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Introduction

- 2.1** The telecommunications industry is experiencing rapid growth on a global scale. This is a direct consequence of technological development and has in turn facilitated the application of new technologies, and a consequent increase in economic activity. Within this sector, one of the greatest growth areas of recent years has been the development of mobile or wireless telecommunications.
- 2.2** The first land mobile services were introduced into the UK in the 1940s, but the significant expansion of services offered to the general public, including the introduction of mobile phones, began in the mid-1980s and rapidly attracted a small but significant number of subscribers. Developments in the early 1990s, such as the introduction of digital networks and the entry of additional service providers into the market, fuelled further increases in the numbers of subscribers.
- 2.3** It is now predicted that within a few years around half the population of the UK will be routinely using mobile telecommunications (see Figure 2.1) and that this will become the dominant technology for telephony and other applications such as Internet access. This wide use of a relatively new technology raises the question of whether there are any implications for human health.
- 2.4** There are conflicting reports relating to possible adverse health effects and these have understandably led to some concern. The Minister for Public Health recognised the importance of this issue and, following consultation with the Ministers at the Department of Trade and Industry, decided to seek the advice of an independent group as to the safety of mobile telecommunications technology, and asked the Chairman of the National Radiological Protection Board (NRPB) to establish an Independent Expert Group on Mobile Phones (IEGMP).
- 2.5** Following widespread consultation with interested parties, the Expert Group was set up under the chairmanship of Sir William Stewart FRS, FRSE. Membership of the Expert Group (Appendix A) represented a wide spectrum of expertise with leading figures from physics, radio engineering, biology, medicine, and epidemiology, in addition to lay members. The remit of the Group was

“To consider present concerns about the possible health effects from the use of mobile phones, base stations and transmitters, to conduct a rigorous assessment of existing research and to give advice based on the present state of knowledge. To make recommendations on further work that should be carried out to improve the basis for sound advice.”

- 2.6** The Expert Group held its first full meeting in September 1999 and determined from the outset that it must consult widely. To this end, advertisements were placed in national newspapers and scientific journals inviting individuals or organisations to submit evidence for consideration. Public meetings were arranged in Belfast, Cardiff, Edinburgh, Liverpool and London.

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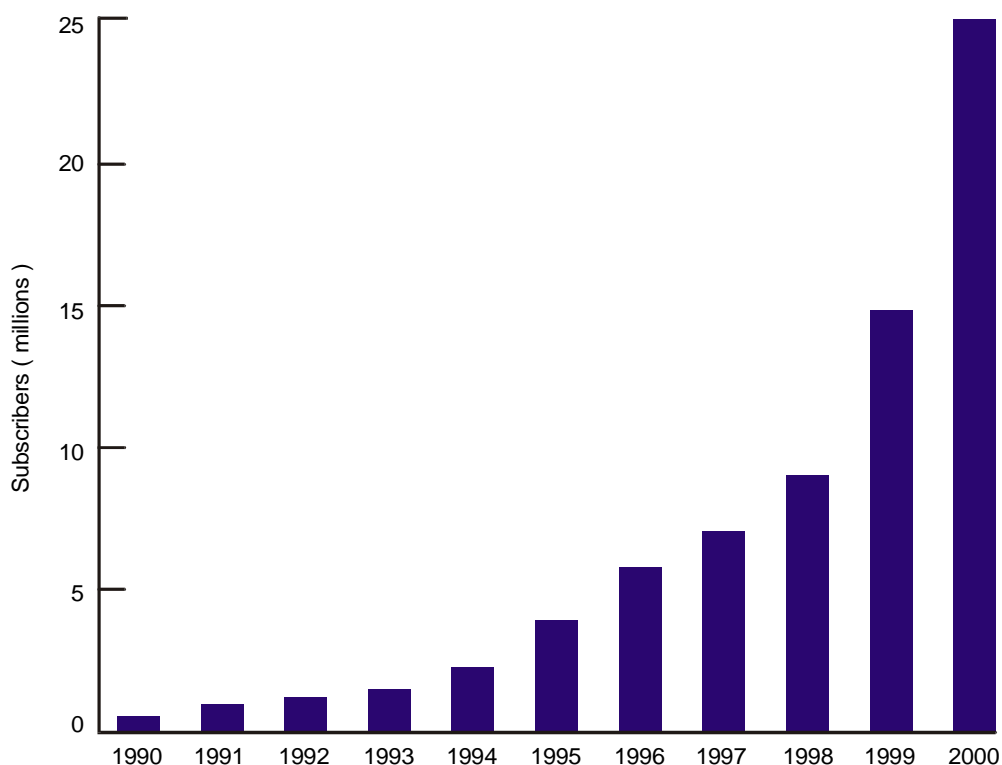


