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Future Mobile Applications

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1 Foreword

This paper is prepared as part of Comreg's Briefing Note Series under the Forward-looking Programme. This Briefing Note on future mobile applications is a follow-up to the 'Potential Applications for Next Generation Networks' paper issued in May 2002[1]. Its purpose is to highlight potential new applications and opportunities arising from the availability of more advanced mobile technology and networks such as GPRS, 3G and Wireless LAN. It should not be taken as endorsing any particular technology or service.

The almost ubiquitous presence of mobile phones has made the development of new mobile applications and services possible for a wide variety of different users in different situations. In particular new applications for text messaging services have been among the most innovative – for example Dublin City Council's mPARK system that allows users to pay for parking in Dublin via their mobile phones. Low data rate or 'narrowband' mobile applications such as text messaging are continuing to develop and bring added value to users. With the advent of more advanced mobile[2] systems with greater data rates such as GPRS, 3G and Wireless LANs deployed in hotspots more sophisticated applications are beginning to emerge. Such applications combine some of the benefits of two well established functions: fixed broadband connectivity and mobility. The adoption of mobile technology by business users enables them to begin 'un-wiring' the office achieving greater efficiency by being able to work while on the move. In addition to GPRS and Wireless LAN, enhanced data rates from 3G systems will also enable new mobile applications to develop including video for messaging and teleconferencing.

Perhaps the most important platform for these developing broadband mobile systems and applications is access to the Internet. More advanced mobile handsets with larger colour displays will enable mobile users to avail of a more satisfactory Internet experience than was previously possible, thus bringing the benefits of the Internet and broadband communications to even more consumers. The application of Wireless LAN hotspots gives users the same Internet experience on a portable device as they would have at a fixed broadband terminal.

For a mobile application to be successful it should provide easily identifiable added value; it should be intuitive and easy to use and it should be inexpensive. Increased development of applications and services can potentially bring about better services with more choice for end users and increase traffic and revenue for mobile network operators. ComReg looks forward to seeing the development of more new applications that can truly add value for mobile users and continue to stimulate the Irish mobile industry.

Etain Doyle

Chairperson,

Commission for Communications Regulation

[1] Comreg doc. 02/45 - www.comreg.ie/_fileupload/publications/odtr0245.pdf

[2] In this Briefing Note the term 'mobile applications' is taken to include 'portable applications' such as those delivered via laptop and notebook computers.

2 Comments on this Briefing Note

We welcome any comments or views on this Briefing Note and these should be sent to:

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to arrive on or before 5.30pm on Friday 4th July, 2003.

In submitting comments, respondents are requested to reference the relevant section of this document. Responses will be available for inspection by the public on request. Where elements of any response are deemed confidential, these should be clearly identified and placed in a separate annex to the main document.

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3 Introduction

This Briefing Note is intended to raise awareness of some of the types of applications that users might expect to see on future mobile networks and the technologies behind them[3]. It is targeted primarily at non-technical readers, with some background technical awareness of the telecommunications industry.

3.1 Background

As usage of mobile services increased throughout the 1990s the key application was voice, enabling users to contact and be contacted while on the move and anywhere within the service coverage area[4]. The ability of customers to operate their mobile phones while abroad (i.e. mobile roaming) also contributed to the growth of mobile usage – particularly in Europe. More recently text messaging applications have become very popular[5]. This service became particularly popular among teenagers and helped to make mobile network operators aware of the potential of data services. This has led to the development of a range of innovative new mobile applications (e.g. parking payments, news alerts, TV voting).

Building on their success, mobile operators and applications developers are continuing to seek new applications and services that could potentially generate additional revenues and increase usage. The emergence of new mobile systems such as WLAN, GPRS, and 3G can make more capacity available for services that require higher speed communications. This creates opportunities for the development of new 'mobile broadband' services. Some of these newer mobile systems can provide always-on access which is identified as an important driver for the development of broadband services. It is likely that mobile systems will follow a similar trend to fixed telecommunications systems in the general move towards broadband. Broadband mobile systems could potentially offer users richer content such as high quality audio (e.g. music) and video (e.g. media clips, teleconferencing). New short range mobile systems that allow devices to connect directly with other devices in their immediate area are also likely to develop forming Personal Area Networks (PANs). These too may create opportunities for new applications.

Most mobile systems being developed now include access to the Internet as a key characteristic. In the case of WLANs the fixed Internet is simply mobilised without changing content in any way. WAP or other specifically mobile adaptations of the Internet developed to meet the needs of wireless connections and smaller device displays. It may well be that, looking back from ten years hence, it will seem strange that any terminal devices were ever 'wired in' as ubiquitous mobility in the home, the office and the street will be taken for granted. A multitude of different types of mobile technologies are being deployed and developed. Consequently, interoperability is likely to be a key technical issue to be addressed to ensure widespread adoption of services. Consumers need to be able to access consistent services easily regardless of the type of device they are using (e.g. phone, PDA, Laptop) or the type of network that is being accessed (e.g. GPRS, 3G, WLAN).

Important economic and commercial issues, however, will need to be addressed by operators, application developers and content providers before the successful implementation of advanced mobile applications and services can be guaranteed.

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[3] See 'Internet for a Mobile Generation' (ITU, 2002) for a more extensive report covering many of the issues in this outlined in this briefing note. www.itu.int

[4] During 2002 there was a total of 3.7 billion outgoing mobile minutes in Ireland.

[5] Approximately 660 million text messages were sent in Ireland during Q4 2002, which is an increase of 43% from the same quarter the previous year.

