AN OVERVIEW OF TODAY'S AND TOMORROW'S M-COMMERCE IN THE NETHERLANDS AND EUROPE

Hong-Vu Dang
BMI Paper

AN OVERVIEW OF TODAY'S AND TOMORROW'S M-COMMERCE IN THE NETHERLANDS AND EUROPE

Hong-Vu Dang
BMI Paper

Vrije Universiteit Amsterdam
Faculty of Sciences
Business Mathematics and Informatics
De Boelelaan 1081a
1081 HV Amsterdam
www.few.vu.nl

August 2006

PREFACE

A part of the masters programme of the study that I am following, Business Mathematics & Informatics (BMI) at the Vrije Universiteit Amsterdam, is writing a BMI paper. In this paper a problem in the field of BMI is assessed using existing literature.

The subjects addressed in this paper are the past, present and future developments of the relatively new phenomenon called m-commerce. Developments discussed will be from a technological perspective as well as a business perspective.

I would like to express my gratitude to Dr. S. Bhulai of the Vrije Universiteit Amsterdam for his guidance while I was writing this paper.

Hong-Vu Dang

ABSTRACT

This paper explains:

- What m-commerce is: in a nutshell, it is commerce using a mobile device such as a hand-held device or a smart phone;
- What it is used for: currently, m-commerce in Europe mainly consists of messaging, such as SMS, and mobile entertainment (think of ringtones, wallpapers, and mobile games);
- What technology is involved with m-commerce: this paper describes the history and future of mobile networks from 1G to 3G, and how other technologies can be used for m-commerce such as GPS, and Wi-Fi;
- The business aspects of m-commerce: how much does it cost to enable m-commerce (for instance the costs of the European UMTS network) and how much turnover is made. Also, success stories for several m-commerce services are described, as well as the target groups and the consuming market;
- The current Dutch m-commerce situation: what networks are currently used, what is the mobile penetration rate and what potential does the Dutch m-commerce market have;
- How big m-commerce is in Japan: what made m-commerce so successful in Japan, and what are the differences with the Dutch m-commerce market.

TABLE OF CONTENTS

1: INTRODUCTION TO M-COMMERCE

1.1: What is m-commerce and what makes it different from e-commerce?

To answer these questions a definition of *commerce* is given first (Wikipedia):
"Commerce is the trading of something of value between two entities. That something may be goods, services, information, money, or anything else the two entities consider to have value."

Then *m-commerce* can be defined as follows (Wikipedia):
"M-commerce or mobile commerce stands for electronic commerce made through mobile devices."

But what products or services fall under m-commerce? Would making mobile telephone calls or sending text messages fall under m-commerce according to the definitions above? A service, in this case the telecom provider allowing you to use their network for calling and text messaging, is traded for your money, i.e., the fee of the call or the fee of sending the message. However, m-commerce is generally related with the selling and buying of ringtones, games and wallpapers (Yates, 2005). So the biggest contrast between typical e- and m-commerce (besides, of course, the mobility) is the type of products and services sold. E-commerce (on a home PC) is more about tangible goods, while m-commerce is more about content. Recent developments in the field of mobile internet and mobile devices are opening many other possibilities for more types of content.

Next, what falls under *mobile devices* suited for m-commerce? A typical mobile device is, of course, a mobile phone. However, mobile phones are more and more becoming multi-purpose devices. Today's mobile phone is not only used for making telephone calls, it is used for sending text messages such as SMS, MMS, and even e-mail as well. It can be used as a photo- and video camera, organizer, web browser, GPS navigation system, document viewer, MP3 player, videogame system, etc. What about PDAs or pocket PCs? Or even portable gaming systems capable of connecting to the internet for content download? Many PDAs can be used as a phone too, what about that? And a pocket PC can also be used for e-commerce purposes. What about shopping on a laptop PC through an internet hotspot then? Should this be called e-commerce or m-commerce? Clearly, there is a thin line between the two and the line gets thinner and thinner as mobile phones become more and more pocket-all-purpose-computers. Many mobile devices today can access the internet allowing the user to participate in typical e-commerce activities, like Yahoo shopping (Webwereld, 2005). However, there are still characteristics separating e-commerce and m-commerce despite m-commerce "catching" up to e-commerce in terms of possibilities. Figure 1 shows the m-commerce and e-commerce capabilities of a standard GSM mobile phone, a smart phone, and a PC:

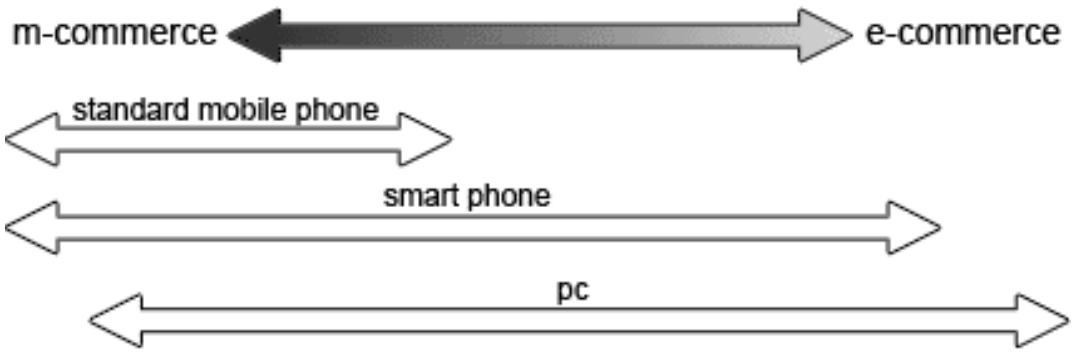

Figure 1: m- and e-commerce capabilities of devices

Today most e-commerce activities can be done on a mobile device that can display (a modified version of) http pages (for example, a smart phone). The reverse is also possible but why would someone surf on inferior internet pages made for mobile devices on their home PC? And who would buy a ringtone or wallpaper using their desktop PC? But also: who would buy something like a vacuum cleaner using a mobile device, even when it is technically possible to do so? Clearly, some services are preferred to be carried out on a desktop PC and some on a mobile device. The most important factors that influence the choice of the device are evidently mobility, screen size, connection speed and costs.

- Mobility: even though a lot of information and services are available for free on the internet and TV, some people prefer to have access to certain information or services anytime, anywhere and are willing to pay a price for it. An example is for instance information about stock prices or news.
- Screen size: the screen size of mobile devices is often too small for carrying out e-commerce activities conveniently. For example, comparison shopping is more convenient on a large screen because less scrolling is needed to see different products on-screen simultaneously.
- Connection speed: since a few years the transfer speed of mobile connections to the internet has become comparable with the speed of broadband internet used at homes and offices thanks to the UMTS network. However, the penetration of UMTS does not even come close to the penetration of broadband connections. Transferring of large files is therefore still dominated by desktop PCs with a broadband connection.
- Costs: memory is becoming cheaper and cheaper, but is still relatively expensive for mobile devices compared to memory for desktop computers due to size restrictions. The storage of large files is therefore much cheaper on desktop PCs. Also, data transfer is often much cheaper on desktop PCs which on top can be networked together and use the same broadband connection.

It is difficult to define m-commerce as it has not yet fully matured, and the line between e- and m-commerce becomes thinner and thinner. For the sake of simplicity, this report will regard m-commerce as: the trading of something of value between two entities (goods, services, information, money, or anything else the two entities consider to have value) through pocket-sized mobile devices, excluding telephony. Included services, according to this outline, are for instance: text messaging (SMS, MMS), e-tainment (ringtones, wallpapers, MP3s, and other content), micro payments, e-commerce through mobile devices, and any other non-voice service through mobile devices. Devices include: mobile phones, PDAs and pocket PCs, or any other portable pocket-sized device capable of connecting to a network that can use the services mentioned. So laptops, for instance, which are portable and enable a user of using the services mentioned, will not be considered as an "m-commerce device" in this paper due to its physical size.

1.2: What is it used for?

