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A comparative study of JME vs. Flash Lite for mobile data services

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Abstract

Mobility is one of the most invigorating features, having an enormous impact of how communication is evolving into the future. It is estimated that there are over two billion mobile subscribers worldwide and that this figure is projected to grow close to four billion by 2010, which is 50% of the world's population. As voice becomes less of a deterministic factor in reducing customer churn, mobile operators are now looking to mobile data services to differentiate themselves from their competitors and at the same time, generate substantial revenue in order to maintain or increase their market share. This has led to the advancement of mobile data services ranging from simple text messaging to complex e-commerce services. This paper aims to identify and explore the evolution of mobile data services and discuss current and future mobile developments and services.

1 Introduction

Initially, speech quality was the most important factor for customers in selecting mobile communication services [Mattila, V. V., 2003] but with the advancement of technology leading to improved audio quality, the difference is less noticeable and speech quality is no longer a competitive factor in attracting and retaining customers. This increases the already high levels of volatility and rapid rates of change experienced in the mobile industry. For example, in 2006, voice calls for the majority of UK users declined by 28 % for prepaid customers and by 22 % for postpay customers [Ahonen, T., 2007]. Over the same period SMS text messaging grew by 43 %. Whilst voice revenue continues to fall, there are an estimated 350 billion text messages sent every month

globally. This shows a paradigm shift in the factors that are contributing to the increase of revenue for mobile operators. In addition to the nullifying of voice as a competitive factor, mobility companies are faced with great expenses in the acquiring of licenses to offer 3G services. In the majority of countries this is done by way of an auction. More than $95 billion has been spent on 3G licenses and $125 billion invested on technology infrastructure by major mobility companies such as Vodafone, France Telecom and Deutshe Telecom [Forrest Research., 2000]. It is expected to take a long time to recoup these costs. Another challenge faced by operators includes high levels of customer churn (customers switching to another MNO) and the lack of Mobile Network Operator's (MNO) intelligence on customers' usage patterns. According to Preez et al. [Reinhardt et al., 2001], customer churn is exacerbated by trends such as shorter contract lifecycles (12 months instead of 24) and number portability, where a customer keeps their number when they switch to another operator. In addition, Preez et al. state that customer intelligence currently focuses on aspects such as monthly spending, income and related factors, whereas lifestyle segmentation features will be important to data services. This is true in the sense that customers will only spend whatever proportion of income they generate to data services that meet their individual needs which have been directly influenced by their lifestyle. Audiences are aware of their social and psychological needs and actively seek the media to fulfil those [Katz et al., 1974]. Therefore, it is of paramount importance for operators to study the growth of mobile data services, not only in the technological arena, but also in tandem with information regarding the needs and preferences of clients. A mobile data service is any service offered on a mobile phone besides voice. Data services are a source of additional revenue, which could slow the current trend of falling Average Revenue per User (ARPU) and support the recovery of 3G license costs. Data services could also provide operators with customer information since they may be required to register for the service and in the process complete a questionnaire regarding preferences about the potential client. In addition, data services could reduce customer churn by offering unique and vibrant services. As discussed in the next chapter, there may also be lucrative relationships that develop as a result of mobile data service usage. For example, research shows that there is a positive correlation between mobile data service usage and increase in voice usage. That is, the more a customer uses data services the more they are like to use voice [Wei, R., 2006]. As an example, a customer may make a voice call on receiving e-mail from a friend or an SMS about a promotion hosted by a company. With these advantages and high penetration rate of mobile data services, it is of great value to study the evolution of the mobile phone and factors which contribute to the increased use of mobile data services, for which the next chapter has been dedicated.

2 Mobile phone data evolution

2.1 The dynamics of mobile phone data evolution

With increasing functionality and services offered, the mobile phone as a hybrid medium has become an integral part of mass communication presenting an alternative channel of communications and entertainment. Given the high penetration rate of mobile phones and an increasing number of mobile data services as illustrated in the previous chapter, the mobile phone can no longer be viewed simply as a peer-to-peer mobile talking device. This chapter draws on the uses and gratifications framework to examine and gain a better understanding of the expanded use of the mobile phone for mass communications and entertainment. Most research on this subject has only focused on one aspect that may contribute to the expanded use of the mobile phone and mobile data services. For example, one may focus on reasons why people use the new functions on a mobile phone and who tends to use mobile data services, whilst another may simple focus on the spectrum of technologies in the mobile industry as a key contributor to mobile phone data evolution. This approach might not present a realistic view of the development of this industry as it focuses on a single subset of an otherwise vast universe of contributing factors and also tends to ignore relationships and trends that may exist between factors. Hence, a broader approach encompassing several factors that contribute to the development of mobile data services is necessary. Instead of immediately focusing on the trend or development itself, the forces that produce the change or drive the trend are first examined. This is a more reliable way of analysing the dynamics of technological change since the factors that cause change are normally not themselves volatile over the short term [Preez, G., AND Pistorius, C., 2002]. Table 1 shows a causal model compiled for the 2.5/3G wireless data development [Preez, G., AND Pistorius, C., 2002]. As can be seen, one of the greatest strengths of the causal model is the fact that it provides a cohesive view of technological, social, political/regulatory and economic/market forces that affect a specific technological development. Thus the forces illustrated in Table 1 could represent subsets of a universal set of factors that affect the development of mobile data services. Hence, now that we have a broader and cohesive view of the contributing factors, subsets can be analysed further enabling a better understanding of the universe. We begin by discussing the widespread adoption of mobile phones as a driving force in the mobile data service evolution.