4 Types of Applications

Some of the types of applications and services that users might expect to see as mobile networks advance are outlined below. While basic forms of most applications such as mobile Internet, instant messaging and mobile video are currently available in Ireland or other countries, this section illustrates some of the many ways in which we can expect to see mobile technology applied to our daily lives. Some potential future applications will rely on high data rates from advanced broadband mobile technology. Other applications will be more reliant on characteristics of future networks such as increased interoperability, location information and security, and may have relatively low speed requirements.

4.1 Communications

Person to person communications has been a major driver of mobile communications to date with voice and 'texting' services. Similarly on the Internet, e-mail has been one of the most significant applications. E-mail is beginning to make its way onto mobile systems, through users connecting their laptop computers to the Internet over a mobile phone connection (bearer service), and by specialised mobile e-mail services such as RIM's Blackberry[6] (using GPRS), and increasingly on more mobile devices. Another important Internet messaging service that is finding its way onto mobile networks is Instant Messaging (IM). This allows users to communicate, initially with text, in a real-time manner. A voice based IM application is 'push to talk' which enables users to operate their mobile phones in walkie-talkie mode. This service can operate in a one-to-one or one-to-many configuration allowing groups of people to take part in a conversation. This also lets users listen in on conversations from other members of their group in the background without having to participate directly, much like a private mobile radio system. Nextel in the US has had much success with the service and other operators are following suit. European equipment manufacturers Ericsson, Nokia and Siemens recently agreed to produce a standard for push-to-talk over GPRS. One-to-many services could potentially be configured to allow 'narrowcasting' to all mobile devices in a given area for example. This may offer useful applications in policing and other emergence services.

More advanced mobile IM services are developing that include video-based messaging (e.g. 5 second video messages can be sent using J-Phone's service in Japan)[7]. Multi-media messaging services (MMS)[8] which enables users to send more advanced messages to one another with the addition of animations, pictures, and video and audio clips are also developing. MMS gives users the possibility to communicate in a more creative ways. Video conferencing services are already available on DoCoMo's 3G service FOMA in Japan. Internet based video conferencing services can also be adopted by WLAN users in hotspot locations.

4.2 Business and Financial

Potential business applications are often the easiest to identify, and are typically the first to be developed by mobile service providers enabling businesses to increase efficiency through enhanced mobile communications. Mobile technologies give business users access to applications that they would have in their offices such as e-mail, calendars, company Intranets and other company information systems. Interaction with company resources will be greatly facilitated by increased data rates on future mobile networks, allowing mobile users to transfer large files and access on-

[6] RIM – Research in Motion

[7] O2 is trialling a mobile video service over its GPRS network in the UK during April and May 2003.

[8] 'Picture messaging' is expected to be a key application of MMS. Phones with embedded cameras are helping to introduce MMS services.

line databases. Similarly technicians and engineers could increase efficiency by gaining access to technical details or service information via their mobile devices. One example of this potential is illustrated by the use of Internet-linked 'wearable' computers connected to 'heads up' displays on glasses, as is being developed for use by aero engine maintenance engineers[9]. As mobile devices develop with more computing power it will become important for users to be able to download software updates and tools over mobile networks[10]. More programmable mobile devices and systems will also create increased demand for enhanced security and virus protection features.

Text-to-speech and speech-to-text converters, which have been adopted by disabled users for many years, could become important applications to enable mobile users to communicate via speech or text in any given situation[11]. Unified messaging[12] and follow-me services are designed to enable mobile users to be contacted by whatever means is available as they travel.

A key issue for business users will be the interoperation of different services and technologies such as GPRS and WLAN. This will allow them to avail of the most suitable service at any given time (e.g. they could use GPRS while in a taxi and switch over to higher speed WLAN while waiting in an airport lounge) – see Roaming and Interoperability Section (5.6). For example, UPS is planning on equipping its drivers with multi functional devices that can operate using WLAN, Bluetooth, CDMA1x, GSM, GPRS, infrared and GPS satellite radio systems[13].

New data upload and telemetry services, based on the use of WLAN hotspots are also likely to develop. For example, equipping petrol stations with WLANs would allow car manufacturers to download operational and maintenance data from both commercial and private vehicles whilst they are being filled up with fuel[14]. Similarly updates to in-vehicle software, such as engine management systems, could also be delivered this way.

Private mobile radio systems such as Tetra are also continuing to develop for business users. Typically these systems have been used by companies involved in transportation, public and emergency services, and taxi firms among others. Location based technology can greatly enhance such services (see Section 5.4).

Financial services such as mobile banking are emerging as an important application for consumers. These services allow users to get updates on their account balances and carry out normal transactions, for example just as they would with fixed Internet banking services. Higher speed mobile networks should greatly facilitate the secure transmission of information. Point of sale applications could also be implemented using mobile technology allowing consumers to purchase products using their mobile

[9] e.g. 'Nomad' from Microvision and the 'Wearable Internet Appliance' from Xybernaut and Hitachi (used by Fedex aircraft maintenance technicians).

[10] Software defined radio (SDR) is an advancement of this concept. See ComReg briefing note on SDR - www.comreg.ie/_fileupload/publications/odtr0159.pdf

[11] Voice over IP is an important technology here – see VoIP briefing note - http://www.comreg.ie/_fileupload/publications/ComReg0321.pdf

[12] Unified Messaging integrates multiple different types of messaging services (e.g. voice, text, e-mail, video) into a single mailbox.

[13] www.ups.com/pressroom/us/press_releases/press_release/0,0,4287,00.html

[14] 3Com has announced a deal with Fiat to implement WLAN capabilities into some Fiat cars - www.3com.es/pressbox/pt/030423.html

devices via an electronic wallet instead of cash or credit cards[15]. An electronic wallet is where credit details are stored on a smart card (e.g. a USIM card[16]) on a mobile device that can then be queried, authenticated and debited when a consumer purchases a product or service.