As stated above, up until today m-commerce activities consist mostly of messaging, mobile entertainment (ringtones, videos, wallpapers, and games) and services such as news, sports, and stock quote updates. As the mobile devices become more sophisticated, memory becomes cheaper, and mobile internet becomes faster, larger files are being offered, like MP3s, video content, or even streaming video (Yates, 2005).

These are only a few examples of the possibilities of m-commerce. But there is and will be much more to m-commerce as mobile devices become more sophisticated and network speed keeps increasing. As stated above, mobile devices are now capable of doing most tasks that a PC is capable doing of. But remember that the 'm' in m-commerce stands for mobility: not only can it be done virtually anytime and anywhere, but with GPS and Wi-Fi technology context aware mobile services are possible as well. It is clear that there are many opportunities for new m-commerce services.

1.3: M-commerce in the Netherlands and Europe: today and tomorrow

This paper discusses today's and tomorrow's m-commerce, particularly in the Netherlands and in Europe. What are the technological developments and why has m-commerce been restricted to mostly sending text messages and e-tainment (ringtones, games, and wallpapers)?

1.4: Set up and structure of this document

First, the history of mobile technology is given, so the current situation can be understood better. Then, the newest technologies will be discussed to see what direction mobile technology is heading to. This technology is put into m-commerce context, it will be clear how m-commerce takes advantage of these technologies. A few examples will also be considered.

Having treated the technical side of m-commerce, business aspects are discussed in the next part. How much do the technologies that enable m-commerce cost and how much money can be made? What is the target group and area of deployment? Some successful m-commerce implementations will be presented to illustrate these aspects.

In the last part, the discussion will be focused on m-commerce in the Netherlands. The technical infrastructure and business aspects will briefly return, but specifically for the Netherlands. M-commerce in the Netherlands will then be compared to m-commerce in its "homeland": Japan.

2: THE TECHNOLOGY BEHIND M-COMMERCE

2.1: History and future of mobile networks

The evolution of mobile network technology can be divided into four generations: 1G (first generation), 2G, 2.5G, and 3G. Some of the standards for each generation are (McKitterick, 2003):

- 1G: Advance Mobile Phone System (AMPS) in North America, Total Access Communication System (TACS) in UK, Nippon Telegraph & Telephone (NTT) in Japan, Code Division Multiple Access One (CDMAONE);
- 2G: Global System for Mobile Communication (GSM), Code Division Multiple Access 2000 (CDMA2000), High Speed Circuit Switched Data Technology (HSCSD);
- 2.5G: General Packet Radio System (GPRS), Enhanced Data Rate for GSM Evolution (EDGE);
- 3G: Universal Mobile Telephone Standard (UMTS).

The major network technologies for mobile devices will be discussed next.

2.1.1: GSM: where digital telephony began

GSM is a system for digital mobile telephony and it is in use by roughly a billion people worldwide in 120 countries. The main uses are telephony and short messaging services (SMS). A GSM user can connect to the internet, but at rates of only 9.6 Kbit/s, because GSM was not optimized for data transfer but only for telephony. Users pay a fee depending on the time they spend online (McKitterick, 2003), (Anker). GSM uses narrowband TDMA (Time Division Multiple Access) allowing eight users to call simultaneously on the same radio frequency by dividing the frequency into eight timeslots and assigning a timeslot to each user. GSM operates at the 900 MHz and the 1800 MHz frequency band in Europe and Asia, and at 850 MHz and 1900 MHz in some parts of the Americas including the USA and Canada. It is possible for users to use their mobile phones when travelling to other countries: dual-band, triple-band, and quad-band phones can operate at different frequency bands (Wikipedia), (India Infoline, 2002).

2.1.2: GPRS: maximizing the GSM network

GPRS may be considered as an overlay network on the GSM networks that maximizes the potential of GSM networks. Instead of using the voice channel for data transfer, GPRS is packet based. Data transfer rates can theoretically reach up to 171.2 Kbit/s (however, typically it runs at 53.6 Kbit/s), and GPRS users are constantly connected to the internet, paying only for data that is transferred. This speed depends on the channel encoding used. There are four encoding schemes, from slowest to fastest: CS-1, CS-2, CS-3, and CS-4. The transfer speed can be adapted depending on the mobile location, when near a Base Transceiver Station (BTS) CS-4 is available, but the further away from a BTS, the slower the encoding will be. The encoding schemes and their speeds are given in Table 1. When using all eight timeslots, the theoretical maximum speed is 8*21.4 = 171.2 Kbit/s. Different GPRS classes are defined, differing in the number of timeslots available for downloads and uploads. The lowest class, class 1, has only one slot for downloads, and one slot for uploads. Depending on the encoding schemes, down and upload speeds will be between 9.05 and 21.4 Kbit/s. The highest class uses the maximum number of slots for both down- and uploads: eight slots each.

	Speed (Kbit/s)
CS-1	9.05
CS-2	13.4
CS-3	15.6
CS-4	21.4

Table 1: the four different GPRS encoding schemes and their speed in Kbit/s

GPRS only uses radio resources when data is actually transferred, so a large number of GPRS users share the same bandwidth, resulting in an efficient use of radio bands. The main uses for GPRS are accessing the internet, e-mailing and faxing (McKitterick, 2003), (Anker), (Wikipedia).

2.1.3: UMTS: currently available and evolving

UMTS has a high data transfer rate (2 Mbit/s). This rate is comparable to broadband connections on home PCs! One distinguishing possibility, next to the possibilities already mentioned, is video telephony. Because of the high transfer rate, it is more attractive to browse the internet, download large files, like music and video content, and stream files using a mobile device (McKitterick, 2003), (Anker). However, currently the majority of mobile devices cannot use UMTS. UMTS is relatively young, so this will change in the coming years, as more and more UMTS mobile devices are available on the market today. Also, UMTS keeps evolving, becoming cheaper and more reliable at every release. It is expected that UMTS will eventually replace the GSM network as the GSM network does not have the capacity to support the growing number of GSM users. UMTS uses the W-CDMA (Wideband Code Division Multiple Access) interface, which also allows multiple users on the same radio frequency, such as GSM. The difference is that the frequency is not divided into time slots, but the narrowband information signal is spread over a wide band of frequencies (a technique called spread spectrum). UMTS uses what is called a paired spectrum, using a pair of 5 MHz spectrum, one for downloading (the 2100 MHz range) and one for uploading (the 1900 MHz range).

2.1.4: The future of 3G

It is evident that the main concern in the history of mobile networks was increasing the data transfer speed to match broadband transfer rates. The internet, however, is used primarily by desktop computers with generally a higher data transfer speed for internet connections and uses the http protocol for displaying web pages. These web pages generally are designed for displays with a resolution of at least 800 x 600 pixels and contain pictures, sounds, video, and other types of media. Therefore, most web pages are not displayed optimally on mobile devices due to the low data transfer speed and limited display size. Even though the transfer rate for mobile devices is comparable to standard broadband internet connections today, the screen size still poses a problem. To enhance internet services a new protocol was introduced: the Wireless Application Protocol (WAP). The idea behind WAP is that internet pages are designed such that the limited bandwidth and screen size of mobile devices are taken into account (Anker). Data transfer is reduced compared to normal http web pages, and the limited screen is used optimally. The Japanese competitor of WAP is called i-mode, which is faster and cheaper. On top of that, existing HTML pages were easier to convert into i-mode pages than into WAP pages. When (and if) UMTS becomes widely used, web pages for mobile devices will probably become richer as there is less need to worry about the transfer speed. As can be seen in Figure 2, the leap made in transfer speed is so large it will take a while before UMTS needs to be replaced by some other networking technology. It is therefore safe to say that UMTS is the future of mobile data networks for now, at least in Europe where UMTS has just rolled out since 2004 in most West-European countries. In Japan, where mobile networks are state of the art, UMTS networks will be upgraded in 2006 that will allow for transfer rates up to 14.4 Mbit/s! (Anker), (Wikipedia).

