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Technological developments and socio-economic issues of wireless mobile communications

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Abstract

During the last 10 years, wireless communications can be considered as the fastest growing segment of telecommunications. In fact, mobile telephones have become an everyday accessory for hundreds of million people, and they are increasingly being used in the most developed and many developing countries in the world. Current forecasts indicate that demands for wireless access will exceed the number of fixed access lines by year 2010. This paper examines the technological developments, as well as the worldwide social-economic impacts of wireless mobile communications. More specifically, it gives an overview on the technological developments of wireless mobile communications, describes the evolution towards the next-generation systems, analyzes the reasons for the growth rate of subscribers, and the related social development. As a conclusion, it suggests several solutions in response to dangerous behaviour generated by wireless terminals.

Keywords: Economic impact; Personal service; IMT-2000; Next-generation system; Technological development; Wireless communication; Mobile communications

1. Introduction

The telecommunications community is going through a huge revolution that will shape the century. The network will be everywhere and computing will shift from professional desktop towards consumer-oriented computing, using compact wireless personal multimedia devices (Danneels, 1998; Negus et al., 2000). Wireless personal

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communications can be considered as the fastest growing segment of telecommunications. In fact, mobile telephones have become an everyday accessory for hundreds of million people, and they are increasingly being used in the most developed and many developing countries in the world (Kim and Litman, 1999). In some countries, substitution of fixed telephony by mobile telephony has been taking place as operators have changed their strategies from offering and promoting mobile telephony as a premium service into offering mobile telephony as everyone's default solution for voice and data communications, at tariff rates that are competitive with fixed network rates (Lossie, 1999). Wireless coverage is almost universal in developed countries, while in developing countries, it is increasingly becoming a substitute for wireline networks as the costs for installing wireless networks decline. Current forecasts indicate that demands for wireless access to global telecommunications will reach 1 billion users by the year 2010, exceeding the number of fixed access lines (Pandya, 1999).

Mobile communications have experienced enormous growth during the last 10 years. First-generation systems such as AMPS, TACS and NMT using analog transmission for speech services were introduced during the early 1980s (Rappaport, 1996). Second-generation systems, which use digital transmission, were introduced in the late 1980s (Steel, 1990). Global systems for mobile communications (GSM), personal digital cellular (PDC), IS-136, and IS-95 are second-generation systems which offer services covering speech and low-bit-rate data (Tabbane, 1997). These systems will further evolve toward the third-generation (3G) systems in order to offer more advanced and innovative services, such as high-bit-rate and broadband multimedia services (Fasbender and Reichert, 1999; Sollenberger et al., 1999). Furthermore, the emerging 3G systems is supposed to make information services instantly available while introducing a more powerful and flexible way of doing business. In this changing environment, telecommunication operators and service providers will want to exploit innovative technologies and create new revolutionary services while maintaining their existing customer base.

This paper examines the technological developments, as well as the worldwide social–economic impacts of wireless mobile communications. It is organized as follows. Section 2 defines some basic concepts. Section 3 gives an overview on the technological developments of wireless communications. Section 4 describes the evolution towards the next-generation systems, as well as the standardization, requirements and services forecast. Section 5 analyzes the economic impact of wireless technology, whereas Section 6 states some cases of social developments and Section 7 gives some concluding remarks.

2. Basic concepts

A vision of personal communications should embrace the integration of several communication concepts, approaches, or systems into one interconnected and interworking network (Cox, 1990). This integrated network should support different wireless and wireline communications devices optimized for their specific environment. As a result, a person is able to initiate or receive information anywhere at any time. The concepts enabling to provide universal personal communications include *terminal mobility* provided by wireless access, *personal mobility* based on personal numbers, and *service portability* through the use of intelligent network (IN) capabilities (Pandya, 1999). Terminal mobility systems are characterized by their ability to locate and identify a mobile terminal as it moves, and to allow the mobile terminal to access telecommunication services from any location. Terminal mobility is associated with wireless access and requires that the user carry a wireless terminal while being within a radio coverage area.