4.3 Information

Information services can include text alerts of news headlines, sporting results, or delivery of entire news stories. SMS alerts are typically sent out to users who have subscribed to a particular service, whereas full articles are more likely to be requested by users on an individual basis. Financial information services (e.g. stocks and shares updates) are currently popular. The Alton Towers theme park in the UK has deployed a service that provides subscribers with information updates and personal schedules via their mobile phones reducing the time patrons spend in queues[17]. When coupled with location-based technology traffic alerts can be delivered to motorists (e.g. AA Roadwatch SMS service[18]). Other information services that can be linked in with location based technologies include timetables for local transport, weather reports, and information on local services such as restaurant and cinema listings (e.g. France Telecom – Mappy service[19]). High speed mobile networks could enable users to connect to interactive local maps as they travel. When combined with location based services users could avail of audio guided tours or text based historical information for example (e.g. Omnitel's Omni Arte audio service and Omniplanet WAP service).

4.4 Education

Many educational applications envisioned for mobile services are typically extensions of the fixed Internet, with on-line e-learning. Mobile Internet access through WLANs and PDAs is being used or are under trial on numerous university campuses. In many cases this is aimed at relieving pressure on university resources such as computer rooms[20]. Furthermore, mobile devices are typically less expensive than desk-top or lap-top computing facilities.

Mobile technology can also be used in school environments, enabling students to access information, check grades and submit work. Such systems could support applications for parents to monitor their children's progress. Using location based technology, parents could also check on the location of their children through these mobile devices.

4.5 Entertainment

Gaming is already an important application for mobile users. Games are typically downloaded from network operators onto handsets on a per-play basis. Other games that involve interactivity with either the network service provider or other players

[15] Visa International trial with NTT DoCoMo: www.3g.co.uk/PR/April2003/5191.htm . Visa International also recently announced that they would jointly develop contact-less chip technology for mobile payments with Philips (source – Total Telecom, 28 May, 2003). Network 365 is an Irish company developing leading edge systems in this field (e.g. mzone avatar) – www.network365.com .

[16] A USIM (Universal Subscriber Identity Module) or UIM is an advanced SIM card for 3G systems. A USIM can contain more information, including financial information and is capable of more security functions than a SIM.

[17] www.m-maximiser.com

[18] www.aaroadwatch.ie/sms/

[19] www.mappy.com

[20] Rococo and Trinity College Dublin are conducting a trial project to address this issue - www.rococosoft.com/press/releases.html#

through the network are likely to become more significant as higher data rates with lower network delays become available. Larger colour screens and more powerful computer processors are likely to increase the popularity of mobile gaming. Some mobile handset manufacturers are directly targeting the gaming market by producing handsets specially designed for gaming (e.g. Nokia N-gage, Sony-Ericsson T310 & T606).

Other types of interactive media could become popular due to the interactive nature of mobile use. Text-based soap-operas with interactivity could be enhanced with MMS capabilities[21]. In Korea, video and animated content is currently increasing in popularity[22]. The personal nature of mobile devices is likely to contribute to the potential growth of adult mobile services[23] as devices become more advanced.

Gambling is another potential mobile application where users can place bets on sporting events, or take part in casino type games via their mobile devices (see Section 6.5). More advanced mobile systems with streamed video would enable users to watch the sporting events that they are gambling on. National lottery services have also been adopted for mobile users in some countries (e.g. Korea, German) [24].

Mobile music services have been available for some time enabling users to download songs or previewed sections of songs to their mobile phones (i.e. typically via the MP3 audio standard). An innovative service operating in the UK (www.shazam.com) enables users to get the details of a song (i.e. artist, song, album, etc.) by dialling the service and allowing 30 seconds of the music to play into the phone. With broadband mobile systems it should be possible for users to avail of music streaming services, enabling them to use their mobile device as a personalised radio service. New approaches to 'pay per listen', such as that launched by Apple Computer on its iTunes service[25] offers an acceptable approach to Digital Rights Management (DRM). Such services balance the need to charge (thus rewarding artists) against the need for some reasonable freedom in local copying to multiple devices for personal use.

Services such as downloadable ring-tones and logos have become popular, particularly within the youth market. Even in Korea and Japan, where high-speed mobile Internet services have been available for some time, these types of downloadable services are still key demand drivers for mobile data[26]. Newer handsets with more advanced colour displays and audio systems are likely to drive this market further, and increase the demand for faster wireless connections.

4.6 Government

Mobile technology is anticipated to be an important means for enabling access to government information services, thereby extending their reach[27].

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[21] The television programmes such as 'Big Brother' and 'You're a Star' have incorporated some interactivity through mobile text messaging, leveraging high mobile penetration levels.

[22] See 'Broadband Korea: Internet Case Study', ITU 2003, for more examples of advanced mobile services in Korea. www.itu.int

[23] See "Digital Content for Mobile Services" – report by Anderson for European Commission DG-InfoSoc. Feb. 2002.

[24] Speirtech is an Irish company developing this type of mobile gaming applications – http://speirtech.com/

[25] www.apple.com/itunes/

[26] See footnote 20 above.

[27] See www.govtech.net/magazine/channels.phtml?channel=14 for a US based source of mobile government applications and developments.

Mobile technology can be used to enable users to carry out voting remotely, potentially increasing 'turn-out' levels. Local governments have tested mobile and other remote electronic voting and public consultation methods in the UK (e.g. VoteHere[28]). Voters need to be assured that the protection of voter privacy, whilst retaining means to confirm the integrity of the voting process, has been achieved.