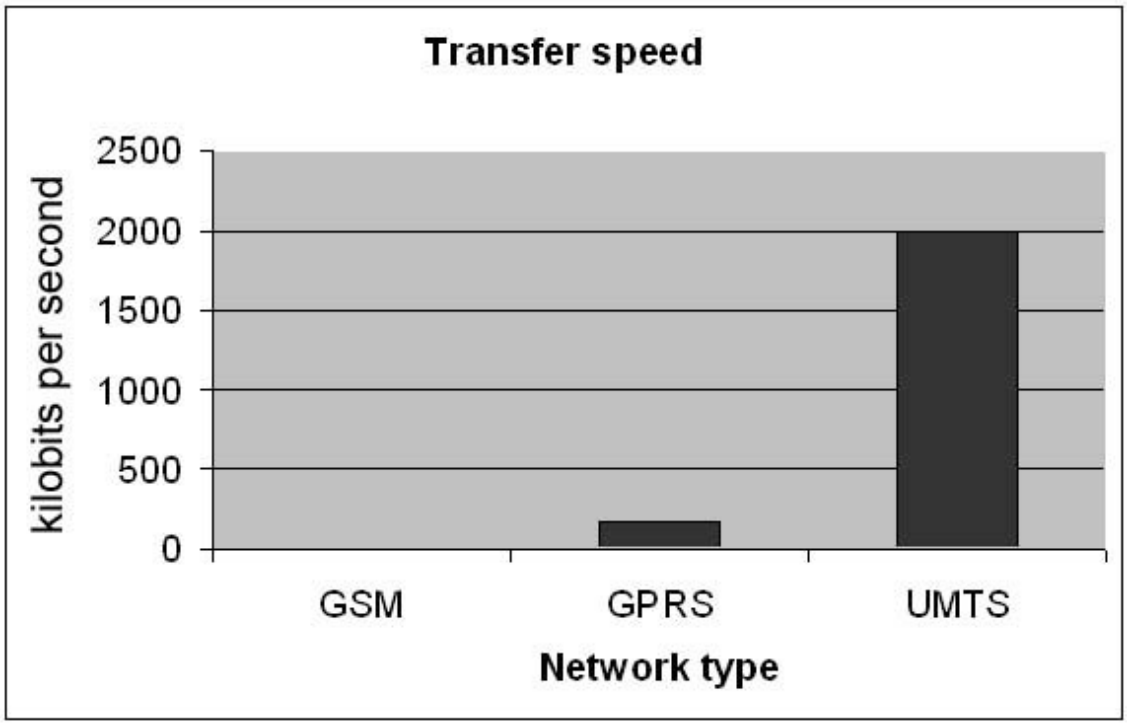

Figure 2: The different network types and their transfer speed in kilobits per second

2.2: Other relevant technologies

Apart from the wireless networks stated above, there are other technologies that could be used for m-commerce. Wi-Fi technology and GPS technology will be discussed here. Mobile devices are starting to have built-in Wi-Fi functionality. Wi-Fi is a popular name for a standard for Radio Local Area Network (LAN), mostly used for wireless computer networking using a radio transmitter and receiver. It is possible for Wi-Fi equipped devices to connect wirelessly to computer networks that in turn can be used to connect to the internet (Anker). For example, Wi-Fi equipped devices can connect to the internet in Wi-Fi equipped waiting rooms or areas, like airports, stations, and even in restaurants (McDonalds restaurants have internet access through, so called, hotspots).

GPS stands for Global Positioning System and is mainly used for navigating with the help of satellites. It can be used to determine one's precise location with an accuracy of approximately five meters and can be combined with different techniques to improve the accuracy up to 1 centimetre (Wikipedia). It is available for public use and is free of charge. Many mobile devices can be combined with a GPS receiver for enabling GPS functionality. Mobile phones with a built-in GPS receiver are available on the market today.

2.3: How do these technologies relate to m-commerce?

2.3.1: Telephony

M-commerce through telephony could be done by asking an additional fee for premium numbers. But, as mentioned earlier, in this paper only non-voice commerce activities through a mobile device are considered m-commerce. Therefore this subject will not be discussed.

2.3.2: SMS

Even though UMTS exists, only a small portion of mobile phone users use it. Every GSM mobile phone user can send SMSs, though. An SMS is a text message with a maximum

size of 160 bytes, sometimes enriched with small images like smilies (sometimes called EMS: Enhanced Messaging Service). Its younger brother MMS can additionally carry sounds and images. But the "inferior" SMS message is the most widely used. SMS can also be used for information services, voting in television shows, buying ringtones and wallpapers (functioning as a payment medium), entering contests, and in some countries it is even possible to do a Google search.

2.3.3: Mobile internet

Mobile internet over wireless networks (including Wi-Fi) enables the user to browse the internet on a mobile device or connect to online games. Now that the transfer rate is at a level comparable to broadband connections, e-commerce activities can be done on mobile devices. This broadens the m-commerce field significantly. Because mobile phones are becoming multi-functional devices, such as media players, more content like music and video can be sold through the internet to mobile users, and TV programs can be streamed to the mobile device. So m-commerce not only grows horizontally, the content becomes richer and more diverse resulting in vertical growth as well.

2.3.4: Context sensitive m-commerce

At the Carnegie Mellon University a group of people are working on a web environment called MyCampus (Sadeh et al., 2003), a context-aware environment aimed at enhancing everyday campus life. The users connect to this web environment using Wi-Fi equipped PDAs. A key element of their architecture is called the e-Wallet, which supports automatic discovery and access of a user's personal preferences stored in the PDAs. Contextual attributes include the user's location on campus, her calendar, friends and classmates, food preferences, etc. An example of how MyCampus could work: a user is about to have lunch. A program (or agent) checks the local weather through an outside website. If it rains, the agent checks for places to eat that do not require the user to walk outside but "keeps in mind" that the user has an appointment or class in 20 minutes by accessing the calendar through the e-Wallet.

Using GPS these types of context-aware services can be applied anywhere. Suppose a user is walking outside with her mobile device looking for a place to eat. Using GPS a program could check for restaurants nearby and recommend a place to eat depending on the user's food preferences.

Google is running tests of a free wireless internet service called Google Wi-Fi. Google earns most revenue through online advertising, showing ads that are relevant to internet users based on their Google searches and internet behaviour. Offering wireless internet access gives the company another way to target the users with ads, but now not only based on their interests, but also based on their location (Mills, 2005).

It is clear that the 3G mobile internet technology will be the biggest contributor in expanding m-commerce in the coming years. The most interesting technology to discuss is therefore UMTS. In the next section the business aspects of m-commerce and the costs for making UMTS widely available are discussed.

3: BUSINESS ASPECTS OF M-COMMERCE

3.1: Costs and revenues of "traditional" m-commerce

In this section the costs and revenues of m-commerce will be discussed for well known technologies (2G and 2.5G) as well as the relatively new UMTS (3G). First, the "traditional" (2G and 2.5G) m-commerce will be discussed, which is mostly based on sending text messages, downloading ringtones, wallpapers, and games.

3.1.1: Costs of enabling 2G and 2.5G m-commerce

SMS messages could be considered as the first non-voice commerce activity through a mobile device. The cost of enabling SMS is negligible, as the already existing GSM network is used to send the message.

GPRS also uses the existing GSM network, and it is not very difficult to modify an existing mobile network and enable GPRS. The two most important additions are the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Node (GGSN). These nodes take care of the processing of the packet-based GPRS data traffic. The SGSN takes care of information for payment through a mobile phone, while the GGSN works like a link between the GPRS network and other networks, like the internet. The nodes are typically based on a general purpose packet switching platform that uses standard software components (Granbohm et al., 1999). The base station merely needs a software upgrade. So it is safe to say that it is relatively very cheap to enable 2G and 2.5G m-commerce as opposed to enabling 3G m-commerce as will be seen later in this paper.