Personal mobility systems are characterized by their ability to identify end users as they move, and to allow them to originate and receive calls, and to access subscribed services on any terminal in any location. The emerging implementations and integration of IN capabilities within fixed and mobile networks provide the dynamic relationship between the terminal and the user. As for service portability, it refers to the capability of a network to provide subscribed services at the terminal or location designated by the user. The exact services that the user can evoke depend on the capability of the terminal and the network serving it. Moreover, the term IN describes an architectural concept that can be applied to all communications networks. It is aimed at facilitating the introduction of new services by decoupling the functions required to support call and connection control from those required to support service control, allowing both sets of functions to be placed on different physical platforms.

For a number of years, the European wireless standard, the GSM, benefited greatly from being the only commercially available and widely supported digital standard globally, and it has been selected by over 150 operators in more than 100 countries throughout the world (Ojanpera and Prasad, 1998). Other operators have chosen between digital AMPS (D-AMPS), time division multiple access (TDMA), code division multiple access (CDMA), and the PCS 1900, variant of GSM in US (Sollenberger et al., 1999). Most digital systems today use a form of TDMA technology which was devised largely for the smooth conversion of AMPS to digital and is a proven technology for enhanced services, including a message waiting indicator, caller ID, voice privacy, authentication, data communications, and short message service (SMS). CDMA has superior spectral efficiency, the ability to reduce deployment costs by simplifying network configuration and lowering required base station density, better voice quality and longer handset battery life.

The International Telecommunications Union (ITU), the United Nations Organization responsible for global telecommunications standards, has been working since 1988 towards developing an international standard for wireless access to worldwide telecommunications infrastructure. This standard is known as IMT-2000, (International Mobile Telecommunications 2000), where 2000 indicates the target availability date (year 2000), as well as the operational radio frequency band (2000

MHz range). Until 1997, IMT-2000 was known as Future Public Land Mobile Telecommunication Systems (FPLMTS) (Pandya, 1999). Also, IMT-2000 represents the 3G systems aimed at providing global access and multimedia communications. In Europe, it is called Universal Mobile Telecommunications System (UMTS).

3. Technological developments

Nowadays, wireless communications encompass many technologies, systems, and services optimized for different applications. Technologies and systems that are currently provided or proposed to provide wireless communications and services can be grouped into several distinct groups. The following sections briefly describe each of them.

3.1. Paging systems

Paging and associated messaging, although not providing two-way communications, provide a form of wireless data communications to many subscribers worldwide. Radio paging began many years ago as a one-bit messaging system. The one-way radio link is optimized to take advantage of the asymmetry. High transmitter power and high antennas at the base stations permit low-complexity, very low-power consumption. Paging has evolved and changed from analog coding for user identification to digitally encoding messages (Gibson, 1999).

3.2. Cordless telephone

Cordless telephone can provide low-mobility, low-power, two-way wireless voice communications with low mobility applying both to the range and the user's speed. Cordless telephone systems using analog radio technologies appeared in the late 1970s, and have experienced spectacular growth. They were originally aimed at providing economical, wireless voice communications inside residences, i.e., using a short wireless link to replace the cord between a telephone base unit and its handset. The most significant consideration in design compromises made for these technologies is to minimize total cost, while maximizing the talk time away from the battery charger. Cordless telephone systems have evolved to digital radio technologies in the form of second-generation cordless telephone (CT-2), and Digital European Cordless Telephone (DECT) standards in Europe, and several different Industrial Scientific Medical (ISM) band technologies in US.

3.3. Cellular mobile radio systems

Cellular mobile radio systems have been evolving for over 50 years. They can provide high-mobility, wide ranging, and two-way wireless communications. In these systems, high mobility refers to vehicular speeds, and also to widespread regional to nationwide coverage. Cellular mobile radio systems integrate wireless access with large-scale networks having sophisticated intelligence to manage mobility of users. They have evolved to digital radio technologies in the forms of the following systems standards: GSM in Europe, Japanese digital cellular (JDC) or PDC in Japan, US TDMA digital cellular (USDC or IS-54), and CDMA.