Government sectors could also benefit from improved business to employee (B2E) communications using mobile technologies. Public service bodies such as the Gardaí could further develop their use of mobile technology for more efficient distribution of information (e.g. pictures of lost children or criminal suspects could be sent to officers electronically). Police in Germany have trialled a system using WAP technology to report on vehicle operating and fuel level details[29]. Social workers can also make use of mobile technology to enhance their safety while in the field by enabling them to be monitored while in potentially dangerous situations.

Government funded applications in areas such as education (see Education section) are in use or under development. Trials involving mobile technology to pay for public transport have been undertaken in several European cities (e.g. Berlin, Helsinki and Paris). Currently these are typically SMS based services, however developing systems are likely to utilise the ability of mobile devices to hold and administer credit information.

4.7 Medical

Access to medical information and advice is likely to be an important mobile service. Users should, for example be able to subscribe to medical advice, use location based services to find the nearest available doctor or pharmacy while travelling, or transmit information from a health monitoring system to a control centre (e.g. a local clinic). Further miniaturisation of mobile devices is an important step towards increasing the usability of wearable medical devices (e.g. heart rate monitors – see Section 5.1) and the implementation of medical home-care systems. Other mobile services that can improve the efficiency of hospital administration could include out-patients being sent reminder messages before appointments.

Mobile technology has a great deal to offer medical workers. Services can be used by ambulance workers to give hospitals advanced notice of incoming patients' conditions (e.g. ambulances in Sweden are using WLAN technology to transmit patient details to receiving hospitals[30]). As higher data rate wireless services become available even more vital information could be sent from incoming ambulances including photo or video images of patients. Similarly other mobile medical staff could use mobile technology to submit patient details (e.g. Eastern Heath Shared Services pilot project to introduce mobile technology for Public Health Nurses - PHN eLink). In hospitals, wireless technologies such as WLANs and Bluetooth can be used to mobilise medical staff internally, enabling them to access digital medical records, drug databases[31] and carry out administrative tasks at any point. A wireless technology was implemented in Cork University Hospital to enable paediatric patients to keep up with their school work through on-line learning while staying in hospital[32].

Network security and data integrity are essential to most medical applications, as is a robust approach to ensuring the privacy of sensitive patient medical information.

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[28] www.votehere.net

[29] www.condat.de/english/presse/systems00_m-government.shtml

[30] www.bcs.ro/content/solution/healthcare_ambulance_case_study.asp

[31] www.ePocrates.com

[32] www.newsfactor.com/perl/story/9317.html

5 Enabling Technology

This section outlines the key technological issues that lie behind advanced mobile services and applications.

5.1 Mobile Devices

Of the numerous different wireless systems available today some are suited to highly mobile users who need to avail of services while actually on the move (e.g. while travelling in a car or train), others are more suited to portable or nomadic uses (e.g. a laptop in a public park). Distinctions between the different types of mobile devices are fading as convergence is taking place between the fixed and mobile computing worlds. At one end of the market there are voice based mobile handsets, which are continuing to be developed with increasing computing power, while at the other end of the market there are laptop PCs, which are continuing to get smaller and more mobile. Laptop computers using WLAN access can potentially make any fixed application a mobile one[33]. In between mobile phones and laptop computers there are Personal Digital Assistants (PDAs) which are being developed with more computing power and greater mobility. It is likely that a whole series of devices will continue to develop ranging from simple mobile phones to laptop devices which gives users the choice to adopt the device which most suits their particular needs (e.g. N-gage from Nokia is a device that is specifically designed for the gaming market; tablet PCs are being adopted by hospital workers). Technology advances in areas such as batteries, smart antennas and low-power processors are all helping to make the mobile computing devices more powerful and more mobile – by reducing the physical size and weight of devices and the need to regularly recharge batteries. The widespread availability of colour displays on smaller mobile devices should help to encourage the development and adoption of a whole range of new applications. Flexible (foldable) displays, currently being developed, will increase the portability of devices whilst retaining a reasonable sized screen[34]. With all of these technology advances and different developing systems it will remain important that devices and applications are easy and intuitive to use, and avoid the need to manually configure devices for different applications or situations.

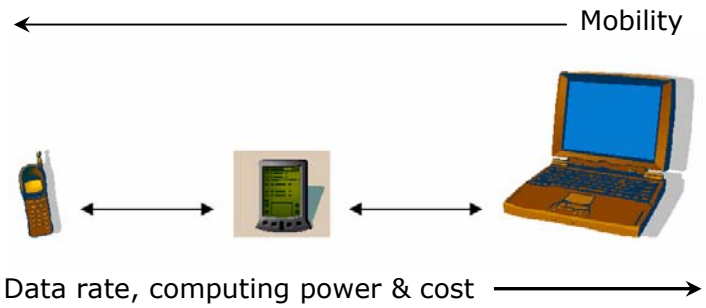

Figure 1 – Mobile devices: Mobile phone/smart phone, PDA and laptop computer.

Hybrid solutions are also developing that enable devices to access more than one type of network. For example, a laptop computer or a PDA can be equipped so that it can operate in a WLAN network or a GPRS network (see following section). Developing technology will allow users to roam between technologies such as these, depending on factors such as network availability, without interrupting a communications session. This will be an important characteristic of future mobile systems (see Section 5.6).

[33] This is often referred to as 'unwiring' e.g. 'unwiring the office', 'unwiring the enterprise'.