3.1.2: Revenues of 2G and 2.5G m-commerce

According to Dajes, 2004, mobile service revenues in Western Europe will increase steadily according to Figure 3:

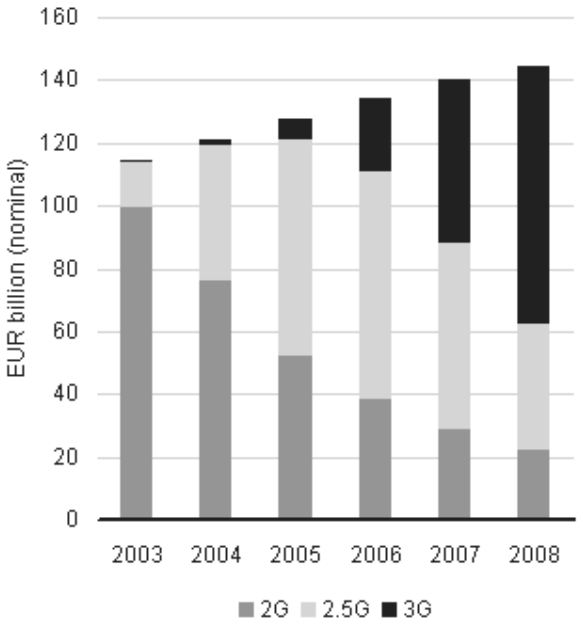

Figure 3: m-commerce revenue in Western Europe in billion Euros

The report was written in 2003, this means the figure for 2003 should be fairly reliable. However, the figure shows only the non-voice revenue, but is this the same as m-commerce? Dajes broke down the services in eight categories: voice, person-to-person messaging, data networking, browsing, paid information, e-tainment, m-commerce, and

video telephony. So according to Dajes, m-commerce is just one of eight services. The definition Dajes gives for m-commerce are transaction-oriented services, including e-pay facilities, mobile shopping portals, mobile banking and share trading, and bookings and ticketing, but excluding games and other forms of content. The definition of m-commerce given earlier in this report would include seven of eight services, namely all but voice, and that is exactly what the figure above is based on. So m-commerce (as defined earlier in this paper) revenue in 2003 for Western Europe was around 118 billion Euros. The figure shows a division of the revenue in three generations, 2G, 2.5G, and 3G. Revenues created by 3G in 2003 are relatively small as can be seen in the figure, but Dajes expects 3G revenues to grow to 80 billion Euros in West Europe by 2008, catching up to the revenue created by 2G and 2.5G m-commerce.

3.1.3: UMTS: what does it cost?

The next figure shows that the costs for operators that want to provide UMTS to customers can be broken down in eight categories, namely: license costs, operational costs, network set up, content acquisition, product development, customer acquisition, handset subsidization, and fixed marketing costs (Yang, 2003).

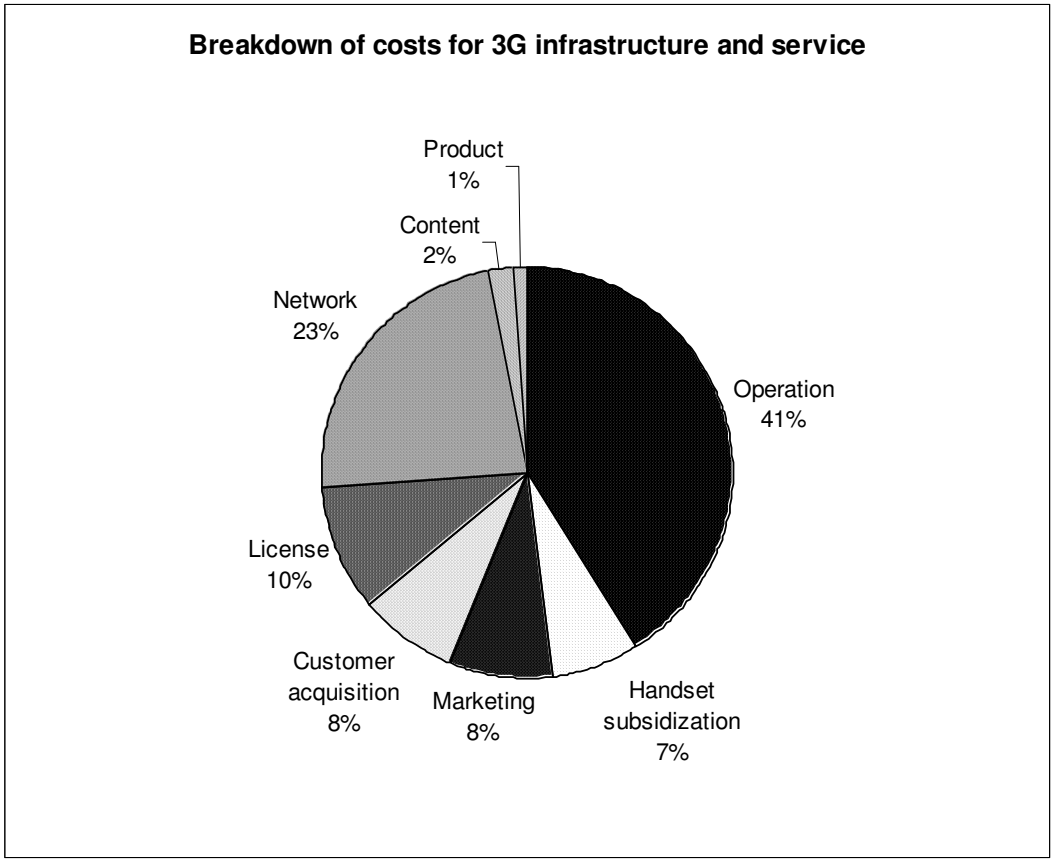

Figure 4: UMTS roll out costs broken down in eight categories

The costs for licenses are calculated next and the breakdown will be used to estimate the total costs of providing UMTS and its services and content.

3.1.3.1: License costs

The costs made by operators for acquiring a license in several European countries is given in the next table (Bauer, 2001):

Country	Population (millions)	Total UMTS license fees (billion Euros)	Total license fees (per head population)	Number of subscribers (thousands)	License fee per subscriber
United Kingdom	60	38	633	23919	1589
Germany	82	50,8	620	23477	2164
France	58	20	345	20594	971
Italy	57	12,2	218	30080	406
Netherlands	15	2,7	151	6797	397
Austria	8	0,8	100	4200	190
Switzerland	7	0,128	18	2943	44

Table 2: license fees per capita

If one examines the costs per capita and costs per current subscribers of the licenses it is clear that significant revenues will be needed to cover these costs. For the Netherlands, in the best-case scenario the per-subscriber license fee is 151 Euros (if everyone subscribes to UMTS), while in the worst-case scenario the fee is 397 Euros. One must consider that these are merely the costs of the licenses, and are only a tenth of the total investments (Bauer et al., 2001). But what if current subscribers are not happy with the UMTS service and decide to end their subscriptions? If no new subscribers are attracted, the license fee per subscriber would be even higher in the worst case scenario. The number of subscribers is also misleading: it seems that this is the number of GSM subscriptions; it is hard to imagine that already almost seven million Dutch people were subscribed to a UMTS service in 2001, whereas UMTS was launched in 2002 in the Netherlands. And what about next generations? The table gives an impression as if 151 Euros should be earned from each subscriber if everyone in the Netherlands would have a UMTS subscription. The table fails at showing the duration of the license, which is different for each country (CEPT, 2004), (European Commission, 2002):

Country	License start	License end	Duration
United Kingdom	2001	2021	20
Germany	2000	2020	20
France	2001	2021	20
Italy	2002	2017	15
Netherlands	2002	2017	15
Austria	2000	2020	20
Switzerland	2001	2016	15