3.4. Wide area wireless data systems

Existing wide area wireless data systems generally can provide high-mobility, wide ranging, low-speed digital communications to both vehicles and pedestrians. These systems have not experienced the rapid growth that the two-way voice technologies have, even though they have been deployed in many cities for a few years and have established a base of customers in several countries. The earliest and best known of these systems in US are the ARDIS network developed and run by Motorola, and the RAM mobile data network based on Ericsson Mobitex Technology (Gibson, 1999). In order to improve the base station capacity, the wide area mobile data systems have been evolving towards a new wide area packet data network known as cellular digital packet data (CDPD). This technology shares the 30-kHz spaced 800-MHz with a data rate of 19.2 kbps.

3.5. Wireless local area networks (WLAN)

WLAN can provide low-mobility, high-speed data communications within a confined region, e.g., a campus or a large building. Coverage range from a wireless data terminal is short, 10s to 100s of feet. WLANs have been evolving for a few years. However, with data rates ranging from 100s of kbps to more than 10 Mbps, and with several products providing one or two Mbps wireless link rates, there is no stable definition of the needs or design objectives for them.

3.6. Satellite-based mobile systems

Satellite-based mobile systems can provide very widespread, often global coverage with limited voice and data quality to very wide ranging vehicles (or fixed locations). However, they cannot provide adequate coverage to people inside buildings or locations shadowed by buildings, trees or mountains. As a result, satellite systems cannot favorably compete with terrestrial wireless systems in populated areas. However, they can complement terrestrial wireless systems in low-population-density areas.

4. Towards the next-generation systems

The current second-generation digital mobile and personal communication systems are based on national and regional standards that are optimized for region or country-specific regulatory environments. Therefore, they are unable to interoperate with each other and can provide mobility only within their radio environments, as well as within geographic regions with a specific standard. Efforts are under way to define the so-called 3G mobile telecommunication systems, or more generally next-generation mobile telecommunication systems that will meet the specific needs of each subscriber. The following describes the evolution aspects, the standardization and the services forecast of such systems.

4.1. Evolution aspects

The underlying vision for the emerging mobile and personal communication services for the new century is to enable communication with a person, at any time, at any place, and in any form, with a paradigm shift from the current focus on voice and low-speed data services to high-speed data, multimedia and Internet services (Pandya, 1999). As a result, it is expected that IMT-2000 system will essentially evolve from existing wireless and wireline networks, in terms of range of environments and services, as well as global mobility. Fig. 1 illustrates such an evolution. In fact, it is not economical to replace existing network infrastructures with a completely new one. The pace of such an evolution is to be determined by factors related to market demands, technology, regulations, and standardization.

In scope, IMT-2000 system service environments will address the full range of mobile and personal communication applications: in-building (picocell), urban (microcell), suburban (macrocell), and global (satellite), as well as communications

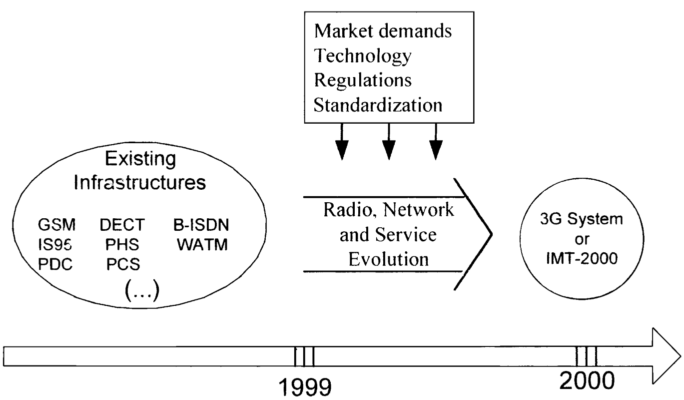

Fig. 1. Evolution towards the 3G systems.

types that include voice, data, and image. Support of communication needs for developing countries in the form of fixed wireless access applications is also included in the scope of IMT-2000 (Pandya, 1999). However, since these capabilities will be achieved by evolving existing wireless and wireline networks. IMT-2000 will be a family of systems rather than a single and monolithic network.