Table 1: A causal model for wireless data services [Preez, G., AND Pistorius, C., 2002]

Force producing change/driving trend	Trend	Impact/effect
• More and more of work and personal lives are spent on the move • Telecommuting and organisations with mobile workforces are on the increase • Globalisation	Increase in time spent away from home or office where users have access to Internet and/or corporate information sources	Demand for ubiquitous access to information and services (personal and business)
		Demand for greater convenience—ability to control home appliances from anywhere (monitor alarm, set VCR/central heating, etc.)
	Increase in time spent away from home town or city	Demand for access to location-based information from mobile devices (e.g., directions to get from X to Y; location of nearest restaurant, pharmacy, etc.)
Various enablers facilitate easier access to a wider range of information (e-mail, eRooms, electronic newletters, Internet)	Information overload	Demand for ability to filter information and customise the presentation according to personal preferences
Dramatic decrease in costs of mobile services	Increase in mobile usage	Mobile phones starting to replace wireline (fixed line) phones
Advances in semiconductor technologies	Smaller components; devices with improved display and computing functionality	Mobile access devices capable of offering complex, multimedia information or services
• Widespread adoption of mobile phones and other mobile access devices, e.g. PDAs • Charging mechanisms such as prepaid instead of contract terms	Increase in number of mobile users	Greater potential customer base for mobile services
	Some users who do not have PC access to the Internet will have mobile phone access	Ability to bring Internet access to new users
• Shorter product life cycles • Increased rates of technological and product innovation	Swift rate of adoption of new technologies and services	Potential rapid adoption of mobile data services
Introduction of new device linking technologies such as Bluetooth	• Increase in number of networked peripherals • Pervasive computing	• Greater usefulness and convenience of mobile phones and other access devices • Enables a greater number of possible data services
Information or services are accessed from a wide range of devices	Use of metalanguages such as XML, which makes the manipulation of device and format independent	Information consistency can be achieved regardless of access device utilised

2.2 Widespread adoption of mobile phones

The mobile phone has evolved from a symbol of status to a necessity, and then to a mobile lifestyle. According to Blinkoff [Blinkoff, R., 2001] and Ling [Ling, R., 2000], the motivating forces of mobile use for adolescents were social networking and peers, whereas family and security drove the use among adults. Work-related, emergencies, and social uses were identified as the primary categories of use among Finnish users [Roos, J.P., 1993]. While the motivations for mobile phone use include newer dimensions of status symbol, mobility, and immediate accessibility [Leung, L., AND Wei, R., 2000] [Ozcan, Y.Z., AND Kocak, A., 2003], Ruggiero [Ruggiero, T.E., 2000] suggests that new concepts like interactivity, demassification, and asynchronicity should be included when studying interactive communication media within the uses and gratifications framework. Thus, we can note that the mobile phone expanded boundary roles of users, for example, to take on both care giving roles and standby roles in emergencies [Geser, H., 2004]. With the introduction of versatile mobile data services ranging from television (news, weather, sports, and alerts of breaking events – the news of the SARS outbreak in China broke first by mobile phone users' text messaging), music to gaming, subscribers can customize this mobile content and stay informed and entertained anywhere, anytime. This is an important service as there is an increase in the number of work and personal lives spent on the move which is another driving force in the development of the mobile industry (Table 1**)**. From this we observe a relationship between subsets of factors that contribute to mobile data services development. Other interesting and important relationships amongst factors have also been noted. For example, Wei [Wei, R., 2006] predicted that the stronger the motivations of mobile phone users to pursue instrumental use (e.g., reassurance) from the mobile phone, the more likely they will use the mobile phone to seek news and information. Results of correlation tests from his research showed this prediction to be true. Wei further predicted and proved that the stronger the motivations of mobile phone users to seek ritualistic use (e.g., to pass time) from the mobile phone, the more likely they will use the mobile phone for entertainment. Table 2 shows results obtained from Wei's research. The construct was measured by 20 gratification items adapted from users who were asked to rate to what extent the mobile phone helped them meet their communication needs on a five-point scale where 1 meant "strongly disagree" and 5 "strongly agree". For example, the first factor, named "pass time", reflected six items focusing on the capability of the mobile phone to help users pass time.

Table 2: Factor analysis of mobile phone use motives [Wei, R., 2006]

The mobile phone helps you…	Pass time	Sociability	Reassurance	Instrumentality	Communication facilitation
Keep company	**.83**	.16	.05	.14	.14
Because the mobile phone is entertaining	**.82**	.13	.06	.23	−.03
Because using the mobile phone is fun	**.76**	.21	.10	.32	−.03
Because using the mobile phone relaxes you	**.75**	.15	.11	.31	.01
Pass the time	**.72**	.32	.12	.18	.19
Chat or gossip	**.65**	.41	.03	−.26	.38
Let others know you care for them	.11	**.78**	.11	.26	.13
Stay in touch with people you don't see often	.30	**.76**	.05	.09	.23
Keep up-to-date on people and events	.37	**.67**	.11	.10	.24
Feel involved with what's going on with other people	.50	**.67**	.05	.07	.17
Get a sense of security	.20	−.01	**.86**	−.05	.00
Have a feeling of safety	.08	.00	**.82**	−.04	.11
Give you peace of mind	.21	.23	**.76**	.12	−.12
Have on hand in case of emergencies	−.11	.04	**.60**	.09	.09
Seek information about products or services	.28	.05	.01	**.74**	.25
Schedule appointments	.21	.37	.04	**.71**	.05
Order things	.46	.10	.11	**.68**	.16
Get news and info	.30	.08	.03	.22	**.80**
Stay informed and in touch anywhere any time	−.04	.27	.12	.07	**.64**
Multitask	.028	.47	−.05	.14	**.61**