Table 3: start, end, and duration of UMTS licenses

Table 4 shows how much each country should earn from each subscriber for each year of the duration of the license if everyone in the country subscribes to UMTS in order to earn back the license fee. So if each person in the Netherlands has a UMTS subscription (and the population does not grow or shrink considerably in 15 years), the operators will earn the license fees back if they earn 12.00 Euros or more per subscriber per year on average. This means that, considering all other factors equal, it will be much more difficult for the operators in the UK to earn back the license fees compared to the operators in Switzerland. The stable case is a better name for what is called worst case by Bauer (because the real worst case could be a lot worse). Also, it should be mentioned that it is assumed that all current GSM subscribers will sign up for a UMTS subscription, which really is not realistic at all, at least not in the near future. It might be more realistic to call the stable case the best case, as the number of GSM subscriptions might give a better idea of the real number of potential customers. As of November 2005, the total number of UMTS subscribers worldwide is 40.6 million, and for Europe 17.9 million (UMTS-Forum, 2005). Keep in mind that part of the UMTS subscribers use UMTS with a laptop and not with a mobile device, currently there are more than one million 3G data card users worldwide. This means that approximately 39.5 million UMTS users are using UMTS with a mobile phone. Assume that of 17.9 million total UMTS users in Europe there are 17.5 million UMTS subscribers that are using UMTS with a mobile UMTS equipped

phone. As of 2004, there are over 570 million GSM subscribers in Europe (International Telecommunication Union, 2004) and probably even more today. Assume the number of GSM subscribers has stayed the same until now, then only 3% of the Europeans with a GSM subscription has a UMTS subscription. So it is clear that, at least until now, the worst case (let alone the best case) according to Bauer, is even a too good approximation for the best case. Based on the findings, it is safe to say that up until now UMTS is not generating enough revenue to compensate for the licensing fees in Europe, let alone all the other costs made by the providers. But, considering UMTS's age, this may change in the future.

Country	Fees per year (million Euros)	Best case	Stable case
United Kingdom	1900.00	31.67	79.43
Germany	2540.00	30.98	108.19
France	1000.00	17.24	48.56
Italy	813.33	14.27	27.04
Netherlands	180.00	12.00	26.48
Austria	40.00	5.00	9.52
Switzerland	8.53	1.22	2.90

Table 4: UMTS license fees per year

3.1.3.2: Total costs

Assume that the breakdown of the costs given above is accurate, and consider that the total cost of the licensing fees for the seven countries above is 124.628 billion Euros. The total cost over 15-20 years would be 1,246.28 billion Euros (the licensing fees are only 10% of the total cost), that is approximately 60 to 80 billion per year. Remember that not all of these costs are made by the mobile operators, but a very large part of it is. Other players involved are, for instance, suppliers for infrastructure and software applications, mobile portal providers (they make stripped down versions of traditional websites), content providers, and handset providers.

3.1.4: Revenues

In 2002, operators expected that UMTS would bring in 5% of total revenues in the first year (2003) and 39% in the fifth year (2007) (Forrester Research, 2002). If the estimate of the total costs made earlier is realistic, it can be said that operators expected to earn at least that amount to break even and thus expected to earn at least 62 billion Euros in 2003 and a cumulative of at least 486 billion Euros in 2007. Forrester's prediction back in 2002 was that only about 10% of European mobile users will use UMTS in 2007, and that operators expected this figure to be five times larger: 50%. As shown above, only approximately 3% of mobile phone users used UMTS in November 2005. So even though Forrester's prediction of 10% was pessimistic, it remains to be seen if the UMTS user base can reach this penetration percentage by 2007. According to Forrester Research even with the operators' unrealistic penetration expectations, they will need to triple the 3G user ARPU (average revenue per user) to break even in 2007. More sensible penetration rates and a realistic, flat ARPU over the full license period push the average break-even point to 2014 for most countries, with the worst cases not breaking even before licenses run out.

According to Forrester Research, the slow growth of the user base is caused by:

- Setbacks due to complex UMTS technology and network planning. Before UMTS was up and running, there were many technological problems that needed time to get fixed. This resulted in early entrants having a bad experience due to bad connections;
- The lack of UMTS phones. 3G phones need to be able to switch between GSM and UMTS networks, support features like video streaming, a camera, Java and internet browsing – all in a low-cost, lightweight, low power unit. Manufacturers were still unsure about the consumer reaction to UMTS and all manufacturers

combined expected to ship only two million UMTS equipped phones globally in 2003, while 11 million were needed to meet the operators' expectations in Europe alone;
- Operators were mainly concentrated on getting the UMTS network to run. Business issues like forming partnerships, working out revenue-sharing models, and creating service-level agreements were postponed and stalled must-have UMTS service creation;
- Other existing services, such as i-mode and Japan's 3G service NTT DoCoMo's 3G Foma, were disappointing in terms of the user base and growth in the user base in 2002. Forrester expected UMTS to repeat history. However Foma has surpassed 20 million subscribers as of December 29, 2005, a little over four years since it was launched (3G.CO.UK, 2006).

UMTS phones sold in Europe are UMTS/GSM dual-mode phones, meaning the phone can also be used on the GSM network. This may also be a reason why consumer demand for UMTS is low. UMTS and GSM now co-exist, while in the 90's there was only one choice: GSM. Next to that, user demand for video telephony is not as high as expected, one of the main features that sets UMTS apart from GSM.

Wikipedia states the following problems and issues:
- Overweight handsets with poor battery life;
- Problems with handover from UMTS to GSM, connections being dropped or handovers only possible in one direction (UMTS→GSM) with the handset only changing back to UMTS after hanging up, even if UMTS coverage returns;
- Initially poor coverage due to the time it takes to build a network;
- For fully fledged UMTS incorporating Video on Demand features, one base station needs to be set up every 1–1.5 km. While this is economically feasible in urban areas, it is impossible in less populated suburban and rural areas;
- Competition for broadband access from Wi-Fi;
- Lack of significant consumer demand for 3G.

Some issues are related and/or overlapping with the issues mentioned by Forrester Research.

Even if UMTS is a money pit up until now, operators will not abandon it because they need the extra capacity as the number of mobile users has outgrown the capacity of the GSM network.

It is evident that the UMTS network has not met the operator's expectations in terms of penetration and revenues. However, it is relatively early to tell whether or not UMTS was a bad investment. It can be said that UMTS has had a bad start when considering the operator's expectations. For m-commerce, UMTS is expanding the ways for users to get in touch with it, i.e. UMTS has opened more possibilities with its connection speed and is another mean for users to get in touch with m-commerce. So whether or not the user base of UMTS is large, it does open new doors for people to participate in m-commerce. But clearly, m-commerce could potentially become a lot bigger when UMTS is more widely used.

Unfortunately, exact revenue figures for UMTS were not easily available and therefore are absent in this report. In Figure 3 it is easily seen that 3G m-commerce revenues in 2003 are almost non-existent in Western Europe. However, because m-commerce and e-commerce are overlapping, it might be difficult to detect whether a user bought an item through a mobile device, a desktop PC, or laptop and thus whether an e-shopper is participating in m- or e-commerce. It might be even more difficult for a seller to detect if the buyer is using GPRS or UMTS.

To give an illustration of how many people are using UMTS, Vodafone reported in September 2005 that 2 to 3 percent (this equals four million customers) of their total

customers have a UMTS subscription (Wiersma, 2005). It is not clear, however, whether or not these customers use UMTS for telephony or m-commerce activities.

3.2: Successful implementations of m-commerce

Following are a few examples of how money is earned through m-commerce.

3.2.1: Ringtones in Japan

Japanese artists have earned at least 65 million dollars in royalty payments of their songs sold as "ringtones" for mobile phones (Wireless World Forum, 2003).

3.2.2: The success of SMS

The number of SMS messages sent worldwide has grown very fast. In 2001, 250 billion SMSs were sent, while only 17 billion were sent in 2000. By mid 2004, SMSs were being sent at a rate of 500 billion per year, which are roughly 100 SMSs for every person in the world. Costing around $0.10 U.S. per message, the revenue generated by SMS is $50 billion U.S. (Wikipedia).

3.2.3: MMS a success in Norway

In the first six months of 2005, 88 million MMS messages were sent in Norway. This equals 19 MMS messages per Norwegian customer on average in this period, making the Norway mobile user the most industrious user of MMSs worldwide by far. At a price of approximately 0.34 Euro, MMS messages generated almost 30 million Euros in this period for Norwegian operators. MMS, at the time at "age" two and a half years, generated more revenue than SMS did, when it had the same "age". To give an illustration of the growth in MMS usage in Norway: in the same period in 2004, the total number of MMS messages sent was only 20 million (Admanager, 2005).

