Part II

Background and evidence

3 Background

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Introduction

3.1. This chapter begins with a brief history of the liberalization of telecommunications in the UK and in particular the development of mobile telephony and its regulation. This is followed by an indication of the financial performance of Vodafone and Cellnet. Finally information is provided about BT and other FNOs and about the other MNOs, Orange and One2One.

Liberalization of telecommunications in the UK

3.2. Until 1981 nearly all telecommunications services were provided by the Post Office, a statutory corporation converted from a government department by the Post Office Act 1969.[1] Under the British Telecommunications Act 1981, telecommunications activities were separated from the Post Office and transferred to British Telecommunications, a new public corporation. On 6 August 1984 the property, rights and liabilities of British Telecommunications were transferred to British Telecommunications plc under section 60 of the 1984 Act. The Government then offered 50.2 per cent of the shares of BT for sale and the shares were admitted to the Official List of the London Stock Exchange and also listed in New York, Tokyo and Toronto (subsequently withdrawn). The remainder of the shares held by the Government were sold to the public in two further tranches in 1991 and 1993. At 31 March 1998 BT had over 2 million shareholders; at 31 October 1998 the equity market capitalization of BT was some £50 billion. At the time of privatization certain special rights, set out in the company's Articles of Association, attached to the special rights redeemable share issued to HM Government. The share, which carried no rights to capital or profits beyond its nominal value, was redeemed at par by HM Government on 10 September 1997.

3.3. A new regulatory framework was established under the 1984 Act which abolished the statutory exclusive right to operate telecommunication systems formerly held by BT and provided, in section 7 of the Act, for the licensing of the running of telecommunication systems. Section 8 of the Act sets special provisions which apply to any licence which includes conditions requiring the licence-holder:

(a) to provide such telecommunication services as are specified in the licence;

(b) to connect or permit connection to the licensed system of such other systems or apparatus as are specified in the licence;

(c) to permit the provision, by means of any telecommunication system to which the licence relates, of such services as are specified in the licence;

(d) not to show undue preference to, or exercise undue discrimination against, particular persons or persons of any class or description (including, in particular, persons in rural areas), whether in respect of charges or other terms or conditions; and

(e) to publish, at times specified in the licence, a notice specifying, or specifying the method that is to be adopted for determining, the charges and other terms and conditions applicable to services provided.

3.4. The 1984 Act gave the principal regulatory responsibilities to the Secretary of State (at present the Secretary of State for Trade and Industry) and the DGT. Section 3(1) (see Appendix 3.1) requires them to exercise their functions under Parts II and III of the 1984 Act in the manner best

[1]Only Kingston-upon-Hull retained a separate telephone company.

calculated to secure that such telecommunication services are provided throughout the UK as satisfy all reasonable demand for them (except where it is not reasonably practicable). This includes the provision of emergency services, public call boxes, directory information services, maritime services and services to rural areas. They must also secure that persons who provide these services are able to finance their provision.

3.5. Section 3(2) requires the Secretary of State and the DGT to exercise their functions in the manner best calculated to achieve a number of objectives including the promotion of:

(a) the interests of consumers, purchasers and other users of telecommunication services and apparatus in the UK in respect of the prices charged and the quality and variety of services provided;

(b) effective competition between those engaged in commercial activities connected with telecommunications; and

(c) efficiency and economy among such persons.

In terms of the distribution of functions the Secretary of State has taken primary responsibility for market opening measures and in particular has the function of licensing new telecommunications operators. Between 1984 and October 1998, 38 PTO licences have been granted by the Secretary of State. These include 33 fixed-link PTO licences and 5 MNO licences. In addition, 177 international simple resale (ISR) licences to provide international services over lines leased from licensees authorized to operate international facilities including BT or Cable & Wireless plc (C&W) (see paragraph 3.9) and 62 international facilities licences have also been granted.

3.6. By virtue of section 50 of the 1984 Act the DGT also has functions in relation to competition exercisable concurrently with the Director General of Fair Trading:

(a) under the Fair Trading Act 1973, in particular in relation to monopoly situations which exist or may exist in relation to commercial activities connected with telecommunications; and

(b) under the Competition Act 1980 in relation to anti-competitive practices in connection with the production, supply or acquisition of telecommunication apparatus or the supply or securing of telecommunication service.