4.2. Standardization

IMT-2000 is intended to form the basis for the 3G wireless system, which will consolidate today's diverse and incompatible mobile environments into a seamless radio and network infrastructure capable of offering a wide range of telecommunications services on a global scale. Within the ITU, the radio aspects for IMT-2000, especially the selection of radio transmission technology (radio interface) and spectrum usage, are addressed in the radio communication sector (ITU-R), whereas the network aspects, which include definition of network signaling interfaces, services, numbering and identities, quality of service, security, and operation and management for IMT-2000, are addressed by the telecommunications standards sector (ITU-T). The specifications are captured in the so-called ITU recommendations (voluntary standards), which provide the essential backbone for worldwide telecommunications. Work is also under way in regional/national standards forums like European Telecommunications Standards Institute (ETSI), Telecommunications Industry Association (TIA) in US, and Telecommunications Technical Committee in Japan (TTC) on the 3G wireless systems that complement and provide inputs and direction to the IMT-2000 activities in the ITU.

4.3. Requirements and services forecast

As IMT-2000 is expected to support a number of different radio operating environments, the air interfaces is to be able to cope with variable, asymmetrical data rates with different quality of service requirements. Also, an efficient packet access protocol is essential to transfer bursty real-time and non-real-time data. In addition, IMT-2000 must support not only global roaming, but also the concept of virtual home environment. In other words, the user will be provided with a set of services and features that have the same look and feel regardless of whether they are accessed from the home or visited network. The establishment of this concept recognizes that service provision and network operation must be separated, allowing services to be offered by organizations not explicitly functioning as network operators. As consumers will be able to download full-text e-mails, enjoy improved graphics, access multimedia files and other applications, wireless subscribers with Internet access will probably outnumber wired Internet users by the end of 2002.

Japan is supposed to launch commercial IMT-2000 services in 2001, which may be the first in the world. European countries (Austria, Denmark, Finland, France, Germany, Netherlands, Norway, Sweden, and Switzerland) are expected to introduce the commercial services by January 2002. As for Italy, it might postpone for one year the start of authorization procedures, due to a problem of clearing the already occupied frequencies to be utilized for UMTS. On the other hand, Canada, New Zealand and the US have left these decisions to the existing and potential PCS operators, expecting that they will upgrade their systems in response to consumer demands.

Regarding the number of players to compete in each market, European countries (Austria, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, and the United Kingdom) plan to have as many national operators as the technical availability of the frequency can accommodate. This is expected to be between three and five national operators. On the other hand, Japan and Sweden plan to licence regional operators with up to three operators per region based on spectrum availability.

5. Economic considerations and issues

The economic impact of wireless mobile communications is obvious. In the following, the reasons for high-penetration rates, as well as the industry investments and the generated revenues are examined.

5.1. High-penetration rates

In 1990, there was just one mobile subscriber per 100 inhabitants worldwide. In June 1999, there were 26 mobile subscribers per 100 inhabitants (OECD, 2000). Recently, mobile communication penetration rates have begun to exceed those of fixed networks, in a growing number of countries. Several factors contribute to this explosive growth.

5.1.1. Competition and cost reduction

In the 1990s, the growth of mobile communication services is one of the tremendous success stories of the telecommunication industry. In 1998, the number of mobile subscribers increased by 45% whereas, between 1992 and 1997, this number grew at a compound annual growth rate of 52% (WOW-COM, 2000). According to economic theory, competition expands the service choices available to the public, which results in a cost reduction (Kim and Litman, 1999). For instance, US which has the greatest number of competitors (OECD, 2000) (up to eight mobile operators in the same regional market) also have one of the highest growth rate of mobile subscribers, as illustrated in Fig. 2.