[34] E.g. 'epyrus' roll-up display from Siemens (http://www.siemens.com/index.jsp?sdc_p=lo1060931umcd1047890n1031561s4fp&sdc_sid=6647399584&sdc_bcpath=1031582%2C&), also www.eink.com/

With software defined radio (SDR) technology future mobile devices will be able to operate in numerous different types of mobile networks using different standards and protocols[35].

At the same time other mobile devices are developing that can be embedded in virtually anything for purposes such as tracking and location, or environmental monitoring. A remote video camera suitable for home security applications is available from Nokia which operates using standard mobile technology[36]. Miniature mobile devices known as radio frequency identification (RFID) tags can be incorporated in products and packaging to assist with automated stock control systems (e.g. a Philips RFID system is being implemented in a German Metro Group supermarket[37]). Extending this concept further, wireless devices can even be embedded in consumers via medical implants (e.g. heart pacemaker). Mobile devices may also need to communicate with fixed devices such as PCs, and other objects with embedded computing ability (e.g. security systems, entertainment systems, household appliances) in close proximity. Personal Area Network (PAN) technology enables networks to be formed in and around an individual's immediate locality through the formation of typically ad-hoc wireless networks (see section 5.2 below).

5.2 Mobile Systems

Most current mobile users rely on cellular systems such as GSM to enable them to avail of voice, data and text services on a nationwide and, with roaming, on a global basis. Systems capable of higher data rates such as GPRS[38] (140kbit/s) and EDGE[39] (384 kbit/s) are evolving from GSM, eventually leading to 3G (2Mbit/s[40]). WLAN is a technology that developed from the data communications world as a replacement for in-building network cabling. WLAN technology[41] (e.g. IEEE 802.11) is now used to provide mobile users with broadband communications facilities (up to 11 and 54Mbit/s[42]) in localised areas typically up to 100 metres across known as 'hot spots'. Although the range of this technology is typically too small to make the roll-out of a continuous wide area network in the same manner as a cellular technology practical, hotspots are already beginning to appear in a large number of publicly accessible places. On an even smaller scale Personal Area Networks (PANs) enable users to connect devices in close proximity (e.g. up to 10 metres for example). Such networks are typically formed on an ad-hoc basis without the need for a network service provider, and use short range technologies such as Bluetooth and IEEE 802.15.3a[43]. Generally speaking the higher the data rate of a technology, the lower the range will be.

[35] See Software Defined Radio Briefing Note - www.comreg.ie/_fileupload/publications/odtr0159.pdf

[36] www.nokia.com/nokia/0,5184,4654,00.html

[37] www.iee.org/oncomms/pn/rf/industrynews.cfm

[38] GPRS – General Packet Radio Service

[39] EDGE – Enhanced Data Rates for GSM

[40] 2Mbit/s is expected to be a maximum available data rate for some 3G systems. Users might typically expect to avail of data rates up to 380 kBit/s in urban areas.

[41] See WLAN technology Briefing Note – http://www.comreg.ie/_fileupload/publications/odtr0216.pdf

[42] Some IEEE 802.11b is capable of delivering data rates up to 11Mbit/s, 802.11a & g are capable of up to 54Mbit/s.

[43] IEEE 802.15.3a is a new standard being developed for Personal Area Networks.

System	Maximum Theoretical Data Rate	Typical Maximum Range[44]	Coverage	Comments on coverage
GSM	9.6kbit/s	35km[45]	Nationwide	Higher data rates may only be available closer to base station, and in smaller cells.
GPRS[46]	140kbit/s			
EDGE	384kbit/s			
CDMAone	144kbit/s	30km	Nationwide	
3G (WCDMA)	2Mbit/s	10km	Nationwide	Higher data rates may only be available closer to base station
WLAN 802.11a, b, g	11Mbit/s, 54Mbit/s	100m	Hot-spot	
Bluetooth	721 kbit/s	10m	Close range	'in-room' applications.
802.15.3a	480Mbit/s	10m	Close range	Under early development.
802.16e	n/a	n/a	Wide area	Under early development.

Table 1 – Comparison of main mobile/portable technologies.

Private digital mobile radio systems such as Tetra are also being deployed.

5.3 Software Systems for Mobile Devices

As with PCs, mobile devices require operating systems (OS) to enable software applications to make use of actual hardware resources such as memory, processors and displays to operate. Standard voice based mobile devices (e.g. 2G) have typically used proprietary OS that are specific to the manufacturer or device model to handle relatively simple operations (e.g. handling voice calls) that are pre-programmed into handsets. Mobile devices from different manufacturers running different operating systems need another layer of software, known as middleware, to run advanced applications on handsets (e.g. Java 2 Micro Edition – J2ME). To deliver Internet content on mobile devices, specially modified mark-up languages (e.g. WML, cHTML, xHTML) are used by protocols such as Wireless Application Protocol (WAP) and services such as i-mode. For a more detailed description of these mobile software standards see Annex 1.

5.4 Location Based Technology

New applications and services are already developing that make use of user's physical location (e.g. MPark - mobile payment of parking meters in Dublin). These types of services are known as location based services and this technology could potentially enable a wide range of new services and applications to develop (see Section 4 for more examples). The availability of location information can enable service providers

[44] Actual cell ranges can depend on a number of factors including data rate, number of other users in cell, physical speed of moving user, multi-path environment, and the frequency band the system is operating in.

[45] Special variants of GSM are available to increase cell sizes for rural environments.

[46] GPRS and EDGE use similar radio modulation schemes and the same frequency bands as GSM.

to target services and information to users relative to their current location (e.g. identifying nearby shops and services)[47]. For information on the different types location based technology see Annex 2.

The ability of an operator to accurately determine the position of any of its mobile users for the purpose of emergency services has been mandated in the US (E-911). The European Commission has set up a group to deal with the issue of location information for emergency services (CGALIES[48]).