3.2.4: Mobile game developer generates revenue of $80 million U.S.

Mobile game developer Jamdat generated an estimated $80 million U.S. in revenues in 2005 and expects to generate $120 million U.S. in 2006 (Brown, 2006).

3.3: Target groups

M-commerce is very broad and, therefore, the target group for m-commerce is very large because of that. The target group for m-commerce cannot be defined similar to that for physical products. There are too many different services and products. Of course, a target group could be defined for each type of service or product.

According to India Infoline, however, the target group in India can be described by the following:
The targeted user group consists of people already familiar with the internet and use mobile phones. They would also need to be capable of paying an additional premium fee to access value-added products and therefore would mostly belong to Socio-Economic class A and would also have the following characteristics:

- Aged at 20-35 years, people that are most likely more responsive to new technologies;
- Living in urban areas, mainly the four metropolises which have a very high mobile phone penetration rate of approximately 60%;
- Prosperous rural areas where telephone connectivity and infrastructure is poor, but where a group of people exists that are willing to pay for commercial services. M-commerce may even be superior to internet-based e-commerce in such cases (India Infoline, 2002).

This profile is, of course, not the same in other countries across the world and some profile characteristics might need a revision. For example, it is not necessary to be familiar with the internet at all to participate in m-commerce activities. Consider the m-commerce activity of sending an SMS. Sending an SMS is hardly an activity that requires

any experience with the internet. Of course, it might come in handy when chatting, sending e-mail, browsing, or shopping online has been done before on a desktop pc, but it is not mandatory. Second, most people that are able to afford a mobile phone are able to pay for a m-commerce service, like sending an SMS. The costs are only around 10 eurocents in Western Europe, so one does not need to belong to socio-Economic class A. This might be true for the more expensive services, however. Third, in, for instance, Europe, as of 2004, the cellular mobile subscriber penetration is higher than 70%, and for the Netherlands this is even more than 90% (International Telecommunication Union). There is a lesser need to worry about the demography as almost everybody has a mobile subscription. Of course, this is entirely different for UMTS-only m-commerce activities, such as video telephony. Virtually all phones in Western Europe are capable of sending SMS messages, many phones can connect to the GPRS network, and a very small percentage of mobile devices have access to UMTS or broadband internet through Wi-Fi.
It can be said that the target group depends on the user's type of mobile device and subscription, the compatibility of m-commerce services and products with the devices and the country in which the product or service is offered. Next is age. Again, this depends on the services and products, but also has a relation to the device. Younger people might not be able to afford expensive phones capable of connecting to the UMTS network, and older people might be scared off by the complexity of 3G phones. Also, a businessman is probably more interested in checking the stock quotes on a mobile device than a teenager.

As stated earlier, it is more realistic to define target groups for different product and service types, rather than defining one user profile and market those products and services to the corresponding target groups. Some examples are given below. Note that these are just examples of how target groups can be defined for different products and services. The figures presented are incomplete and not proven to be true as these examples are only for illustrating how it can be done.

Product type:	SMS
Target group device:	GSM and/or UMTS compatible
Target group age:	Between 10 and 80 years
Target group demography:	Where a GSM / UMTS network is available
Target group income:	Any, SMS only costs around 10 Eurocents

Product type:	Video telephony
Target group device:	UMTS compatible
Target group age:	Between 20 and 35 years
Target group demography:	Where a UMTS network is available
Target group income:	> (insert amount)

Product type:	MP3
Target group device:	GPRS and/or UMTS compatible
Target group age:	Between 10 and 80 years
Target group demography:	Where a GPRS / UMTS network is available
Target group income:	> (insert amount)

3.4: Consuming market

Again, because m-commerce is so broad, the consuming market is also very large. Tariffs of mobile communication have become low and handset costs are low due to heavy competition. In the same way as target groups, consuming market needs to be defined for different products and services. Some examples (for the Netherlands in 2004):

Product type:	SMS
Consuming market:	14,800,000

Product type:	Video telephony
Consuming market:	(number of UMTS devices in the Netherlands)
Product type:	MP3
Consuming market:	(number of devices that can play MP3 files)

As of 2004, there are more people in the Netherlands with mobile subscriptions than there are people that have access to the internet at home, (≈91% versus ≈73%) (International Telecommunication Union), (CBS, 2004). This means that more people have access to m-commerce than e-commerce. As phones keep improving in functionality and are becoming cheaper, more doors besides SMS are opened to allow for other types of m-commerce. For instance, now that more and more devices allow for video playback, analysts expect the mobile video market to be worth 5.4 billion dollars in 2008 (Emerce, 2004). However, do not expect commerce through internet to become big on mobile phones anytime soon. As of the year 2005, only 3 percent of the online revenue was due to transactions through mobile phones. In Europe, this was only 0.1 percent (Emerce). This market is dominated by e-commerce using PCs.

4: THE FUTURE OF M-COMMERCE IN THE NETHERLANDS

4.1: Present situation

Next, an overview will be given of the situation in the Netherlands: what networks are available, what is the penetration rate of mobile phones and what potential does m-commerce have?

4.1.1: Available networks in the Netherlands

The first GSM network became operational in 1994 in the Netherlands, GPRS was introduced to consumers in 2001 and in 2002 KPN introduced i-mode (De Heer et al.). UMTS rolled out in 2002, but became available on mobile phones in June 2004. Coverage was only available in "de Randstad" (Blankesteijn, 2004). As of 2005, only two of five license holders (Vodafone and KPN) have a working UMTS network, national coverage of UMTS is expected in 2007 (the license holders have an obligation to cover at least 70% of the Netherlands). Telfort, one of the license holders, believes that UMTS is too expensive and, therefore, provides a cheaper alternative: EDGE. Although the transfer speed is far below that of UMTS, EDGE is capable of video and music download, but not of live television. However, a new technology called DVB-H will allow for live television on mobile devices and Telfort, therefore, sees no reason to use the UMTS bandwidth for this purpose. They are working on a UMTS network, but mainly because of the obligation that came with the license. They will not put it to use unless there is a good reason to do so (Van Miltenburg, 2005).

4.1.2: Current m-commerce penetration rate and market

Mobile subscription penetration is over 90% in the Netherlands, making it a very interesting country for m-commerce services. There are now more mobile phones than wired phones in the Netherlands. Surprisingly, even when mobile phones have become more sophisticated, the older audience has also been captured by these devices in the Netherlands. As of 2002, 45 percent of the Dutch elderly population (65 years of age and older) had a mobile phone and 14 percent sends SMS messages. Of the young audience (12 to 20 year olds) in the Netherlands, the percentage that sends SMS messages is 97 as of 2002. 26 million SMS messages were sent weekly in the year 2002 by Dutch mobile users (Multiscope, 2002).

What about other m-commere activities besides SMS? According to the four largest manufacturers and distributors of ringtones in the Netherlands, the Dutch market of ring- and video-tones (a ringtone that includes a small movie) is worth a revenue of twenty to thirty million Euros (Emerce, 2004). Unfortunately, revenue figures for mobile games and videos could not be found specifically for the Netherlands.

4.1.3: The potential Dutch m-commerce market

Internet subscription penetration is also very high in the Netherlands. This might mean that, relatively, Dutch people have more experience with e-commerce compared to other countries that have a lesser internet subscription penetration. This could influence the barrier of participating in e-commerce through mobile devices, and therefore participating in m-commerce in a positive way.

Mobile phones are becoming multi purpose devices, such as cameras, MP3 players, organizers, navigation devices, pocket PCs, gaming machines, etc. Memory has become relatively cheap which means that downloading content is possible on more and more devices. M-commerce is becoming more and more like e-commerce due to this, but still relies a lot on content (games, ringtones, wallpapers, etc.). And the internet is not as accessible on a mobile device as it is on a computer. As stated earlier, online shopping using mobile phones is almost non-existent in Europe (also in the Netherlands). This

could change when mobile internet becomes faster and more user-friendly, but probably not in the near future.