Figure 2.1 Growth in mobile phone subscribers in the UK between 1990 and 2000 (based on data from Federation of the Electronics Industry, FEI)

- 2.7** Those who submitted written evidence to the Expert Group are listed in Appendix B. A number of individuals and organisations accepted invitations to present evidence to closed meetings of the Group and these are indicated in Appendix C.
- 2.8** This report describes the work of the Expert Group. It presents the wide picture of mobile telecommunications as they impact on the general public, and recognises the contribution of mobile telecommunications to the quality of life and to the UK economy. It considers the underlying technology and the characteristics of the RF fields generated by present and near future (3–5 years) handsets and base stations, with particular reference to the magnitude of the fields. It provides an appraisal of the experimental and theoretical work that has been carried out which has a bearing on human health, and makes a number of recommendations to Government.

Background to the Introduction of Mobile Telecommunications

- 2.9** The UK telecommunications system was initially developed and operated as part of the General Post Office (GPO). In 1981, this situation changed with the passing of the British Telecommunications Act, which effectively separated the telecommunications and postal businesses of the GPO, and led to the creation of British Telecom (BT). The next stage in telecommunications development was the creation of a competitive marketplace governed by a new regulatory body, the Office of Telecommunications (OFTEL), which was established in 1984. These changes paved the way for the introduction of cellular telecommunications in a competitive environment.

2.10 Initially two companies were granted operating licences, Telecom Securicor Cellular Radio Limited (Cellnet) and a subsidiary of Racal Electronics plc (Vodafone). In January 1985, both these companies launched national networks based on analogue technology (see paragraph 4.10). However, in the late 1980s there was a move to develop standards for a second generation of mobile telecommunications throughout Europe in order to provide a seamless service for subscribers. This was achieved with the development and deployment of a new operating standard called the Global System for Mobile Telecommunications (GSM), which employs digital technology (see paragraph 4.11) and is now the operating system for 340 networks in 137 countries (Figure 2.2). Although this system is now used worldwide, the European geographical area is still the dominant user, with more subscribers than any other region. It has, however, been widely accepted in other areas such as the Asia Pacific region.

