likely that WLAN could develop into a complementary standard to UMTS, so that subscribers could use WLAN for data-intensive mobile applications that are needed while outside of one's home or office but not necessarily while physically on the move. Both the standards could, thus, reinforce the need for each other and give impulses for the success of each other.

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23 1 mbps = 1000 kbps.

24 An alternative standard to IEEE is HIPERLAN developed by the European Telecommunications Standards Institute (ETSI). HIPERLAN works on the 5 GHz frequency.

25 Current statistics for Germany can be found at: http://www.hotspots-in-deutschland.de/de/statistik.asp, as on: 19.07.2006.

3.2 Bluetooth

Bluetooth is basically a cable-replacement technology, intended to simplify the communication amongst and between mobile devices and personal computers (PC) [GSM Bluetooth, 2005]. Bluetooth has established itself as a useful tool for Mobile Commerce, serving for diverse business needs such as mobile payment and direct marketing [Incisor, 2004]. The primary reasons for its success are [Ericsson Glossary, 2004]:

i) Bluetooth makes it possible to create temporary (ad-hoc) networks;
ii) It facilitates both voice- and data communication;
iii) It can communicate with any other device having Bluetooth;
iv) It helps synchronise data from different devices (e.g. transfer music and video files from mobile phone to PC or vice versa).

Bluetooth works with a freely usable, non-licensed frequency of 2.4 Gigahertz (GHz) in the Industrial, Scientific and Medical (ISM) band. It is a low-cost, short-range radio technology that can be used in a radius of about 10 meters, in some cases up to 100 meters. Bluetooth can transmit data with a speed of 432.6 kbps in case of synchronous and up to 724 kbps in case of asynchronous data links.[26] A Bluetooth device changes its broadcasting frequency (frequency hopping) up to 1600 times per second to provide better security while transmitting data [Ahlke, 2002]. It is, thus, a high speed, secure and yet low-cost as well as low energy-consuming technology and for this reason highly suitable for mobile devices, despite range limitations.

4. Display and Programming Standards

The previous section described protocols employed for voice- and data transmission. The transmitted data however must be presented to the user on his mobile device via a suitable and uncomplicated user-interface. This section describes two such programmable display standards, namely WAP and i-mode.

4.1 Wireless Application Protocol (WAP)

WAP is a non-proprietary (open), global standard that was introduced in its first version WAP 1.0 in 1998. It has been developed by the WAP Forum[27], a consortium of leading manufacturers of mobile phones including Ericsson, Motorola and Nokia. The objective of

[26] For technical specifications see [Ferro and Potorti, 2004].
[27] The *WAP Forum* has been, in the meantime, renamed as *Open Mobile Alliance*.

developing WAP was to provide an industry-wide specification for developing applications that operate on mobile telecommunications network and transmit Internet contents on mobile devices independent of the transmission technology used by network carriers [WAP-Forum, 2001].

WAP applications can be written with the help of Wireless Mark-up Language (WML), a language that resembles in its structure the Hypertext Mark-up Language (HTML) used for creating Internet pages. It is used to specify content and user interface for delivery to a narrowband device", e.g. a mobile phone. WML can work with constraints that a mobile device typically possess, e.g. small display, limited user input facilities, narrowband connections and limited disk and memory resources [WAP Forum, 2002].

A WAP Gateway acts as interpreter between the mobile device and a web server which decodes and encodes the information in a way that the server and the mobile device can communicate with each other [Lei et al., 2004].

Ever since the introduction of GPRS and higher data transfer rates, WAP can also work with complicated graphics and images. It allows a relatively easy and unproblematic integration of mobile applications into existing Internet services. Web servers can be modified with the help of suitable software to offer WAP functionality. On the hardware front only a WAP Gateway is required. However the content must be made WML compatible so that it can be read by mobile devices [Lei et al., 2004]. Translating all relevant content into WML increases the temporal and monetary costs of WAP.

Another major problem of WAP 1.0 was that the data were decrypted by WAP Gateway before transmitting them to the web server and sensitive data, e.g. credit card information, could potentially be misused. The new version WAP 2.0, which was introduced in 2001, takes care of this problem and the data are no more stored in decrypted form on the WAP Gateway [Lei et al., 2004]. WAP 2.0 also defines a new programming language "Extensible Hypertext Mark-up Language Mobile Profile" (XHTMLMP) that supports both of the established standards, namely WAP and i-mode. On account of its open, non-proprietary nature WAP is attractive for developers and application providers.