With the introduction of location based services technology users may initially feel intimidated or threatened by the potential loss of privacy which could adversely affect the adoption of services. On the other hand, many users may find such services very useful, since many person-to-person mobile communications are currently initiated by users disclosing their locations (e.g. "Hello, I'm on the train!"). To protect the privacy of users, location information should only be submitted to service providers on an opt-in basis (i.e. with the consent of the user) except for emergency services[49]. This would involve users only disclosing their locations on a case by case basis or for an authorised set of services. Applications such as Friend Finder from Openwave[50] enable users to locate their friends or co-workers via their mobile phones. Similar applications can also be used to support mobile dating services for example.

5.5 Networks Infrastructure and Content Standards

Traditionally mobile cellular networks[51] have been circuit switched networks as they were developed primarily to provide voice services. As in fixed networks, with increasing amounts of data traffic, it has become more practical to include some packet based infrastructure (e.g. Internet Protocol – IP). To this end GPRS has developed to handle packet based data in GSM access networks, and more advanced 3G cellular networks are likely to have packet based core networks. WLAN technology is designed to carry IP data. As fixed networks migrate towards packet switched technologies it will become increasingly convenient for the mobile networks that interconnect with them to also be packet based. This could help bring about increased convergence between fixed and mobile networks, enabling users to avail of the same services regardless of which type of network they are using. Packet based networks are also more suited to 'always-on' type services which are expected to be a key element driving the up take of 3G.

As with the fixed Internet, numerous content standards are being adopted by content providers and device manufacturers (e.g. MP3 and MIDI for audio, MPEG4 and DVB-X for video).

5.6 Roaming and Interoperability

The ability of subscribers to use their mobile phones while roaming in other countries is one of the key reasons for the success of this technology. Global roaming is now possible with multi-mode mobile phones which are able to operate in the major cellular bands and systems, although this service can be expensive. However, as

[47] Norwich Union in the UK has recently announced a trial with Orange to using location based technology to offer motorists 'pay as you go' insurance.

[48] Co-ordination Group on Access to Location Information by Emergency Services

[49] This approach to the treatment of location based information is taken in the new EU Electronic Communications Privacy Directive. It is likely that location information of users may be obtained on an anonymous basis for purposes such as network management, control and planning.

[50] www.openwave.com/products/location_suite/friend_finder/

[51] A mobile network typically consists of a radio access network and fixed backhaul and core network (e.g. a national microwave ring).

more different mobile standards from Personal Area Networks (PANs) to WLANs to cellular phones develop it will become increasingly important for users to be able not only to avail of services in different countries, but also to be able to roam on different types of networks. It is already possible in some cases for PDA and laptop users to roam between GPRS and WLAN networks with dual mode wireless devices (e.g. WeRoam from TOGEWAnet[52]). Users will seek to be able to operate the same applications and services regardless of the type of the network that is available. Technical issues relating to the interoperation of applications over different networks and handover of users will need to be solved[53]. For users of more than one type of device it is important that the same service can be adapted for each type of terminal (i.e. take into account small screens). Personalised profiles will present users with their own familiar mobile environment when they access the different networks or use different devices. In the future PANs that enable all sorts of devices to interact wirelessly are likely to emerge and these will need to interoperate with other mobile systems and devices also.

[52] www.togewanet.com

[53] Some commentators believe that when different wireless systems such as 2G, 3G, WLAN and other short range technologies can interoperate seamlessly (i.e. without interrupting or being noticed by the user) then this combined system could lay claim to the '4G' label.

6 Commercial and Economic Factors

6.1 Billing Models

To encourage widespread adoption of new mobile applications and services, network operators need to develop and offer attractive pricing models. With the introduction of GPRS, operators are already moving away from per/minute charges towards volume based charging (e.g. number of Mbit/s). It is likely that, similar to fixed networks, this will eventually migrate toward flat-rate charging[54]. WLAN hotspot services are typically charged on either a subscription based flat-rate system, or on a pre-paid per minute basis.

The presence of multiple content, applications and service providers (see Section 6.3 below) creates a complex billing environment for network operators and end users. A crucial determinant of consumer adoption of multiple networks, multiple application roaming is likely to be a simple, single approach to customer identification and billing – possibly based on enhancements to the GSM SIM card. This would permit seamless access to WLANs, for example, without having to establish new configurations[55], login, password and billing processes for each different provider[56].

6.2 Branding

Traditional mobile network operators have been establishing their brands on a global basis (e.g. Vodafone, O2). Mergers and roaming agreements among WLAN hotspot operators and aggregation companies are also helping to create international brands[57]. Mobile equipment manufactures currently enjoy strong brand awareness, although the convergence of mobile devices and portable computing devices could potentially erode this (i.e. with product distinction based on operating system compatibility instead of handset manufacturer). More advanced mobile systems will increase the potential for multi-media content providers to use their brands in the mobile sector (e.g. Disney[58]).

6.3 Open access to markets and Revenue Sharing

The importance of mobile network operators opening their networks to third party content and applications providers has been demonstrated by the success of DoCoMo's i-Mode. Where networks are open, network operators, and content and applications providers must develop revenue sharing relationships. For example, DoCoMo collects revenue from customers on behalf of third party content providers and retains a percentage of revenue as part of their i-mode service[59]. Mobile users accessing service via WLANs are typically more accustomed to paying for services and content separately from access to the Internet (i.e. typically by entering credit card details).

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[54] Flat-rate charging is typically associated with 'always-on' services which are a key element of broadband systems – see Section 5.5.