3.7. Section 12 of the 1984 Act allows for licence modifications by agreement between the DGT and the relevant licensee. The DGT also has the power under section 13 of the 1984 Act to make references to the MMC requiring the MMC to determine whether any matters relating to the provision of telecommunication services or the supply of telecommunication apparatus by a licensee operate, or may be expected to operate, against the public interest and if so whether the adverse effect could be remedied or prevented by modifications of the operator's licence. Section 14 requires the MMC to specify licence modifications which could remedy any adverse effects. Under section 15, the DGT is then required to make such licence condition modifications as he considers requisite though he must have regard to the modifications specified in the report. A reference to the MMC under section 13 normally takes place when the licensee and the DGT cannot agree on a licence modification.

3.8. Since the early 1980s the Department of Trade and Industry (DTI) has used its licensing powers to promote competitive entry into the telecommunications markets. The timing, pace and nature of the resulting changes have differed from one market to another. For example, in the telephone equipment market competition developed rapidly after liberalization, stimulated by the provision for independent approval of apparatus and the establishment of the British Approvals Board for Telecommunications, whose functions include the inspection and approval of telephone handsets and other equipment—such as answering machines—which users attach to operators' networks. In 1981 liberalization also took place in value-added services (such as voicemail and electronic data exchange), enabling firms to provide value-added services over lines leased from BT.

3.9. The Government decided in 1983 that only one network operator should be licensed to provide a fixed network to compete with BT (after 1984) for a period of seven years. It was thought that the investment needed was so large and the risk so great that no company would be prepared to

enter the market with the prospect of competing with both BT and other new operators. The operator chosen in 1983 was Mercury, a consortium in which C&W had a 40 per cent shareholding and which began operating in 1986. By 1984 Mercury had become a subsidiary of C&W and it subsequently merged in 1996 with a number of cable and television companies to become CWC, with C&W having a controlling shareholding of 53 per cent.

3.10. Mercury initially focused on particular areas of the telecommunications business including long-distance and international calls and services to large corporate customers which generated a high volume of call traffic per line. It did not compete directly with BT in providing services to smaller customers, but did offer them services by means of indirect connection through BT's local network.

3.11. In 1983 licences were granted to two companies to operate mobile cellular services, namely Racal-Vodafone Ltd (subsequently Vodafone) and Cellnet. Cellnet is a wholly-owned subsidiary of CGL, of which BT owns 60 per cent of the issued share capital. The initial licences were replaced by PTO licences under section 7 of the 1984 Act in 1985 when the MNOs commenced operations. In 1991 three further licences were issued to provide mobile services using digital technology operating PCNs, but a subsequent merger reduced these to two: Mercury Personal Communications Ltd (MPC) and Orange. MPC operates its licence in a partnership called Mercury Personal Communications (trading as One2One) which comprises the company and subsidiaries of Media One International[1] and C&W. Orange was originally a wholly-owned subsidiary of Hutchison Telecom (UK) Ltd (HTUK), but in 1996 a public offering of shares in its parent company—Orange plc—took place and the shares were admitted to the Official List of the London Stock Exchange. At 31 March 1998 there were more than 9 million subscribers to the four mobile networks.

3.12. During the period when only BT and Mercury were licensed as national fixed network operators (known as the duopoly period) companies were licensed under the Cable and Broadcasting Act 1984 to provide broadband cable television services in specific geographical areas. Some of these cable companies were a potential source of competition to BT and Mercury as they were also capable of providing telephony services on their networks. However, they were only able to provide such services as agent for either BT or Mercury. The cable companies in turn were given some protection in that licences granted to BT and Mercury (and Kingston Communications (Hull) Ltd (Kingston Communications)) prevented these operators from using their networks to convey broadcast entertainment and information services to the home. However, BT and Mercury were free to own local cable franchises and to provide broadcast and entertainment services to any non-residential premises including businesses, schools, universities and hospitals. In 1990/91 the Government reviewed the duopoly policy and in the White Paper *Competition and Choice: Telecommunications Policy for the 1990s* (Cm 1461, March 1991) outlined proposals to end the duopoly within the UK and sought to ensure the growth of competition in all telecommunications markets with a presumption in favour of additional licences being granted. Applications for licences would be considered from any company wishing to establish fixed telecommunications networks in competition with BT and Mercury. In addition cable companies were permitted to provide voice telephony services directly. The White Paper indicated that restrictions on the conveyance of broadcast entertainment services would not be removed until 2001, though the position would be reconsidered in 1998 if the DGT advised that removing the restrictions would be likely to promote more effective competition in telecommunications.