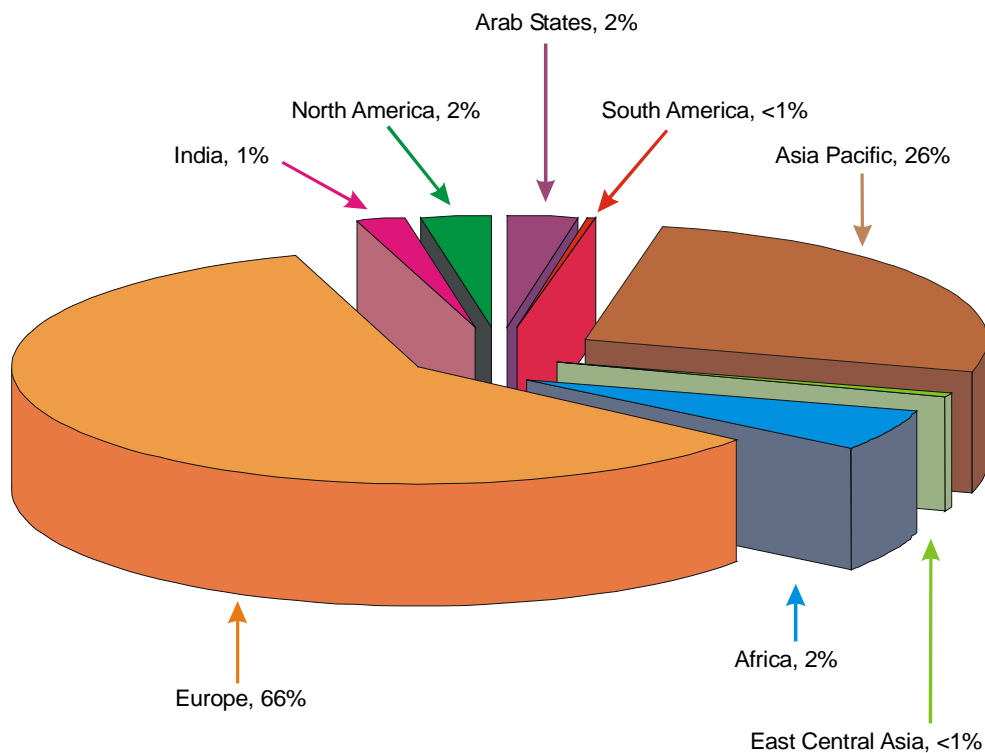


Figure 2.2 Distribution of GSM subscribers by geographical location (based on data from the GSM Association)

2.11 In the UK, the new GSM networks became operational in July 1992 (Vodafone), September 1993 (One 2 One), December 1993 (Cellnet), and April 1994 (Orange) the companies involved being referred to in this report as the network operators. The original analogue networks are still operational, but the Government has indicated that the analogue system should be removed from service by 2005.

2.12 On a worldwide scale, there has been a rapid growth in both the numbers of countries with operational networks and the number of mobile phone operators (Figure 2.3). There are a further 39 networks under construction for the GSM system alone.

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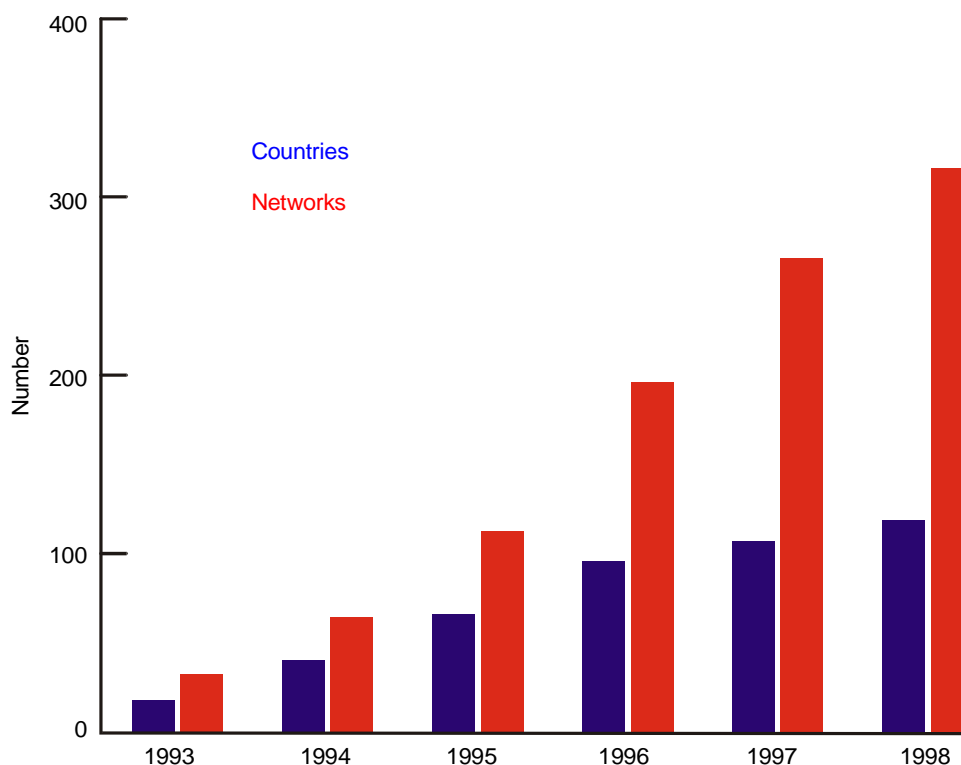