[55] e.g. Microsoft's Zero Configuration engine is designed to allow automatic configuration of WLAN terminals

[56] Am-beo is an Irish company that provides a rules-based rating and revenue settlement product for complex mobile environments – www.am-beo.com

[57] Telstra, Korea Telecom, Maxis Communications, and Starhub have partnered to roll-out a network of 20,000 hotspots across Australia, China, Malaysia, Singapore and South Korea under a single brand name. Boingo Wireless is a US based hotspot aggregation company – www.boingo.com

[58] www.mobile.disneyinternational.com

[59] Integrated payment for content is particularly important in Japan where credit card circulation is relatively low.

6.4 Content

The availability of useful or compelling content is essential to encourage users to make greater use of mobile systems. To date the availability of narrowband content such as phone ring tones and logos have been commercially successful. As more advanced mobile systems capable of operating at greater data rates develop broadband content such as video will need to be created or adapted to help drive these markets.

Digital rights management is also an important issue for creators and distributors of content on mobile networks. Content providers must try to strike a balance between protecting themselves against piracy and creating easy access for authorised users. Content that needs to be protected can include music, video, information, games and software tools. The manner in which authorised customers are billed for access to protected content in also important for commercial success (see Section 6.3).

6.5 Consumer Protection and Security

Users of the fixed Internet are all too well aware of the unwanted e-mail messages known as 'Spam' (i.e. junk e-mail). Filtering out spam mail from genuine wanted mail is an ongoing task for most e-mail users. This task can be assisted to varying degrees by filtering software. The problem may become more annoying for mobile users who could find themselves paying high access fees to receive un-wanted e-mails. In some countries legal measures have been taken to limit Internet spam by making it illegal to send un-solicited spam mail to users (i.e. an opt-in approach). This approach has been recommended by the European Parliament. Alternatively an 'opt-out' approach allows spam to be sent, but must be stopped once an addressee requests this. In other cases service providers are making attempts to reduce this problem by limiting the number of e-mails that a user can send per day (e.g. Microsoft Hotmail).
As more mobile systems, applications and service providers emerge the environment generally becomes more complicated for users. It is therefore important that consumers are made aware of their rights.

With the widespread availability of mobile communications services, both nationally and internationally, consumers and service providers should be aware of any local national standards and legislation applicable to particular services and content in their countries. Some services which are permitted in one country may not necessarily be treated the same way in another (e.g. gambling, adult services).

Security is an important issue for users of mobile communications. For users to adopt new mobile services and applications they need to be assured that their personal information cannot be revealed to unwanted third parties. This is particularly important with financial transactions and other personal details. Technological solutions are continuing to emerge for mobile systems and are generally becoming available. Such solutions need to be simple to use and users need to be confident of their security. Similar to fixed devices connected to the Internet, mobile devices that can download software will require anti-virus protection.

6.6 Implications for Ireland

The availability of new mobile applications and services on Irish networks will help to increase choice for Irish users. The adoption of mobile solutions by corporate users can help to increase efficiency and make Irish businesses generally more competitive. The adoption of open software standards for mobile applications and systems creates potential opportunities for Irish software firms to develop mobile software as third parties. By adopting advanced mobile technologies, Irish operators could potentially generate new sources of revenue through useful or appealing new applications and services.

The implementation and adoption of advanced high capacity mobile services will have a significant impact on Irish telecommunications infrastructure. 3G networks will require high capacity links to connect base stations, and a network of masts. Similarly WLAN hot-spots need to be linked into fixed networks. Access to the government-backed optical fibre rings[60] could help with the deployment of hot-spots in Irish towns and cities. In other cases hot-spots can be served by DSL connections or leased lines.

As well as providing opportunities for mobile operators to increase their range of mobile services (e.g. O2 in Ireland[61]), WLAN technology can enable fixed network operators to increase their range of services to end users. Examples of this can be seen in Ireland (eircom[62]) and in other countries – e.g. UK (BT Open Zone), US (Verizon), and Korea (Korea Telekom).

[60] www.dcmnr.gov.ie/files/NDP%20Man%20Brochure%20Version%2034.doc

[61] http://www1.o2.ie/about_o2/latest_news_21

[62] http://www.eircom.ie/cgi-bin/bvsm/bveircom/bladerunner/showContent.jsp?BV_SessionID=@@@@0413456229.1054207350@@@@&BV_EngineID=fadchgdkhhejbedcfjgchgcghk.0&cid=WirelessBroadbandServiceBus&fromChannel=ProductInfo&selectedChannel=BroadbandServices

7 Conclusion

Mobile and portable systems such as 3G and WLAN are emerging with the capability to provide users with broadband mobile services. New applications are likely to emerge that can take advantage of high data rates, always-on, and other advanced characteristics of these mobile networks. Applications such as teleconferencing and high speed access to company information are likely to benefit business users. Whereas more advanced communications, education, e-government, medical and entertainment services – among others – could benefit all mobile users.

Future mobile systems will enable consumers to use applications and access content regardless of whether they are connected through a 3G mobile, WLAN, PAN, or any other type of wireless network connection. This means that they will be able to use their applications and services without having to be aware of what sort of network is available. This will involve complex interactions between numerous different networks and systems, which need to be simplified or made transparent from the end users perspective.

As the Internet becomes more accessible through mobile networks, innovative new applications are likely to emerge to take advantage of their convergence. WLAN technology is, in effect, mobilising the existing fixed Internet within limited coverage areas (e.g. hotspots), enabling users to access the Internet in same way they would sitting in an office or at home (i.e. 'unwiring' the office or home). The traditional mobile industry is pursuing a different path to mobile Internet and other future mobile applications whereby content is specifically adapted to suit cellular networks and smaller handheld devices. However the line between these two approaches is blurring.