4.2: Comparison with Japan

What makes m-commerce so big in Japan and why? Answering these questions may help in identifying what has to be done in order to increase the presence of m-commerce in the Netherlands and Europe.

4.2.1: How m-commerce took off in Japan with I-mode

NTT DoCoMo Inc., the world's leading communications company, launched I-mode in 1999. After only 3 months, the number of customers exceeded 220,000 and after 6 months the 1 million mark was surpassed (India Infoline, 2002). Shortly after I-mode launched, DoCoMo's competitors launched similar services, one of which was acquired by Vodafone and renamed to Vodafone Live! As of June 2006 over 80 million subscribers in Japan use these services. 46.8 million out of 80 million are I-mode clients. In contrast, there are only 5 million I-mode users outside of Japan as of June 30th, 2006 (Wikipedia). According to India Infoline, the success of I-mode lies in the following features:

- The service can be used anywhere, anytime;
- A wide diversity of content, carefully selected to ensure that the services they provide are useful in everyday life and suitable for a portable medium (such as mobile phones);
- The creation of I-mode sites is simple, because I-mode is based on the HTML and HTTP protocols;
- I-mode is based on packet data transmission, allowing users to be online at all times while only being charged when data is transferred, not the amount of time spent online. This allows, for instance, that e-mails are displayed automatically when they arrive;
- The services and the I-mode handsets are simple and user-friendly;
- The billing system for using services is very convenient for the customer and service providers. Even when using services from different providers, the customer pays DoCoMo, and DoCoMo in turn pays the providers. This way, the customers do not have to deal with multiple billing agencies, and service providers do not have to deal with billing all their customers.

4.2.2: The current G3 penetration in Japan

Japan was the first to launch a 3G services on a large scale. As of December 29th 2005, NTT DoCoMo announced that the number of subscribers to their 3G FOMA service in Japan, launched on October 1st 2001, surpassed the 20 million mark (3G.co.uk, 2006). According to DoCoMo the rapid subscriber growth was made possible by mainly:

- A large range of 3G handsets;
- Information download services;
- Automatic information update services;
- A nationwide coverage.

4.2.3: Some example services unavailable in the Netherlands

- Besides the features known in Europe (for instance, video telephony, watching TV, buying ringtones, etc.), current handsets in Japan can be used as a debit or credit card (Wikipedia). This mobile phone wallet technology uses a chip inside the handset that can be charged with credits and a user can pay by putting his or her handset near a special reader. The system is quite popular and can be used in many convenience stores. It may lower the threshold for participating in m-commerce for consumers, as it is another easy way for paying for m-commerce services. For instance, Japanese customers can book a flight through the I-mode enabled ticket service and on the day of travel the ticket can be picked up and paid with the mobile phone wallet;

- A QR (Quick Response) Code is a two dimensional bar code which can be read by mobile (camera) phones (Figure 5). QR codes are common in Japan and relieve the user of the tedious task of entering data in their phone. Instead, a photo of the code can be made and the data, for instance URLs or business card information, is read into the phone. The user can visit the website without having to type a URL, or having to quickly copy personal details. The QR codes are becoming increasingly common in magazines and advertisements in Japan, opening many doors for m-commerce;

Figure 5: QR code

- In Japan, there is a service that sends out a beacon with your location. This service can, for instance, be used by children to let their worrying parents know where they are by displaying a map with the child's position. This service is rather popular, because it allows the child to discretely let himself be monitored rather than making a phone call in front of their friends (Cellsuite, 2005);
- Using GPS, a satellite image (street level) of the user's current location can be downloaded to the phone with the aid of for instance Google maps. This can be used to find a certain store or attraction.

4.2.6: Cultural differences

Japanese people generally are more familiar with the newest technology (and are more eager to own the latest gadgets) than Dutch people and therefore may be more likely to engage in m-commerce activities. In Japan, there is even a so called "keitai culture", which translates into "mobile culture" (Wikipedia). However, the current generation in the Netherlands is getting more and more familiar with technology, so this gap may become smaller over time, but the Dutch do not have such a thing as a mobile culture. Due to this culture, Japanese people are more familiar with the possibilities of their handsets and, therefore, are more likely to engage in m-commerce.

4.3: What can be done to increase m-commerce's presence?

4.3.1: Copy from Japan?

Of course, implementing the features and providing a wide range of handsets and services in the Netherlands does not guarantee the same success m-commerce has in Japan, but it is certainly worth to take a look at what could be done in order to get closer to the Japanese business model for 3G. What I-mode features that were critical for its success (according to India Infoline and DoCoMo) are (un)available for Dutch customers today?

- GPRS can be used anytime, anywhere, but is relatively slow. UMTS cannot be used anywhere, as coverage is not nationwide in the Netherlands. Therefore, nationwide UMTS coverage could stimulate m-commerce;
- The diversity of content is very wide, as, for instance, surfing the internet is possible, but most websites are not specifically made for mobile devices. However, Vodafone Live has its own categories that seem to be selected for using in everyday life and especially made for UMTS handsets. Whether or not these

sites are used by Dutch people is hard to say, but there seems to be enough content;
- Whether or not the Dutch population experiences the services and handsets as user-friendly is hard to say. I-mode has never broke through in the Netherlands, and that was partly due to the high costs. The devices also ran out of battery power really fast. Current UMTS devices are undoubtedly better, and the costs for m-commerce services have also come down but it might still be a high threshold for the Dutch population. However, even though handset batteries have improved, the handsets may also draw more power, for instance, due to bigger full colour screens, bluetooth, Wi-Fi, GPS, etc.
- Getting online and paying for services can be done in different ways: for instance, it is possible to be online constantly and pay for data transfer only, but it is also possible to go online and pay per minute. Also, surfing on Vodafone Live! sites is cheaper than surfing on internet sites. With a different subscription form no additional costs are charged for surfing both Vodafone Live! sites and the internet. And then there are many different charges depending on the services: video telephony, mobile TV, music and ringtones, games, MMS, e-mail, etc. These different price constructions may be a source for confusion for the Dutch customer. A more transparent and clarifying price structure may improve things;
- Billing for content, such as ringtones or games, is the same as for I-mode in Japan, an additional fee for the service is added to the phone bill. Therefore, this is not the cause for Dutch people not engaging in m-commerce as the Japanese people do. Also, a mobile phone wallet may lower the threshold for paying using a handset;
- There is a wide range of UMTS handsets to select from today. How this choice was in the past few years is hard to say, but the number of different handsets should not be a problem today as there are approximately 50 handsets capable of connecting to the UMTS network. However, the 3G handsets do not seem to interest the European consumer very much, operators had to give away the handsets because nobody was buying them (International Herald Tribune, 2006). Whether this is due to the quality of the handsets or the quality of the 3G services, or both, is not easy to say;
- Information download and update services are available today, so this should not be a cause for not engaging in m-commerce.

4.3.2: Other possibilities for increasing m-commerce activities

- Advertisement-companies may be willing to pay for (maybe, a part of) premium content. This makes the content cheaper and thus more accessible which influences the use of m-commerce in a positive way;
- Handsets and services should be more user-friendly in general. Moreover, because Japanese people are more familiar with technology, the user-friendliness for both handsets and services should be improved even more for the western market;
- Use more standardized browsers and pages, cheaper 3G connections, more standardized technologies and protocols, more user friendly applications. In general, make the internet more accessible for mobile devices and less inferior than internet on home PCs;
- As the speed of mobile internet increases and memory becomes cheaper, the content can be larger in size. So a transition can be made from ringtones, wallpapers, and small games, to MP3s, video, large (online) games, and applications, respectively (vertical growth);
- New technologies bring new ways to make money: (location and context specific) advertising with the help of GPS, payment with mobile devices instead of credit cards, using mobile devices as a key, etc.