Figure 2.3 Growth of GSM networks throughout the world (based on data from the GSM Association)

Mobile Phone Networks and Communication

- 2.13** Individual mobile phones operate by communicating with fixed installations called base stations. These have a limited range (see paragraph 4.9) and mobile phone operators have to establish national base station networks to achieve wide coverage. It takes many years to establish a network that will provide both complete coverage and adequate capacity across the country and, even today, none of the UK networks provides complete coverage. However, since operators invest a great deal of money to purchase licences and establish networks and other infrastructure, they need to offer potential subscribers an effective communication system as quickly as possible. Moreover, operators were required, as a condition of their operating licences, to provide a minimum level of coverage within a given time frame. They established operational networks designed to allow most subscribers to access a base station most of the time. The initial phase of construction of such a network involves the installation of base stations in urban areas with high population densities, and along major transport routes such as motorways. These basic networks are then extended to provide coverage in more rural areas and increased capacity in urban areas. By developing networks in this way, operators can offer a functional system to the majority of the population. The more rural areas of the UK, particularly in the west of the country, still have rather poor coverage.
- 2.14** Base stations can be categorised into macrocells, microcells and picocells (see paragraph 4.9) depending on their size and power output. There are approximately 20,000 macrocells in the UK at present and, in general, all the major operators can now offer coverage to over 97% of the population. The number of macrocells is continuing to rise as operators seek to complete their geographical coverage and improve capacity. Since each base station can only handle a limited number of connections at any one time, operators need to install more base station units in densely

populated areas to cope with increasing demand. It seems likely that these will mainly be microcells and picocells. The overall number of base stations is likely to double within the next few years.

Present and Future Use of Mobile Phones

- 2.15** Initial market penetration by mobile phones was modest, with less than 1% of the UK population subscribing by the end of the 1980s. However, the advent of the more advanced GSM technology, in conjunction with greater competition in the market place, led to continuing growth in the number of subscribers throughout the 1990s (Figure 2.1).
- 2.16** At present there are approximately 25 million subscribers in the UK, which is equivalent to a market penetration of around 40%. Within the next five years it is expected that this will have increased to 75% market penetration or 45 million subscribers. At present it is estimated that around 45% of subscribers have a pre-paid mobile phone. Although it might be expected that many of these phones would not be used on a routine basis, the operators believe that around 90% of them are in regular use.
- 2.17** Within the next three years the “Third Generation” of mobile phones will be launched. This will employ a new operating standard called the Universal Mobile Telecommunication System (UMTS, see paragraph 4.15) and will enable operators to offer a full range of multimedia services. The introduction of these new services will require access to additional RF spectrum,