2.3 Culture

We shall now discuss another important aspect regarding widespread adoption of mobile phones as a driving force in the mobile data service evolution, and this is culture. Hofstede [Hofstede, G., 1980] defines culture as "the collective programming of the mind which distinguishes the members of one group of people from another". According to Choi et al. [Choi et al.,2005], "culture cannot be understood by studying one individual; rather, culture can only be read clearly as a set of shared characteristics within a group of people that affects the behaviours of individual members by providing norms for that group". Culture has a great influence towards the system interface of a device as diverse groups of people interpret interface designs differently which could lead to the acceptance or rejection of a service. Hence, Human Computer Interaction (HCI) practitioners are faced with the challenge of offering usable products and services to an enormous variety of users [Khaslavsky, J., 1998]. It is not enough to simply translate messages (or in any case; software) into a different language to localize them culturally [Russo, P. AND Boor, S., 1993]. Several important

factors need to be considered relating cultural aspects of the locales to the software under discussion (mobile data services in this case). Choi et al. [Choi et al., 2005] identify key factors that differentiate cultures from one another. The first factor mentioned is uncertainty avoidance. This can be defined as "the extent to which the members of a culture feel threatened by uncertainty and ambiguity, along with their eagerness to avoid such situations" [19]. When the quality of a mobile data service is uncertain or uneven as compared to the familiar, users may refrain from using it. Web pages, for example, belonging to the same site may be presented with contracting interfaces on different devices and the interface unfamiliar to the user may cause the user to feel uncomfortable and refrain from using that site or service. The next factor involves individualism versus collectivism. Users with individualistic tendencies select data services based on personal appropriateness, and therefore will opt for personalized (or interfaces that they can customize) mobile data services. On the other hand, users with a collective mindset tend to use services that enable them to feel more connected to other people, for example Instant Messaging (IM) and Location based (LB) services. Context is another factor and is defined by Hall [Hall, E.T., 1976] as the information that surrounds an event. People in high-context cultures tend to rely on visual elements and symbols, whereas those in low-context cultures tend to rely on hard facts and statistical data [Choi et al., 2005]. Hence high-context users may prefer the use of animated mobile data services, whereas low-context users would prefer text-based mobile data services. The fourth and final factor discussed is time perception. There are two distinct notions of time that have been identified and these are monochronic and polychronic [Hall, E.T., 1959]. People who carry out one task at a time, proceeding in a sequential and linear manner are said to be monochronic. Polychronic cultures carry out many tasks at once and proceed in a simultaneous and concurrent manner. Since polychronic users execute several tasks at a time they become less organized [Hoft et al., 1996] and might use mobile data services for scheduling or reminder purposes. Rose et al. [Rose et al., 2002] found that participants from polychronic societies were less troubled by download delays and perceived the delays to be shorter than people from monochronic cultures did. Polychronic users, as defined, can multitask and so whilst waiting for a download to complete may partake in another task, becoming preoccupied in the process, whereas monochronic users would perform no other task beside wait for the download process to complete and might become impatient in the process. Choi et al. [Choi et al., 2005] carried out research by investigating participant preferences among mobile data service attributes. The results obtained presented eleven attributes (Table 3) commonly considered important by interviewees in three different countries namely, Korea, Japan and Finland.

Table 3: Eleven main attributes of mobile data services

Attribute	Description
Minimal Steps or Keystrokes	Service requires minimal steps or keystrokes in search for desired contents.
Iconic Menu Style	Menu items are represented by icons.
Secondary Information about Contents	Service provides additional information about contents, such as ranking points, movie ratings, or related pictures.
Variety of Contents	Service provides a wide assortment of contents to choose from. For example, for games, number of games, game genres; for movie ticket reservations, number of movie theaters; for ring tone downloads, number of ring tones, musical genres; for sports news, number of news items.
Logical Ordering of Menu Items	Service orders menu items or contents logically.
Clear Menu Labeling	Menu labels tell users clearly what they can find behind them.
Efficient Layout or Space Usage	Service uses small the screen space of the mobile phone efficiently.
Variety of Font Sizes	Service menus use a variety of font sizes for different menu types.
Variety of Font Colors	Service uses different colors for different menu items.
Large Amount of Information within a Screen	Service displays a large amount of information on a given screen.
Various Options for Contents	Service provides various options for contents. For instance, for games, stage option, difficulty option; for movie ticket reservations, seat selection; for ring tone downloads, chord selection; for sports news, choice of amount of information to display

The results in Table 3 show main attributes concerning mobile data services which have contributed to their development and widespread use trans-cultures. This information can also lead to an effortless acceptance of future mobile data services.

2.4 Wireless Technologies

So far we have discussed several factors, centred on customer uses and gratifications, which have contributed to the development of mobile data services. The advent of new technologies is another factor that is of principal importance to the development of mobile data services. As shown in Table 1 earlier, technological factors are segmented into several different forces that produce change or drive trends in the mobile phone industry. Included are advances in semiconductor technologies, which have led to the manufacturing of smaller components, pioneering the introduction of devices with improved display and computing functionality. These include colour displays, integrated cameras, enhanced download capabilities, increased memory size (this has taken an even higher dimension with the introduction of Apples' iPhone capable of storing up to 8GB of storage [Apple Inc., 2007]), and improved sound quality and input methods. Mobile phones are now capable of

offering complex, multimedia information or services and hence, the evolution of highly interactive and advanced mobile data services. Wireless technologies have also contributed to the evolution of mobile data services immensely. These range from first generation (1G) networks through to third generation (3G) networks. Increased rates of technological and product innovation have enabled the potential introduction of forth generation networks (4G). This section discusses the contributions of these networks toward the development of mobile data services. Section 2.3 presents a more detailed discussion about the network architectures. Evolution of wireless technologies have enabled improvements from analog to digital signalling, upgrade of data transfer rates, and efficient use of resources for data services through packet-switching. These improvements are the factors that actually differentiate the wireless technologies. Initially, wireless networks were not designed for data transmission as in the case of first generation (1G) technologies [Trillium., 2000]. Second generation (2G) wireless networks introduced digital signalling and enable limited services such as SMS and fax to be offered. The data transfer rates offered by 2G systems nevertheless could not handle advanced mobile data services such as web browsing and multimedia applications. The low data transfer rates also frustrated users due to slow download times [Preez, G., AND Pistorius, C., 2002]. Moreover, 2G systems were circuit-switched resulting in users paying for a connection whether or not data was accessed or transmitted over that time. This resulted in expensive billing systems experienced by users. However, popularity of Internet services brought about increased demand for wireless data services [Bettstetter, C., AND Vogel, H., 1999] and this led to the introduction of 2.5G networks. These networks introduced packet-switched data transmission and higher data transfer rates into the mobile industry. In a packet-switched environment information is split into “packets” of data that are transmitted and received in bursts rather than through a continuously open or dedicated radio channel [Preez, G., AND Pistorius, C., 2002]. This is more attractive for users as they are only charged for the amount of data that they access or transmit and not for the duration of the connection. Third generation wireless technologies have brought about data transfer rates of 2 Mbps (megabits per second). This has immensely contributed to the development of mobile data services by offering value added services that are both affordable and globally accessible [Selian, A., 2002].