Location based technology is already emerging as a significant factor in the development of new applications and services for mobile users. The development of useful content, applications and services is vital to the uptake of advanced mobile systems. Advances, not only in mobile and wireless technology, but also in colour device displays, for example, are likely to lead to richer content and higher capacity services. In order for these applications to develop over traditional mobile systems, operators need to 'open' their systems to third party service and content providers. Open systems with shared revenue agreements between operators and content providers are more likely to create an environment in which new applications and services can thrive in.

8 Annex 1 – Mobile Software Systems

As more demanding applications develop for more sophisticated devices OSs must grow to meet these needs. Although laptop computers typically operate standard PC type OSs other specifically mobile devices with more limited computing capabilities such as phones and PDAs typically use: Symbian, Palm, Microsoft (Smartphone, Pocket PC), or Linux[63]. Applications developers must therefore enable their applications to function on several OSs. This has led to the development of middleware[64] which enables the applications to function on any OS. Java is currently the most successful form of middleware (J2ME – Java 2 Micro Edition). BREW (Binary Runtime Environment for Wireless) is a competitor.

Wireless Applications Protocol (WAP) was designed to adapt and deliver Internet content over mobile networks. Early experiences of WAP over slow GSM networks led to slow take-up. Other problems such as lack of content, time based charging and a generally poor experience of the Internet also contributed to WAP's lack of success. However, with the availability of higher speed packet based services (e.g. GPRS, 3G) and a newer version of the protocol (WAP 2.0), WAP users can experience a more satisfactory mobile Internet experience. NTT DoCoMo's i-mode service is often compared to WAP, although it is a platform and not a protocol, because it also delivers Internet content to mobile users. Much of i-mode's success is attributed to widely available content and because it gives users an experience that resembles the fixed Internet and because it is generally inexpensive.

Mark-up languages are used to deliver actual content to mobile devices of which numerous different standards have developed. There are two main mark-up languages; Wireless Mark-up Language (WML) used by the WAP platform, and compact HTML (cHTML) used by DoCoMo. A new mark-up language – xHTML – that will help interoperation between WML and cHTML is underdevelopment.

Element	**Standard**
Operating Systems	Linux Microsoft - Smartphone/Pocket PC Palm Symbian Device specific systems
Middleware	BREW[65] J2ME
Mobile Internet Platform	i-Mode WAP
Mark-up Language	cHTML[66] WML[67] xHTML

Table A1 – Examples of operating systems and programming platforms for mobile devices

[63] Each of these OSs is competing to move beyond their own initial device markets. Microsoft has recently opened up its Windows CE OS (Smartphone 2002 & Pocket PC) allowing device manufacturers to modify code without having to pay additional royalties.

[64] Middleware is a type of software that mediates between OSs and application programmes.

[65] BREW – Binary Runtime Environment for Wireless

[66] Compact Hiper Text Mark-up Language (cHTML)

[67] Wireless Mark-up Language (WML)

9 Annex 2 - Location Based Technology

A user's location can be made available to a network operator or a service provider in a number of different ways with varying levels of precision:

1. By the mobile user actively sending information about their location (e.g. texting pay station ID number).
2. From the base station of the mobile network that a user is connected to, since the operator will know the location of all their base stations *(cellID)*
3. From measurements made in the operators network (typically based on the time it takes signals to reach nearby base stations – *Time of Arrival (TOA) / Time Difference of Arrival (TDOA)*[68])
4. From measurements made in the mobile handset (typically based on timing information sent from the network *(Observed Time Difference of Arrival – OTDOA/ Enhanced Observed Time Difference - EOTD).*
5. Through a GPS[69] device integrated in the user's handset.
6. Hybrid combinations of the above.

Technology	**Accuracy**
CellID	Depends on cell size (100s of metres to several km's)
TOA/TDOA	~100 metres
EOTD	~100metres
GPS	0 - 100 metres

Table A2 – Comparison of main location based service methods.

[68] T-mobile, AT&T Wireless and Cingular Wireless are implementing TDOA in the US.

[69] Global Positioning System (GPS) is a satellite positioning systems that can accurately identify the location of a user.

10 Annex 3 – Glossary

3G	Third Generation mobile
4G	Fourth Generation mobile
BREW	Binary Runtime Environment for Wireless
CDMA	Code Division Multiple Access
CGALIES	Co-ordination Group on Access to Location Information by Emergency Services
cHTML	Compact Hyper Text Mark-up Language
DVB	Digital Video Broadcasting
EDGE	Enhanced Data Rates for GSM
EOTD	Enhanced observed time difference
GPRS	Generalised Packet Radio System
GPS	Global Positioning System
GSM	Global System for Mobile
HTML	Hyper Text Mark-up Language
IEEE	Institute of Electrical and Electronic Engineers
IM	Instant Messaging
IP	Internet Protocol
ITU	International Telecommunications Union
J2ME	Java 2 Mobile Edition
LAN	Local Area Network
MIDI	Musical Instrument Digital Interface
MMS	Multi-media Messaging Service
MPEG	Motion Picture Experts Group
OS	Operating System
OTDOA	Observed time difference of arrival
PAN	Personal Area Network
PC	Personal Computer
PDA	Personal Digital Assistant
RFID	Radio Frequency Identification Device
SDR	Software Defined Radio
SIM	Subscriber Identity Module
SMS	Short Messaging Service
TDOA	Time difference of arrival
USIM	Universal Subscriber Identity Module
VoIP	Voice over IP
WAP	Wireless Application Protocol
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network
WML	Wireless Mark-up Language
xHTML	Extensible Hyper Text Mark-up Language