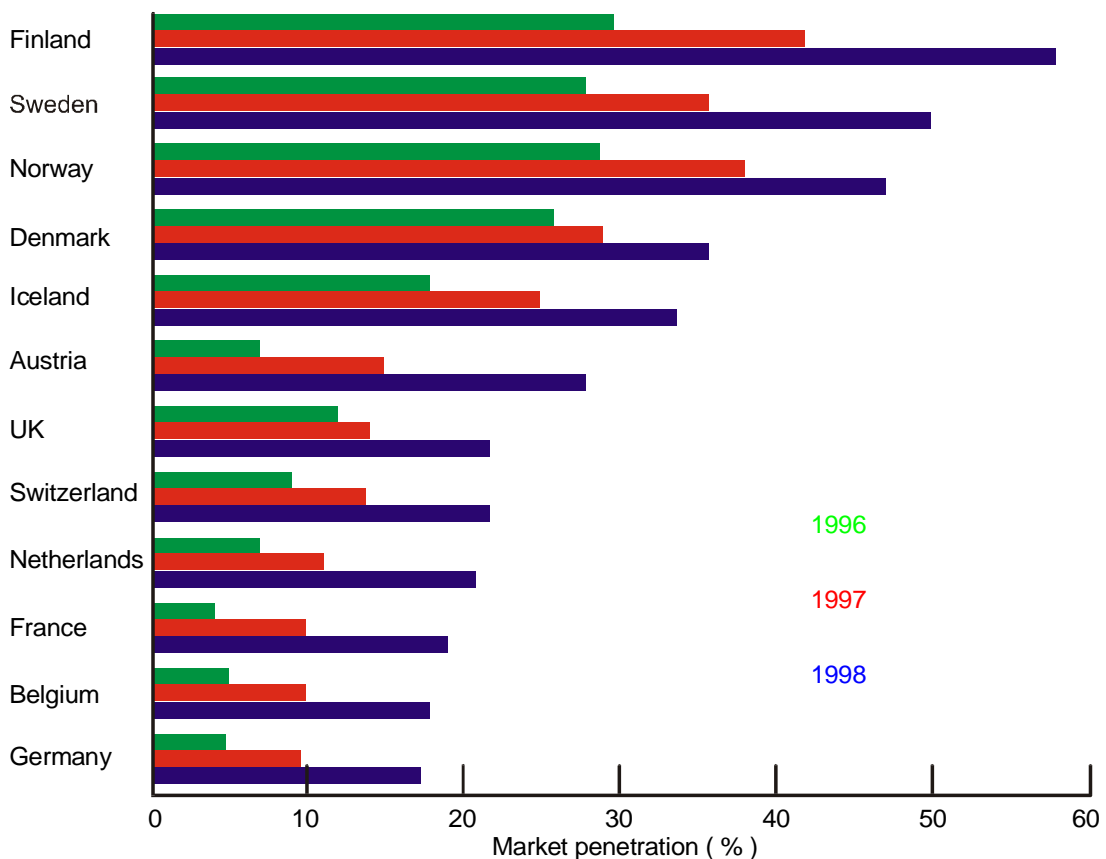


Figure 2.4 Increase in market penetration between 1996 and 1998 in Western European countries (based on data from MobilTeleBranschen)

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and the UK Government has recently auctioned licences for the use of new spectrum. Five licences are to be issued.

- 2.18** The growth in the mobile phone market that has been observed in the UK reflects similar trends in Europe and elsewhere in the world. In Europe the greatest market penetration has occurred in the Scandinavian countries and in Finland is approaching 60%. However, all Western European countries have experienced a rapid growth in mobile phone use in recent years (Figure 2.4).
- 2.19** It is expected that the recent trends in the use of mobile phone technology will continue for the foreseeable future, with the number of GSM subscribers worldwide predicted to increase by a factor of three or more over the next five years (Figure 2.5).