2.5 Independent manipulation of devices

We shall look at a final aspect of mobile data services development involving information consistency, regardless of access device or access format is of extreme importance. The introduction of “metalanguages” such as Extensible Markup Language (XML) has made the

manipulation of device and format independent. XML is a cross-platform, software and hardware independent tool for transmitting information [W3Schools. 2007]. Information in XML can easily be translated into Wireless Markup Language (WML), Hypertext Markup Language (HTML) or Voice Markup Language (VoxML) [Preez, G., AND Pistorius, C., 2002]. The great development and adoption of XML by software vendors has enabled mobile data services to seamlessly interact with servers, personal computers, personal digital assistants and a vast number of other devices. Hence, the availability of a higher dimension of interactive, value-added mobile data services has evolved.

We note from the above discussion that there are several forces that have contributed to the development of mobile data services. Correlations and trends amongst factors where also identified and this enabled a broader understanding about mobile data service evolution. Moreover, most of the factors discussed in this section are still further developing. For example, research into fourth generation (4G) technologies are at an advanced stage which will introduce much higher data transfer rates enabling a new and wider range of interactive, content-rich mobile data services [ESTO Project., 2004] [Hussain et al., 2006]. Technological and product innovations keep advancing, presenting more features on mobile phones and mobile data services can then be created which would interact with these features. Hence, it is expected that mobile data services will continue evolving, presenting greater opportunities of revenue for mobility companies and a wider range of compelling services to mobile phone users. The next chapter gives a discussion into the currently available mobile data services.

3 Types of mobile phone data services

There are over 2 billion mobile subscribers worldwide with a projected figure of over 3.9 billion expected by 2010. With this increase in number of mobile phone subscribers, usage of mobile data services has increased in recent years. This section discusses some of the various mobile data services that are currently available. A mobile data service is any service offered on a mobile phone besides voice.

3.1 Short Message Service

The first commercial mobile data service was a Short Message Service (SMS) sent over the Vodafone GSM network in December 1992. Mobile data services have increased exponentially and are projected to generate large amounts of revenue for mobile phone operators (Table 4).

Table 4: US Mobile Data Revenues, by Category, 2009 (billions and % of total revenue) [Belcher, J., 2007]

US Mobile Data Revenues, by Category, 2009 (billions and % of total revenue)		
	% of total	Revenues
Messaging	**51%**	**$8.2**
Text messaging	33%	$2.7
Multimedia messaging	29%	$2.4
E-Mail	24%	$1.9
Instant messaging	15%	$1.2
Entertainment	**29%**	**$4.6**
Graphics/logos	6%	$0.3
Games	26%	$1.2
Ringtones, other music and audio	31%	$1.4
Interactive entertainment and communities	16%	$0.7
Adult	4%	$0.2
TV and film	17%	$0.8
Information	**20%**	**$3.1**
Productivity	4%	$0.1
Non-voice directory	33%	$1.0
News, sports, travel, etc	63%	$2.0
Total	-	**$15.9**

Currently, the most popular mobile application is SMS [Scharl et al., 2004]. According to the Data-monitor [Hsu et al., 2007], the value of the messaging market will increase from US$ 17.4 billion in 2002 to more than US$ 29 billion in 2006. It is projected that 80% of mobile expenditure while be on messaging services by 2007 [Hsu et al., 2007]. According to Kona Survey, 350 billion text messages are sent every month worldwide [Kona LLC., 2007] There are multifunction uses of SMS that lead to its success. Firstly, advertising agencies may send text messages to clients or potential clients including weather, news, and traffic reports, market rates, and details about movies currently showing. Secondly, SMS are less intrusive than phone calls. Recipients can read text messages at their leisure time and choose when to respond, if at all [Geser, H., 2005]. Finally, SMS can be integrated into other mobile data services. For example, Loopt [Loopt Inc., 2007] is a United States based mobile data service and integrates SMS with Global Positioning System (GPS) and Instant

Messaging. When the GPS locates a registered contact within certain proximity, a notification SMS is sent to the user. Other mobile data services currently offered by mobile operators include mobile music. This service was started in Japan, and during 2003 and 2004, KDDI Corporation, the second largest operator in Japan, sold and delivered more downloads of high-quality music to mobile phones in Japan than Apple did with its i-Tunes services worldwide [Weber, A., 2007]. These were about 100 million downloads until mid-2004 [Fasol, G., 2005].

3.2 E-commerce services

"Wallet" mobile data services are also currently available. These present functions such as electronic money and electronic credit cards and enable users to purchase goods using their mobile phone. This feature is prevalent in Japan [Weber, A., 2006]. In addition, data services offering QR-code readers (a 2D square barcode for reading information using the phone's camera as a scanner) have been integrated into mobile phones. Hence, a user may scan the barcode of some goods to obtain the price and then pay for it using their "wallet" facility available on their mobile phone. This presents an insight into the degree of dependency that customers may have for mobile data services and this will in turn increase the development of data services in the mobile industry.