4.2 i-mode

The Japanese network carrier NTT DoCoMo (NTT) introduced i-mode in 1999 as an open standard based on programming language iHTML (i-mode compatible HTML). It is based on packet-switched network technology and is thus GPRS- and UMTS compatible, allowing for a wide range of push- and pull services [Teltarif, 2004]. i-mode users get access to Mobile Internet sites offering specialised services such as e-mail, online shopping, banking, ticket reservations and restaurant advice. Users can access sites at low rates, because charges are based on the volume of data transmitted, not the amount of time spent.

The i-mode compatible sites can be divided in two categories:

i) Content provided by official providers: It is integrated in the i-mode menu and can be accessed directly by clicking on the menu item. Official partners need an agreement with NTT, which charges a 9% commission for collecting bills on the behalf of the content providers and approves the content.

ii) Content provided by unofficial providers: Such sites can be viewed by customers by typing the site-address in a mobile browser, similar to the Internet sites. These providers have to find their own mechanisms to collect charges for their services.

Content providers, generally, do not have to pay fees for offering i-mode compatible content. The real profit of NTT comes by transferring data on account of network usage. Other network carriers wishing to offer i-mode services need a license.[28] i-mode has been successful in Japan, attracting 45 million subscribers and offering access to over 96,000 Internet sites via mobile phones as of January 2006, according to information provided by NTT.[29]

In Germany there are over a million ***E-Plus*** customers that subscribe to i-mode services. One more network carrier in Germany, namely, *O_2* is set to launch i-mode services in early 2006. The service shall, however, be named *MMO2* owing to legal complications with ***E-Plus*** [Kroder and Wihofszki, 2004]. The i-mode technology, however, has seen little success outside Japan. Only in 14 countries worldwide, apart from Japan, i-mode services are available up to now. These are: **Taiwan** (since 2002), **Germany** (2002), **Holland** (2002), **Belgium** (2002), **France** (2002), **Spain** (2003), **Italy** (2003), **Greece** (2004), **Australia** (2004), **Israel** (2005), **Russia** (2005), **United Kingdom** (2005), **Ireland** (2005) and **Singapore** (2005).[30]

The main advantages of i-mode as against WAP are:

i) Official content providers do not have to install own payment mechanisms and pay relatively low commission charges;

ii) iHTML is developed as a subset of HTML so that Internet content can be transferred to i-mode with less problems. This results in reduced programming costs. This advantage, however, could be offset by XHTMLMP that is HTML based and WAP *and* i-mode compatible.

28 See NTT's official information on its i-mode business strategy, online available: http://www.nttdocomo.com/corebiz/imode/why/strategy.html, site consulted: 02.03.2005.

29 NTT provides on its Internet site regularly updated statistics on i-mode usage: http://www.nttdocomo.com/corebiz/services/imode/index.html, site consulted: 09.03.2006.

30 Source: http://www.nttdocomo.com/corebiz/global/imode/index.html, site consulted 20.07.2006.

A severe handicap of i-mode is that it requires special i-mode compatible devices [Kroder and Wihofszki, 2004]. The proprietary nature of i-mode services for network carriers is another reason why i-mode does not seem to be gaining ground in other parts of the world.

5. Future-Scenario: The fourth Generation (4G)

As the 3G services are just beginning to reach users, 4G is a distant scenario expected to be launched in year 2010, notwithstanding announcements by individual firms, e.g. NTT, to prepone 4G to year 2006 [Dholakia et al., 2004]. Nevertheless principal trends of 4G are expected to go along following lines:

i) A seamless roaming between 2.5G, 3G and WLAN may be achieved so that mobile devices will automatically detect the presence of a network with higher bandwidth and switch to it. The handover will take place without interrupting existing connections. So that WLAN, as a complementary technology, could become an integrated component of Mobile Commerce [EITO, 2004].

ii) Speed of data transfer is expected to reach, and probably even exceed, 100 mbps [EITO, 2004]. This would allow offering of highly data-intensive applications, e.g. live video streaming.

iii) 2G and 2.5G technologies are expected to be still around since 3G/UMTS networks are not expected to extend their reach to all geographic areas. A downward compatibility of mobile devices would have to be ensured [Dholakia et al., 2004].

6. Summary

The discussion above has shown that the technology is now ripe for fully functional, content-rich and value-added Mobile Commerce applications. The relevant issue is of finding suitable applications and offering them for affordable prices.

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