Apart from US, the countries with the most mobile competitors are Japan, Korea and the Netherlands which can have up to five mobile operators in the same markets (OECD, 2000). Other countries where new operators are expected to start services before the end of the year 2000 are Austria, Czech Republic, Hungary, Italy and

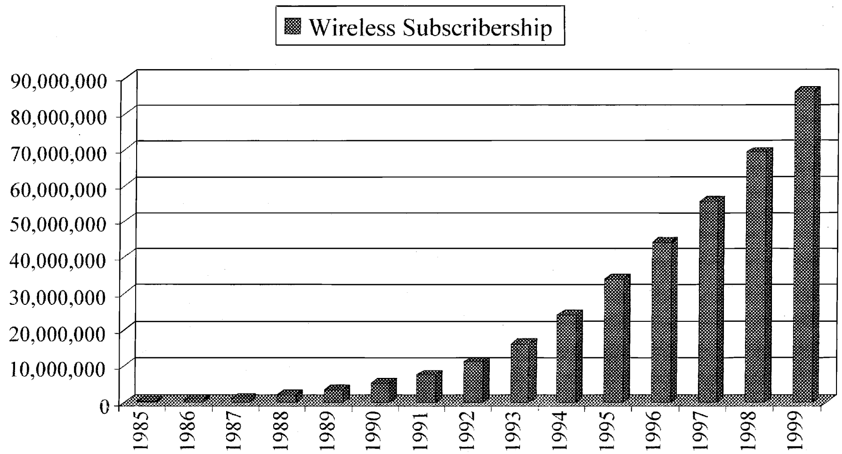

Fig. 2. Evolution of wireless subscribers in US.

Turkey. In Ireland, there is a legal challenge to the awarding of the third license, but an operator is expected to be in service during this period. In Sweden, a fourth license was granted to Telenordia in 1996 (David, 1999). The license stipulated that 50% of the Swedish population should be covered within four years.

The growth rates of mobile subscribers also reflect trends in the pricing of services related to market structure. New entrants brought the innovation of flexible tariff packages aimed at different types of users. In other words, by selecting an appropriate tariff package, users can make mobile service more affordable for themselves without operators necessarily lowering their overall prices. For instance, Luxembourg and Switzerland are benefiting from the introduction of new operators in 1998 and improvements were evident as of 1999 (OECD, 2000).

The benefits of flexible tariff packages directly reflect lower monthly bills for mobile service over recent years. The Cellular Telecommunication Industry Association's (CTIA) semi-annual survey shows the average local bill for mobile service, in US, has fallen steadily from $ 96.83 in December 1987 to $ 39.43 in December 1998 (WOW-COM, 2000). Fig. 3 illustrates such an evolution. An important factor in the cost reductions during this period was the increasing range of tariff schemes increasingly tailored to meet subscribers' needs. In response to increased competition, these cost reductions, in the most recent years, appear to be more attributable to price competition. Another recent study published by Strategies Group found that the average price per minute for mobile telephone service in US had fallen from $ 0.51 in 1993–1994 to $ 0.33 in 1998 (OECD, 2000), which confirms the mobile price reduction in US.

Tracking the average monthly bill may not convey the benefit of flexible tariffs for some users. In 1998, the Canadian Wireless Telecommunications Association

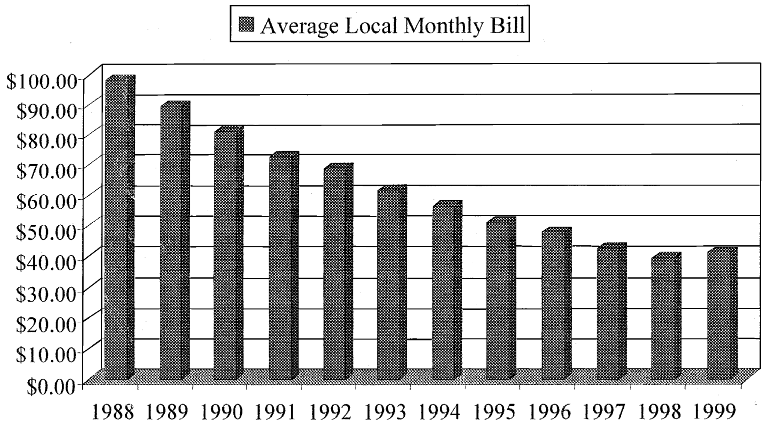

Fig. 3. Evolution of average monthly bill.