3.3 Mobile Gaming

One of the earliest mobile data service offered was gaming. The gaming market is currently worth Euro 1.6 billion, with 50% of that revenue based in South Korea and Japan. By 2011 it is projected to be worth Euro 2 billion [Screen Digest., 2007]. As noted, the long-term growth potential for mobile games is limited. This is imposed by niche segment appeal of service and the growing complexity and escalating costs of game development [Telecom., 2005].

3.4 Mobile Television

Finally, one of the upcoming mobile data service available is television (TV). Research shows that this service is set to emerge as the strongest performer globally, delivering Euro 4.7 billion of revenue from 140 million subscribers by 2011 [Screen Digest., 2007]. Figure 1 shows projected revenues from TV, music, and games applications. With the large amounts of revenue generated by the immense number of mobile data services currently available, mobile operators are set to introduce even more compelling data services in order to surpass such figures. A contributing factor

that will enable the introduction of more compelling mobile data services is the development of wireless technologies. These technologies are discussed in the next section.

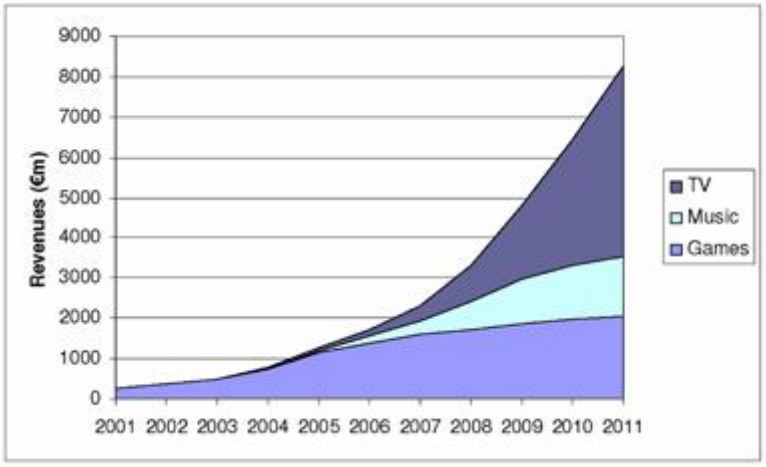

Figure 1: Global mobile content revenues 2001-2011 [Screen Digest., 2007]

4 Mobile data service Technologies

Mobile telephony has become one of the most convenient information exchange tools since the introduction of circuit-switched, Global Systems for Mobile Communications (GSM) networks [Scharnhorst et al., 2006]. Mobile carriers can now provide data services in a more bandwidth-efficient way over the cellular network with the introduction of packet data services such as General Packet Radio Service (GPRS) [Kang, J., AND Nath, B., 2005]. The advancement of wireless technologies has a pivotal role in the development of mobile data services. This section discusses the evolution of wireless networks and presents the various features of each network. Table 5 shows the evolution of mobile technologies including the types of systems implemented, data transfer rates and available features.

Table 5: Evolution of Mobile Networks [ESTO Project. 2004]

	System		Bandwidth	Features
1st Generation	AMPS	Advanced Mobile Phone System	9.6 kHz	analogue voice no data transmission capabilities
	TACS	Total Access Com.Syst.		
	NMT	Nordic Mobile Teleph.		
2nd Generation	GSM	Global System for Mobile Communic.	9.6->14.4	digital voice, advance messaging, global roaming, circuit switched data
	CDMA/IS	Intermediated Standard 95	64	digital voice, data, integrated voice mail
	PDC	Personal Digital Communication	-> 28 kbps	digital voice, data, I-mode
	HSCSD	Switched Data	9.6->57.6	extension of 2G/GSM higher data speeds
	GPRS	General Packet Radio System	9.6->115	Extension of 2G/GSM always-on connectivity packet switched data
	EDGE	Enhanced Data Rate for GSM Evolution	64->384	Extension of 2G/GSM always-on connectivity faster than GPRS
3rd Generation	IMT2000	International Mobile Telecommunications 2000		
	UMTS	System	64->2.048	always-on connectivity global roaming, IP-enabled
	CDMA2000	Multicarrier CDMA		IP-enabled
	TD- SCDMA	Time Duplex - Space Code Div. Multiple Access		
4th Generation	WWICP	Wireless World Integrated Communication Platform	-> 1,000,000	Integration of Multiple Wireless technologies, introduction of new high capacity transmission scheme

4.1 First generation communication

The first generation (1G) of wireless communication was based on analog signalling. 1G networks were circuit-switched technologies and primary focused on voice communications and provided localized wireless services [Selian, A., 2002]. Systems implemented in North America were known as Analog Mobile Phone Systems (AMPS), while systems implemented elsewhere were identified as a variation of Total Access Communication Systems (TACS). However, first generation systems had no data transmission capabilities.

4.2 Second generation communication

Second generation (2G) systems were introduced in the late 1990s and were based on low-band digital signalling. They had enhanced voice capability in comparison to analog systems, better spectrum management, wider coverage area and better mobility. 2G technologies were composed of Global Systems for Mobile Communications (GSM), Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) and its introduction brought about dramatic growth rates. At the end of 2003, the number of mobile subscribers reached 64.8 million [Doganoglu et al.,

2006]. 2G technologies provided data transfer rates of 9.6-14.4 kbps (kilobits per second). This could handle some data capabilities such as fax and SMS but it is not suitable for web browsing and multimedia applications. GSM can provide better voice quality, network capacity, SMS, data encryption and roaming [Tseng et al., 2006]. Unfortunately, 2G systems could not meet the increasing demand for wireless data services. Firstly, the typical data transfer rate on a GSM network is 9.6 kbps, which is too low and severely limits the richness of information and complexity of the wireless data services and applications that can be offered. This also leads to user frustration with long download times [Preez, G., AND Pistorius, C., 2002]. Secondly, mobile data services were provided based on circuit-switched (CS) radio transmission, where a channel is exclusively allocated for a single user for the entire call duration, regardless of whether the user is transmitting data packets or not at that moment. This results in highly inefficient use of resources for data services with disintegrated traffic characteristics [Chung et al., 2006]. In addition, the user pays for the entire connection time instead of for the amount of data processed or transferred during that time. Lastly, most operators offering data services on a GSM network have billed for services in the same way as for voice service, that is, duration-based billing [Preez, G., AND Pistorius, C., 2002]. With these negative factors, accessing wireless data services on the GSM network has been both frustratingly slow and prohibitively expensive.