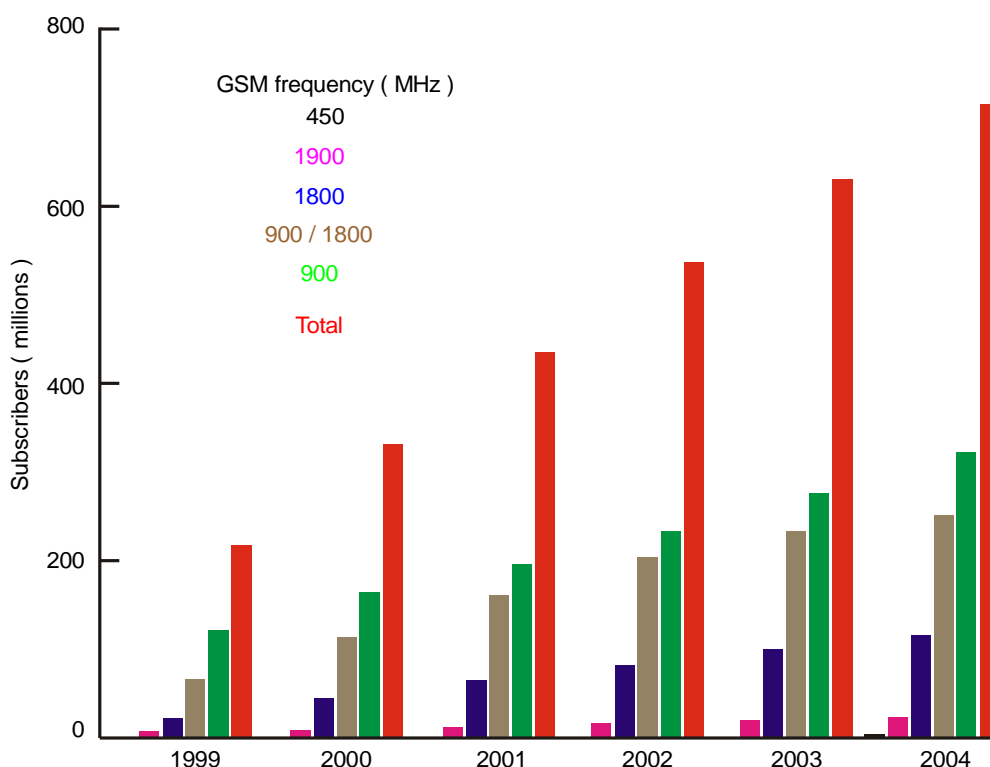


Figure 2.5 Predicted growth in the number of GSM subscribers worldwide. The different GSM frequencies (see paragraph 4.11) are used in different systems around the world.

Benefits of Mobile Telecommunications Technology

- 2.20** An active mobile telecommunications sector brings a number of economic benefits to the UK in terms of employment and tax revenue, which will be discussed in paragraph 2.22. There are also, however, a number of other advantages to be derived from application of this technology. Mobile telecommunications play an increasingly important role in general commercial activity and thereby make an indirect contribution to the national economy. This is difficult to quantify, but is likely to be significant.
- 2.21** It is already apparent that mobile telecommunications also offer benefits in emergency situations. For example, the use of a mobile phone may reduce the time taken to notify the emergency services of road traffic accidents and other dangerous situations including crimes. An assessment

of this aspect in Australia has recently been given by Chapman and Schofield (1998a,b). There have also been several accounts of individuals using mobile phones to alert rescue services following mountaineering or skiing accidents. Mobile phone availability may also be helpful during much rarer large-scale emergencies. For example, it is believed that many lives were saved following the earthquake in Kobe, Japan, because those trapped under rubble were able to use their mobile phones to alert rescue teams.

Economic Significance of the Mobile Phone Industry to the UK Economy

2.22 Information supplied by the Department of Trade and Industry indicates that the mobile phone industry is a major contributor to economic activity in the UK. Network operators had an estimated combined turnover of some £5.8 billion in the financial year 1998/99 (Figure 2.6).