(CWTA) puts the average Canadian monthly mobile bill at $ 47.50 (CWTA, 1998). One Canadian mobile company, Fido, offers 200 minutes of local airtime per month for $ 16.60 (Microcell, 1999). Therefore, for many users making only local calls on their mobile (with a mobile phone for personal rather than business use), $ 16.60 would be the total cost of their monthly bill for mobile service.

It seems that the price of wireless services is relatively inelastic and that any elevation in price must have commensurate service features associated with it, such as call screening and call routing, SMS, fax, modem, etc. Although the cost of services is expected to decline gradually, current monthly service fees continue to prevent some subscribers from entering the market. In other words, a significant price reduction may be required to sustain the surge in usage seen to date and to penetrate the next socioeconomic layer of customers.

5.1.2. *Introduction of pre-paid services*

The major innovation in the pricing of mobile services has undoubtedly been the introduction of pre-paid cards. In 1995, the first pre-paid card services were introduced in Germany and Switzerland (GSM Osby Mikro, 1999). These non-rechargeable cards were mainly aimed at international business travellers rather than developing the domestic market, which made them expensive in comparison with the standard charges. In September 1995, Telecom Portugal (TMN) introduced the first rechargeable pre-paid card and made it readily accessible from automatic teller machines (Telecom Portugal, 1996). The impact of this service was immediately apparent with revenue from mobile services increasing 65% in 1996. In 1997, TMN's number of subscribers grew by 129%, compared to 1996, and Telecom Portugal attributed this success to their pre-paid products. At the end of 1997, 63% of TMN's customers used pre-paid products (TMN, 1998). In June 1999, some 85% of TMN's users were pre-paid. In Spain, over the first six months of 1999, Telefonica gained a net 1.6 million clients, taking the total customer base to 6.5 million (OECD, 2000). Telefonica's group of pre-paid products for digital mobile service was the main driver of this growth, since more than three-quarters of Telefonica's monthly registrations were for pre-paid services.

Even if Southern European countries were not the first ones to introduce pre-paid services, they were leaders in adapting the concept to card services. Telecom Italia Mobile (TIM), in Italy, followed TMN's innovation in pre-paid cards the following year. The impact was immediate during 1996, and further innovations followed in 1997. As a result, in June 1999, in Italy, 80% of TIM's users were pre-paid (OECD, 2000).

In Northern Europe, mobile operators began to offer pre-paid card services in 1997. At that time, Sweden's Comviq sold 190,000 pre-paid cards in the first nine months after the launch of the service (Jakob, 1998). In July 1999, Telia's Mobitel Refill card service, in operation for 12 months, sold more than 550,000 refill cards (Telia, 1999). In Norway, at the end of the first quarter of 1999, the number of Telenor's digital subscribers was 1.4 million (Telenor, 1999). The net increase in that quarter was 139,000, with 119,000 subscribed to the pre-paid service.

Pre-paid service is also a growing part of the market in North America. For example, there is an increasing tendency to have uniform national and international rates for mobile service as represented by AT&T's digital one rate plan (and the possibility to include roaming in Canada in this option) (OECD, 2000). Similar options are available in Canada for roaming in US. In Canada, in the fourth quarter of 1998, pre-paid mobile phone subscribers accounted for 42% of new subscribers added in the quarter (CWTA, 1998). In the second quarter of 1999, 70% of those who bought Microcell's "Fido" PCS service chose pre-paid (James, 1999).

Pre-paid service is an increasing part of the subscriber base of most mobile operators. The most obvious advantage is that, without a fixed monthly charge, users have greater control over their costs. From the perspective of operators, there are less customer acquisition and billing costs in servicing pre-paid card users. In addition, the advent of pre-paid cards has enabled mobile service to be available for many users who would not otherwise have had a credit rating sufficient to qualify for a traditional pricing package. In Australia, 40% of people wanting a conventional digital mobile service were refused because they could not meet the credit checks (ADCIT, 1998). This led the Australian Government to note, after the introduction of pre-paid service in June 1997, that pre-paid service can meet the needs of those people because there is no credit relationship or billing system required.