4.3 2.5 generation communications

2.5G technologies were introduced and these had the advantage of providing services based on packet-switched radio transmission. General Packet Radio Service (GPRS) and Enhanced Data Rates for Global Evolution (EDGE) are two common 2.5G technologies. The concept behind GPRS was to reserve some physical channels (that is, time slots), in this case called packet data channels, exclusively for data traffic [Tangemann et al., 2000]. Data transmission on GPRS is packet-switched, which means that information is split into “packets” of data that are transmitted and received in bursts rather than through a continuous open or dedicated radio channel [Preez, G., AND Pistorius, C., 2002]. The radio spectrum is used only when data is actually transmitted. Thus, billing is only charged for the amount of information that is accessed or downloaded and not for the duration of the connection. The fact that GPRS is “always-on”, gives it another advantage over a GSM network, as it eliminates the need for call and connection set-up each time a service or application is accessed. EDGE represents the final step in the evolution of mobile telephony from GSM towards UMTS, that is, from 2G to 3G [Halonen et al., 2003]. Maximal available data transfer rates up to 192kbps were achieved with this technology [Schnabel, P., 2003]. Services such as

voicemail, e-mail, location-based services (LBS), and web surfing using Wireless Application Protocol (WAP) become available with 2.5 systems. Hence, 2.5 generation systems enabled a wide range of mobile data services to be offered.

4.4 Third generation communications

Third generation (3G) systems represent the convergence of various 2G technologies into a single global system that includes both terrestrial and satellite components [Trillium., 2000]. An important aspect of 3G is the ability to integrate existing cellular standards, such as GSM and TDMA, into one component. Therefore, 3G can have an integrated network for circuit-switched and packet-switched services presenting several advantages [Trillium Inc., 2000] [Kang, J., AND Nath, B., 2005]. For example, GSM networks provide a better call quality whereas GPRS consumes less radio bandwidth when transmitting data [Kang, J., AND Nath, B., 2005]. Universal Mobile Telecommunications System (UMTS) is a 3G wireless technology. It has a data transfer rate of 2 Mbps (megabits per second) enabling complex and content-rich applications to be offered such as videoconferencing. The main features of 3G systems are “always-on connectivity”, “IP network”, “Global roaming” and value added services. Some disadvantages associated with 3G systems include high licensing fees required by mobile operators, great difference in the terms of acquiring licenses governed by state authorities [Preez, G., AND Pistorius, C., 2002], and the high pricing of 3G enable mobile phones.

4.5 Higher bandwidth capabilities

From this discussion, we note that immense progress has been made to provide users with content-rich, highly interactive, and affordable mobile data services with regard to wireless technologies. Although there are still some limitations on data transfer rates achievable with the available technologies, research is underway for the introduction of fourth generation systems capable of data transfer rates of up to a Gigabit per second [ESTO Project., 2004] [Hussain et al., 2006]. Japan’s leading mobile network operator, NTT DoCoMo, plans to implement High Speed OFDM Packet Access (Super 3G) networks by 2010, which will be capable of data transfer rates of up to 300Mbps [Cheng, J., 2007]. Such high speed networks will be critical to the success of services such as mobile TV and video, and high-speed Internet access, which require high bandwidths for efficient delivery. This will inevitably bring about a new breed of mobile data services, increasing revenue for mobile operators and enhancing user experience for mobile customers.

5 Mobile Data Services in South Africa

This chapter discusses the development of mobile data services in South Africa. In most cases, Japan will serve as a precursor to the South African mobile market. As Japan is the world's leading mobile industry [Weber, A., 2007], this comparison will enable us determine the level to which mobile development has been achieved in South Africa, and the strategies that have been implemented to reduce the gap between the two markets.

5.1 Wireless Technologies in South Africa

Since the introduction of GSM and GPRS networks in South Africa, in 2002, the mobile phone industry has evolved exponentially. With a population of about 44 million people, South Africa is the leading mobile market in Africa with an estimated 34 million mobile subscribers and a penetration rate of about 70% [Global Telecoms., 2007]. This figure is more than in the Canadian and Australian markets combined and close behind the mobile market in Spain [Research., 2007]. 3G technologies become available to South Africa's leading cellular network, Vodacom, in February 2006 [Vodacom., 2007]. These dates may be contrasted by Japan's GPRS systems introduction in 1997, 3G network implementation by 2001, and the introduction of advanced technologies faster than W-CDMA by 2003 [Weber, A., 2007]. Japan has 98.8 million subscribers in total and a 77.6% penetration rate [Answers. 2007]. Whilst this may be viewed as slower development and adoption of mobile infrastructure and services in the South African market, this may have an advantage in that, research can be carried out detailing successful implementation strategies used by advanced mobile markets. These results would then be used when implementing the technologies locally.

5.2 Mobile Operators in South Africa

South Africa has three competing mobile networks namely, Vodacom, MTN and Cell C. This is not that different compared to the five competitors in Japan [Answers., 2007]. With the introduction of the number portability mobile data service customer churn can easily be experienced between the three South African competitors. Hence, each should offer unique and compelling data services to maintain customers. A number of strategies to achieve this are in place. For example, MTN has

partnered with Cisco to deliver advanced multimedia mobile services, such as mobile TV [Cisco Inc., 2007], whereas Cell C partnered with Europe's Virgin Mobile to offer Virgin Mobile branded services [Global Telecoms., 2007], and Vodacom partnered with Europe's Vodafone network to offer Vodafone branded services [Cellular., 2007].