5: CONCLUDING REMARKS

With UMTS, the current mobile network seems to be catching up with broadband internet connection speeds. However, the price paid for the network will most likely not be earned back in the near future, as UMTS is not catching on in Europe. The reasons for this are lack of nationwide coverage in most European countries, handsets that are not user-friendly and run out of battery power too quickly, lack of attractive but affordable services, and confusing price structures.

These problems aside, a fast connection can be used to unleash many new m-commerce services: MP3s instead of (or rather, next to) ringtones, videos next to wallpapers, bigger (online) games, location specific services using Wi-Fi and GPS, and in general a much better internet experience. However, many m-commerce activities have cheaper substitutes. In order to make m-commerce more attractive it should become cheaper. This can be done by advertising as is done on TV and internet to lower costs, and maybe even location and context sensitive advertising.

In the Netherlands a UMTS network is up and running, however, there is no nationwide coverage, and not all providers are optimistic about the future of UMTS. UMTS handsets sell badly, and it seems that m-commerce is not evolving as expected now that a 3G network is in place. There is still a long way to go before the Dutch and European m-commerce is on par with Japan's, if it ever will be. The technology is here, the handsets are here, so it seems that the business model is faulty and/or the market is not ready. In short, the main causes are high prices, complex handsets, and a too optimistic attitude in slowing m-commerce's evolution.

6: GLOSSARY

1G:	First generation mobile networks, including: Advance Mobile Phone System (AMPS) in North America, Total Access Communication System (TACS) in UK, Nippon Telegraph & Telephone (NTT) in Japan, Code Division Multiple Access One (CDMAONE).
2G:	Second generation mobile networks: Global System for Mobile Communication (GSM), Code Division Multiple Access 2000 (CDMA2000), High Speed Circuit Switched Data Technology (HSCSD).
2.5G:	"Second-and-a-half" generation mobile networks: General Packet Radio System (GPRS), Enhanced Data Rate for GSM Evolution (EDGE).
3G:	Third generation mobile network: Universal Mobile Telephone Standard (UMTS).
Commerce:	commerce is the trading of something of value between two entities. That "something" may be goods, services, information, money, or anything else the two entities consider to have value.
E-commerce:	e-commerce consists primarily of commerce over electronic systems such as the Internet and other computer networks.
GPRS:	General Packet Radio System. A mobile data service available to users of GSM mobile phones.
GPS:	Global Positioning System. A system that uses satellites for accurately determining the location of a GPS receiver.
GSM:	Global System for Mobile Communication. The most popular standard for mobile phones in the world.
HTML:	HyperText Mark-up Language. A language designed for the creation of web pages.
I-Mode:	A wireless internet service made specifically for handsets. Provided by NTT DoCoMo.
M-Commerce:	E- commerce made through mobile devices.
MMS:	Multimedia Messaging Service. A messaging system that allows sending messages that include multimedia objects besides text.
PDA:	Personal Digital Assistant: an electronic device that can include some of the functionality of a computer, a cellphone, a music player, and a camera.
QR code:	Quick Response code: A two-dimensional bar code used for (among other things) quickly reading data with a mobile phone that has a camera.

Smartphone:	Any electronic handheld device that integrates the functionality of a mobile phone, personal digital assistant (PDA), or other information appliance.
SMS:	Short Message Service, a popular form of text messaging on cell phones.
UMTS:	Universal Mobile Telecommunications System: one of the third-generation (3G) mobile phone technologies.
WAP:	Wireless Application Protocol: an open international standard for applications that use wireless communication.
Wi-Fi:	The underlying technology of wireless local area networks.

7: REFERENCES

3G.CO.UK. (2006). 3G FOMA Subscribers Top 20 Million Mark. *http://www.3g.co.uk/PR/Jan2006/2438.htm*

Admanager. (2005). MMS is a Huge success in Norway. *http://www.admanager.nl/mobile/nieuwsbericht.php?id=3470&backlink=%2Fmobile%2Fnieuws_zoeken.php%3Fsearch%3Dsms%26start%3D40*

Anker, P. Wegwijs in Frequentieland. *http://www.frequentieland.nl/*

Bauer, J. M. and Westerveld, R. and Maitland, C.F. (2001). Advanced Communications Infrastructure: Technical, economic and regulatory conditions of UMTS network deplyment. Faculty of Technology, Policy and Management, Delft University of Technology.

Blankesteijn, H. (2004). Mobiele videotelefoon nu te koop. *http://www.nrc.nl/krant/article80434.ece*

Brown, K. (2006). Games becoming a Mobile Play: Adapting Console Hits Gets Eyes On Small Screens. *http://www.multichannel.com/article/CA6297534.html*

CBS Centraal Bureau voor Statistiek. De digitale economie 2004. *http://www.cbs.nl*

Cellsuite (2005). http://cellsuite.jp/news/

CEPT. (2004). Final Report from CEPT on the 5th Mandate on IMT-2000/UMTS: Harmonisation of the frequency usage within the additional frequency band of 2500-2690 MHz to be made available for IMT-2000/UMTS systems in Europe.

Dajes, A. (2004). Western European Mobile Forecasts and Analysis 2003-2008 (September 2003 edition). *http://research.analysys.com/default.asp?Mode=article&iLeftArticle=1343&m=&n=*
*Note: the product overview of this article is used for reference, not the actual report.

Duarte, B. (2001). UMTS: challenges and perspectives. *Alcatel Telecommunications* Review, 1st Quarter 2001, 5-9.

Emerce. (2004). *http://www.emerce.nl*

European Commission. (2002). Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector.

Forrester Research. (2002). 3G Break Even Doubtful. *http://www.3g.co.uk/PR/October2002/4186.htm*

Granbohm, H. and Wiklund, J. (1999). GPRS - General Packet Radio Service. *Ericsson Review*, no 2.

Heer, J. De and Kranenburg, H. Van and Ponsioen, C. And Teeuw, W. (Year unknown) GigaPort Highlights 4 Personalisatie en context-awareness van mobiele diensten. *http://www.gigaport.nl*

India Infoline. M-Commerce. (2002).
http://www.indiainfoline.com/cyva/repo/mcom/ch01.html

International Herald Tribune. (2006). 3G cost billions: Will it ever live up to its hype?
http://www.iht.com/articles/2006/07/30/business/3G.php

International Telecommunication Union. (2004). *http://www.itu.int/ITU-D/ict/statistics/ict/index.html*

Mills, E. (2005). Google builds an empire to rival Microsoft.
http://news.com.com/Google+builds+an+empire+to+rival+Microsoft+-+page+2/2100-1032_3-5875433-2.html?tag=st.num

Miltenburg, O. Van. (2005). Waar blijft het success van UMTS?
http://www.hccmagazine.nl/index.cfm?fuseaction=home.showArtikelen&id=47822

Multiscope. (2002). *http://www.multiscope.nl/layoutarchstatistiek.phtml*

OECD. (2001). OECD Communications Outlook. *Paris: OECD.*

Sadeh, N. and Chan, E. and Shimazaki, Y. and Van, L. (2002) MyCampus: An agent based environment for context-aware mobile services. *AAMAS- First International Joint Conference on Autonomous Agents and Multi-Agent Systems.*

UMTS-Forum. (2005). *http://www.umts-forum.org/servlet/dycon/ztumts/umts/Live/en/umts/Resources_fastfacts*

Webwereld. (2005). Yahoo Shopping gets 'social commerce' features.
http://www.webwereld.nl/articles/38352/mobile

Wiersma, T. (2005). Vodafone: vier miljoen UMTS-abonnees.
http://www.emerce.nl/nieuws.jsp?id=844429

Wikipedia. *http://en.wikipedia.org/*

Wireless World Forum. (2003). *http://w2forum.com*

Yang, Y. (2003). UMTS Investment Study. *Seminar Report, Telecommunications Business II, Helsinki University of Technology.*

Yates, D. (2005). M-Commerce Twice the Cash Value of E-Commerce.
http://ezinearticles.com/?M-Commerce-Twice-the-Cash-Value-of-E-Commerce&id=70225