5.2. Revenues forecast

As demands for wireless services are driven by great marketing and advertising efforts, rapid expanding networks, and technological advances, wireless service providers become a real thriving industry sector. In US, the number of new wireless subscribers has dramatically increased from 1992 to 2000. A total of 82% of American people with an income higher than $35,000 per year (approximately 90 million people) is expected to become subscribers by 2002. In 1997, the Federal Communications Commission in US (FCC) reported that overall revenues for wireless services reached $30 billion (WOW-COM, 2000). In 1998, mobile communications represented more than 20% of the total telecommunications revenues worldwide (OECD, 2000). In US, the evolution of revenues generated by wireless service providers from 1985 to 1999 seems to be exponential, which is illustrated in Fig. 4. In fact, industry revenues are expected to continue to increase over the next few years, as higher capacity digital networks are being implemented and new services become available. Telecompetition Inc. (2000), in a recent report, has stated that revenues for wireless services in US metropolitan areas will exceed $40 billion by 2003.

According to the CTIA (WOW-COM, 2000), industry investment grew to $46 billion in 1997, up over 41% from 1996. Also, worldwide revenues from personal assistant services are estimated to be $267 million at the beginning of 2000 and reach $25.9 billion by 2005 (Kim and Litman, 1999). As a result, in 1998, mobile operators directly employed more than 260,000 people and created many more jobs among resellers and related businesses worldwide (OECD, 2000). The evolution of direct employment generated in US by wireless service providers is illustrated in Fig. 5.

6. Social impacts

Mobile communication is changing the society's behavior. The development of new intelligent services applications such as advanced messaging, data and video trans-

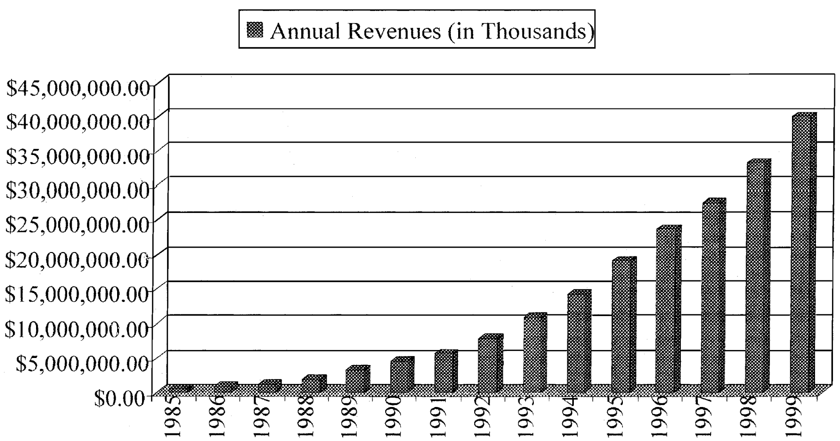

Fig. 4. Evolution of revenues generated by wireless services.

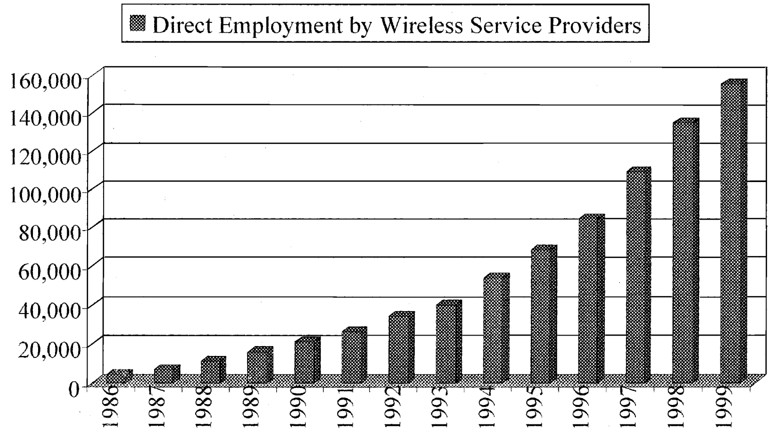

Fig. 5. Evolution of direct employment generated by wireless services providers.

mission, location technology, and remote monitoring can make an impact on people's lives and greatly enhance social developments around the turn of the century.