5.3 Mobile data services in South Africa

Most services offered in Japan are also available in South Africa. These include, Internet browsing, e-mail, mobile music, ringtone downloads, SMS, MMS, Instant Messaging, e-commerce, and weather and news reports. This indicates the extent to with the mobile market in South Africa has grown within the past decade. SMS is the most popular mobile data service in South Africa [Global Telecoms., 2007]. Other popular mobile services include Instant Messaging and MMS. It is also expected that MMS usage will grow in the lead up to the 2010 football World Cup Tournament [Global Telecoms., 2007].

With the high competition among mobile operators, and advanced wireless technologies available in South Africa as discussed in this section, a wider range of mobile data services are expected in the market and the South African mobile industry is set to continue growing with a projected 37.8 million subscribers by the end of 2011 [Global Telecoms., 2007].

6 Future of Mobile phone data services

As discussed in the previous chapters, mobile data services have evolved from simple applications to complex and content-rich, interactive services, generating large amounts of revenue for mobile operators and enhanced customer experience for mobile phone users. Increased rates of technological and product innovation are enabling a new dimension of mobile data services to be offered and quickly adopted among mobile phone users [Preez, G., AND Pistorius, C., 2002]. This chapter discusses some of the upcoming mobile phones and mobile data services that are expected to increase revenue and user experience in the mobile market.

6.1 Mobile phone innovation

Innovative mobile phones are set to initiate the introduction of a new range of advanced mobile content and services. The new advanced features and capabilities on mobile phones are enabling mobile data developers to be less constrained when considering possible data services that can be implemented. For example, at the beginning of 2007, LG and PRADA released the first completely touch screen mobile phone. It includes a wide LCD screen which maximizes visual impact, allowing the user to benefit from several key features of the phone [LG., 2007]. It also hosts an array of additional multimedia functions, including an MP3 player and a music multitasking function for messaging. An external memory slot is included allowing the user to increase the memory capacity for images, music and video clips. Another example is Apples's iPhone, which includes a 3.5 inch 480 x 320 touch screen display with multi-touch support. It can offer a maximum of eight Gigabits of storage and has support for Widgets, Google Maps, and iTunes. Apple quotes five hours of battery life for talk and video, with a full 16 hours in music mode [Ziegler, C., 2007]. These highlighted features and functionalities show the development of storage capacity, processor speed, screen size and resolution on mobile phones. Thus, some services that could not be offered on mobile phones at one time, due to hardware and software constraints, can now be easily implemented in the mobile industry. This will bring about a new dimension of mobile data content and advanced user interfacing in the mobile industry.

6.2 Upcoming Mobile data services

Mobile TV is the latest of all mobile content offerings, and looks set to emerge as the strongest performer globally, delivering Euro 4.7 billion of revenue from 140 million subscribers by 2011. Mobile TV's revenue potential is greater than that of games or even music due to the mass market nature of the product [Screen Digest., 2007]. A rich media TV service can contain arbitrary types of multimedia elements, leading to a rich user experience. Personalisation of TV content is also possible in two aspects [Rauschenbach, U., 2006]. Firstly, additional information is supplied with the main TV programme, from which the user can select the pieces they are interested in. Secondly, by sending metadata with the programme, the Home Media Server can record those segments of the TV programme which are of interest to the user according to a specified or learned user profile. This way, a user can create a personalised news show [Rauschenbach, U., 2006]. Mobile music is another high revenue earner and is projected to generate even higher revenues in the future due to the availability of subscription services which offer more than just audio tracks. The introduction of Apple's iPhone is also expected to bring about mobile music growth. Forecasts predict that the

global over-the-air full track music download market will grow exponentially over the next five years, reaching Euro 1.47 billion by 2011, an eight fold increase from 2006. SMS is still expected to be one of the greatest revenue earners among mobile data services. There are currently over 90 million SMS users in the US and it is estimated that there are over 350 billion text messages sent every month globally [Kona LLC., 2007] Location-based services (LBS) is a service category which is consistently mentioned as an important category of new services in practically all comprehensive research that deals with future mobile data services [Li, C., 2005]. Location-based services enable the provision of value-added services based on location and traffic data. In 2011, the total population of GPS-enabled location-based services (LBS) subscribers will reach 315 million, up from 12 million in 2006 [Alleven, M., 2007]. Several mobile data services now seek to use the widespread adoption and success of SMS and LBS by integrating the capabilities of these two services as additional components of the new data service. For example, Loopt is a US mobile data service that has become popular among mobile users in that region. Loopt notifies users when a registered contact is within a defined proximity, and enables the user to send a text message to that contact [Loopt Inc., 2007]New services are also now available from major companies such as Goggle and Yahoo, and these services are expected to generate more revenue in the future. For example, Google is offering services that initially were not feasible on some mobile phones due to lacking capabilities such as Web browsing. A user can still conduct a search by sending an SMS to a Google number and receiving the search results a reply. This indicates that future mobile data services will be made available to users in a way that can bypass the limitations of the user's mobile phone. Revenue from mobile data services such as mobile entertainment, including games, gambling and adult content, is projected to double from US$ 18.84 billion in 2006 to US$ 38.12 billion in 2011 [Slocombe, M.,2007].

The developments discussed in this chapter show that even though the mobile market has reached maturity, technological and product innovations will enable a new dimension of mobile data services to be offered in the future. Hence, it is expected that mobile data services will continue to deliver increased revenue for mobile operators and deliver gratification to the mosaic requirements of mobile phone users.

7 Development Environments/Platforms

As the mobile market continues to evolve, several mobile development environments become available enabling compelling data service creation. Symbian, Windows mobile and Palm OS are

examples of operating systems designed for mobile devices. Java Micro Edition (JME), Flash Lite, Binary Runtime Environment for Wireless (BREW), Python and .Net Compact Framework are examples of development software that can run over the mentioned operating systems. In this chapter we shall discuss the various capabilities and features of these mobile development environments.