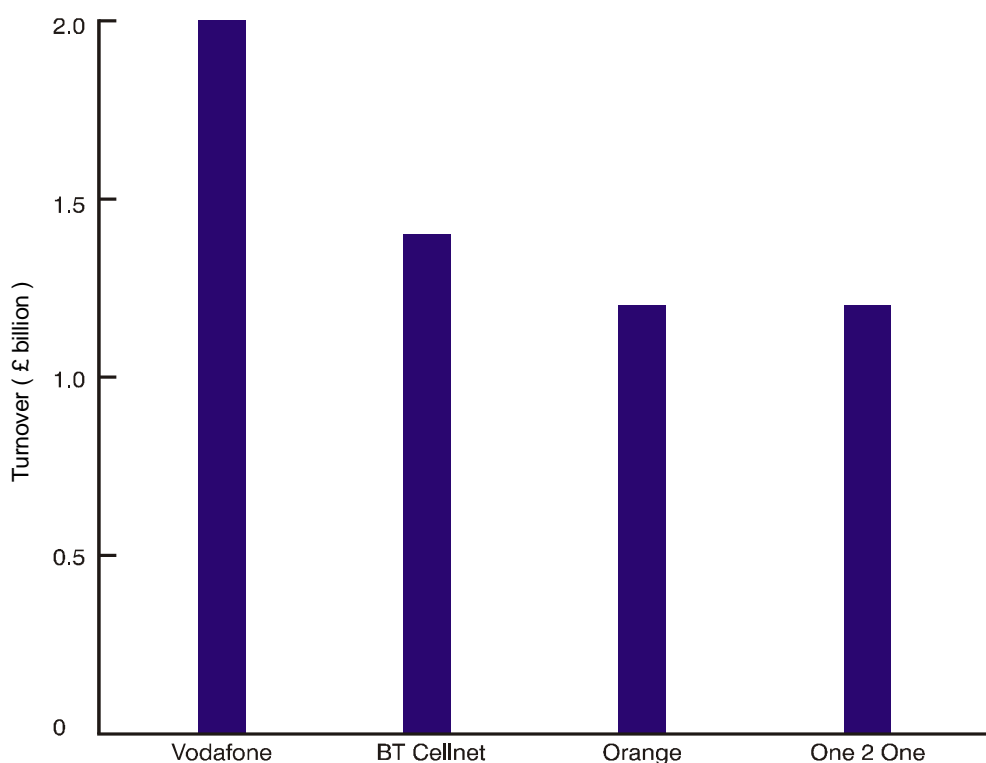


Figure 2.6 Annual turnover of UK network operators (data provided by the Department of Trade and Industry)

2.23 Vodafone has the largest turnover and, since its merger with the US company Air Touch, when it had a market capitalisation of £77 billion, and subsequent takeover of the German company Mannesmann, is now a major multinational. The other three operators (here we treat Orange as an independent company) are smaller, but nationally major companies. In late 1999, BT Cellnet and One 2 One were valued at around £8.4 billion, with Orange slightly more at that time. The Vodafone mergers emphasise the international nature of the mobile phone industry. All four UK operators have expanded into overseas markets in recent years; Vodafone and Orange have taken the lead in this respect. Between them, these two operators now have stakes in over 14 countries, including Australia, France, Germany, the Netherlands, Sweden, South Africa and Switzerland. The manufacture of mobile phone equipment is also an international industry and is dominated by

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a few large multinationals. Although none of these is based in the UK, three of them, Nokia, Motorola and Ericsson, all have a significant presence through both manufacturing and research and development (R&D) facilities. Nokia and Ericsson bought out UK companies in the early 1990s and both have since expanded their operations. Other manufacturing companies that have invested in the UK include Lucent, NEC, Panasonic and Samsung. This is a rapidly changing sector and the above figures are indicative only.

- 2.24** The manufacturing base generates secondary manufacturing by companies such as Hewlett Packard and Racal, both of which make test equipment. In addition, there is some manufacturing of components by companies such as Filtronic Ltd. The latest available information on manufacturing turnover values the telecommunications sector at £3.5 billion in 1997, but it is growing rapidly. Mobile telecommunications represent a significant and increasing element of this sector.
- 2.25** The UK provides significant input into mobile telecommunications R&D through universities and their spin-off companies. A consortium of UK universities has formed a Virtual Centre of Excellence in this area to provide a focus for this work and ensure effective collaboration with industry. Funding for this Virtual Centre from industry and the Engineering and Physical Sciences Research Council totalled £3 million for the last three years and the budget for the next three is £4.5 million with industry providing 70%.
- 2.26** The mobile sector provides significant employment opportunities in the UK. It is difficult to obtain accurate data because the sector is developing so rapidly. However, taken together, the operators, manufacturers, and sales outlets probably employ about 100,000 people in the UK (industry estimate). This number seems likely to increase when mobile phones become more closely linked to the provision of Internet services.