6.1. Personal security and emergency services

The importance of mobile networks is not limited to increasing access to communication services. Certain uses of wireless technology can make an impact on people's lives and greatly enhance social developments in areas such as personal security and emergency services. In US, for example, some 98,000 calls are made every day from mobile phones to emergency services (WOW-COM, 2000). A lot of discussion has also been on the *location services*, i.e., the accurate geographic placement of a subscriber requiring emergency services. Furthermore, some cars in the near future are expected to alert emergency officials when airbags are set off. All those features can greatly improve the ability for emergency services to respond to distress calls, which results in real life-saving uses of wireless technology.

Moreover, hospitals and other healthcare facilities are among the largest buyers of wireless systems, such as pagers, cell phones, handhelds, and WLANs (WOW-COM, 2000). Handhelds are used to keep current patient records, synchronizing through a WLAN any new information about the patient. This information is instantly entered into the hospital's central database available to anyone with clearance to access it. In the past, the process of entering this kind of patient data could take weeks. Again, this proves how wireless technology can be useful for the whole society.

6.2. Solutions to dangerous behavior

Certain people tend to be distracted by a wireless mobile terminal while driving a vehicle, which can result in dramatic events. In certain countries, driving a vehicle while operating a cellular phone is prohibited if the operation of that phone requires the driver to hold the terminal. For instance, in US, nearly 20 states have legislation pending that will limit the use of a cellular phone inside a vehicle (Gibson, 1999). Such laws are also common in Western Europe, and their goal is to address safety issues associated with a driver being distracted by attempting to make or receive a cellular call. There are two components to this problem. The first is juggling the phone in one hand while driving with the other; the second is concentrating on dialing digits instead of focusing on the road. These restrictions should be seen as an opportunity to increase the penetration of enhanced services in wireless networks and a chance for the industry to showcase its social and safety conscience.

Part of the legal answer is to provide ways for a mobile phone to operate a hand-free environment, which can be accomplished by headsets and speaker phone adapters. Such devices are readily available today from multiple sources and, typically, can connect to the car's lighter and the phone's headset connector (Fasbender and Reichert, 1999). They are easy to install and operate, without compromising the ability to remove the phone from the vehicle. However, even if they keep both the driver's hands on the wheel, these devices do not solve the problem of users trying to push buttons in order to make or manipulate calls, which is more dangerous. To tackle this issue, the use of network-based intelligent services is necessary.

Intelligent services enable to have driver–handset interaction simulate conversation with a passenger. Effective intelligent services must be simple to operate while requiring cost-effective implementations that allow them to be bundled into the basic service price. Many of them are currently being developed. The first one is called the *voice activated dialing service*. A typical implementation of such a service uses a single keystroke or speed dial option to reach a service node or an intelligent peripheral that can control a call setup from a spoken word. This relieves the user from being distracted by trying to dial a digit string. A concrete application of this feature is the *Enhanced 411 service* that can be evoked without juggling the wireless terminal, in case of emergency.

Another feature that helps prevent dramatic events is the *integrated voice messaging* which integrates messages in the form of a voice mail one can talk to. Voice mail can announce the presence of messages, without the need to push any key. These services are in their infancy, but benefits to mobile subscribers are huge. Obviously, there are some technical challenges in providing these services. Yet, operators have the opportunity to offer them as soon as possible both in order to increase revenues and satisfy a real social need.

7. Concluding remarks

As we move towards the next-generation systems, and the price of current wireless devices and services continue to decline, more and more people subscribe for wireless services in order to get access to a great variety of broadband and advanced services, including video and INs. This contributes largely to the economic development of the world, by increasing industry investments and revenues, and by creating a lot of jobs. In fact, mobile telecommunications represent more than 20% of the total telecommunication revenues. Also, some uses of wireless technologies enhance social developments in areas such as personal security and emergency services. Therefore, in the light of the emerging wireless potential of the Internet, these technologies are likely to change our lives, putting smaller, faster, portable, all-inclusive devices into our hands. As vision becomes reality, the question will not be how to live with wireless communication, but how did we ever live without it.

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