7.1 Symbian

Symbian OS is a proprietary operating system (OS) produced by Symbian Limited. Symbian is the market leading provider of open OS software with a 70% share of the smartphone market to date [Symbian Ltd., 2007]. It is very powerful for general purposes and can support 2D, 3D graphics as well as several widgets. C++ is used as the foundation language with full phone data access. Symbian has an average run time speed largely due to limited functionality of handsets where Symbian is available. The developer and community support is extensive and the Symbian based S60 platform is strongly supported by Nokia and Sharp [Symbian Ltd., 2007]. In 2006, global smartphone shipments totalled 72.9 million units, up 50% from 2005, with Symbian leading the market holding 71.7% market share [Symbian Ltd., 2007].

7.2 Palm OS

This is a compact operating system developed and licensed by Palm and designed to be easy-to-use and similar to desktop operating systems such as Microsoft Windows. It holds about 2.3% of the smartphone market share [Symbian Ltd., 2007]. C and C++ are the foundation languages used, with support for 2D, 3D graphics and several widgets. Palm OS has the largest developer network compared to its competitors.

7.3 Windows CE

Windows CE is a variation of Microsoft's Windows operating system for mini computers and embedded systems, and has a distinctively different kernel rather than a trimmed-down version of Windows available on desktops. It is ideal for enterprise applications with an existing PC infrastructure, however it is not cross platform and is limited to Microsoft devices. C and C++ are the foundation languages and it has support for 2D, 3D graphics and many widgets. It also has a very good runtime speed [Yao, P., 2007].

7.4 Java Micro Edition

Java Micro Edition (JME) is an established mobile development platform from the Java Community and has an extensive number of developer community and support. JME uses subsets of Java Standard Edition components designed for desktop computers, and includes a set of technologies and specifications developed for smaller devices such as pagers and mobile phones. Eclipse and Netbeans are the main integrated development environments (IDE) available for JME. JME requires a Java Virtual Machine embedded on a device for it to run and is therefore not completely platform independent. It has support for 2D, 3D graphics and many widgets, and some limited phone data access varying according to the type of handset. JME has an average runtime speed due to Java bytecode and includes flexible user interfaces, robust security, built-in network protocols, Bluetooth APIs, and support for networked and offline applications that can be downloaded dynamically [Li, S., AND Knudsen, J., 2005]. JME is widely used for creating games and has an extensive developer community of over one million [Sun Microsystems Inc., 2007].

7.5 Adobe Flash Lite

Flash Lite is the Adobe Flash technology specifically developed for mobile phones and consumer electronics devices. Flash Lite accelerates the delivery of rich content and browsing, and customized user interfaces. Even though it is a new competitor in the mobile industry, Flash Lite has developer and community support of over one million [Adobe Inc., 2007a]. This growth is driven by the mature Flash authoring environment and rendering engine that delivers enhanced content and browsing, customized user interfaces and rich mobile experiences across devices [Adobe Inc., 2007b]. Over 200 million Flash-enabled devices had been shipped by the start of 2007 [Adobe Inc., 2007c]. Actionscript is the foundation language used with Flash Lite and has support for 2D, 3D graphics including several widgets. Flash Lite uses a compressed file format called SWF, that can be reused by a player running on any system and enables faster download speeds of graphically rich applications. Flash Lite offers support for high-end video manipulation as video clips can be embedded into animations using the Flash 8 Professional interactive development environment IDE) [Vander Veer, E.A., 2006]. Flash Lite supports loading and parsing of XML data in Flash content enabling a wider range of interactive devices to communicate, thereby also enabling more interactive and content-rich mobile data services to be offered [Adobe Inc., 2007b]. Phone data access is also possible which provides the ability to locally store and retrieve relevant,

application-specific information such as preferences, high scores and usernames. This provides a much more robust development environment.

The various types of mobile development platforms available, as discussed above, enable for the efficient and rapid creation, deployment and maintenance of mobile data services. This in turn allows for the development of compelling and highly interactive mobile data services. Therefore, just as wireless technologies and user gratifications are key contributors to the enhancement of mobile data services; mobile development environments play an important role in the mobile market.

8 Conclusion

In this paper, we discussed factors that influence the wide adoption and development of mobile data services. These factors have a direct effect as to which mobile development platform will receive a high market penetration rate. A mobile development environment should provide developers with key functionalities that allow for the creation of compelling services. We noted that concepts such as interactivity, demassification, and asynchronicity are important factors that contribute to the wide adoption of mobile data services. Hence a mobile development platform that allows for the creation of services that provide easy and efficient interactivity between the user and also other external devices, will receive better developer adoption. Such interactivity can be provided through dynamic text input, Bluetooth APIs, Markup languages such as XML, and in-built network protocols. Mobile data services with dynamic multimedia such as mobile TV and GPS are also driving developers toward platforms that enable creation of sophisticated graphics and animation, as well as video capabilities. Hence mobile development platforms that offer such capabilities, efficiently and seamlessly, receive a wider adoption by developers. A scripting language that allows portability across devices will enable developers to port their applications to a wider audience, and this will inevitably offer a greater potential customer base for mobile data services. Hence, a mobile development environment which supports such a scripting language will gain developer and user support. Culture also plays a pivotal role in the adoption of mobile data services. Hence, there arises a demand to filter information and customise the presentation according to personal preferences. Thus, mobile development platforms that enable the creation of customized user interfaces will attract a greater number of developers working under that platform. According to Chapter 7, we note two mobile development platforms namely, Java Micro Edition and Flash Lite, which support a large number of functionalities that bring about mobile data service adoption and growth. As a

result these two platforms have a great potential for growth and adaptation, both in the developer community and in user support. We note that, the functionalities of these two platforms may differ; hence it is imperative to study and compare the environments. This will enable developers to make a trade-off as to which platform to use, depending on the particular specification of the required mobile data service.

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