3.13. BT told us that customers could obtain telecommunications services from three main types of supplier: network operators, who generally provided direct services to selected customers over their own network access; indirect service providers or resellers, who may not own a network, but leased bulk capacity, via private circuits, to provide indirect call services to customers (over other operators' access networks); and aggregators ('switchless resellers') who provided indirect services but did not need their own switches or a licence and offered least-cost routing over the networks of other operators.

3.14. Whilst network access could be provided only by network operators physically connecting the customer's premises to the network, call services could potentially be supplied by all types of suppliers. BT said that some network operators may offer network access to particular customers (for

[1]Until 1998, when Media One International was split from US West Inc, the joint parent of One2One was US West.

example, business customers, or customers in a particular geographic area), but may also offer call services as resellers to all customers. Resellers may market their services directly to customers, through aggregators, or through agents who may repackage and rebrand the reseller's services.

3.15. BT told us that the spread of the UK's cable television companies was now approaching half of all the country's homes; the companies had a telephony penetration rate (that is, the percentage of customers in homes passed taking cable telephony) of around 30 per cent (February 1998) and the DTI had been able to announce in April 1998 that the restrictions on BT and other PTOs, preventing them from offering broadcast entertainment services over their networks, would be progressively lifted. BT and other PTOs now had the option of providing broadcasting to the 17 per cent of UK homes currently outside cable franchise areas and, from 2001, would be able to compete across the country.

Development of mobile telephony

3.16. Public mobile telephony was first introduced to the UK in 1985 with the instigation of analogue TACS networks operated by Vodafone (then Racal-Vodafone) and Cellnet. Prior to this BT had operated a 'radio-phone' service but its capacity was very limited, coverage was poor and it was very expensive. Several other portable telephone services have been licensed in the UK, notably 'telepoint' services such as Rabbit. Telepoint services allowed users to make calls when they were in areas with coverage but not receive them. It was the lack of ability to receive calls together with the restricted coverage that eventually led to the commercial failure of such services. The only other public mobile communication systems generally available in the UK are PAMR, pagers and mobile data services. A nationwide PAMR network is operated by NB3 Ltd, which offers mobile radio communication to users such as road haulage and courier companies. A number of smaller local PAMR services are also available but none of these services offers an interconnection with the public switched telephone network (PSTN). A digital PAMR service using the European Telecommunications Standards Institute (ETSI) preferred standard TETRA (Terrestrial Trunked Radio) is due to be launched later this year by Dolphin Telecommunications Ltd. Pagers typically allow either numeric or short alphanumeric messages to be sent. Mobile data services are two-way but require specialized equipment to provide a service.

3.17. The next major step forward was the introduction into the UK in the early 1990s of digital GSM when Cellnet and Vodafone were awarded licences. Three further GSM licences, but at a different frequency (1800 MHz as opposed to 900 MHz), were awarded in 1991 to Mercury, Unitel Limited (Unitel) and Microtel Communications Ltd (Microtel). The Unitel licence was surrendered and Unitel joined with Mercury, now One2One. Microtel was purchased by HW and renamed Orange. One2One commenced service in 1993 and Orange in 1994. Cellnet and Vodafone also have 1800 MHz spectrum available to them. At the time of our inquiry commercial services had not yet been introduced on these frequencies, but Cellnet told us that it was about to commence using 1800 MHz spectrum in London and would continue to deploy information to exploit its additional spectrum both for increasing capacity and to support in-building services.

3.18. The use of radio for communication is essential for any service where subscribers require mobility. Radio spectrum is a limited resource as any frequency can only be used simultaneously at any given time in geographically isolated areas (the degree of isolation depends on the characteristics of the service). Hence, there is great demand for radio spectrum and limitations are imposed on that allocated for a given service. Spectrum at 900 MHz was originally allocated to Cellnet and Vodafone for their analogue TACS services. Part of this, together with additional 900 MHz spectrum, was then made available to them for GSM. There is no further spectrum currently available at this frequency. However, the TACS networks will continue to operate only until the year 2005 at the latest. The RA stated that, at that point, part of the spectrum which they occupy will be available for the expansion of GSM and the remainder reassigned to other users. Spectrum at 1800 MHz has also been allocated for GSM services. The Government has plans to allocate spectrum at 2200 MHz for the next generation of mobile services. There are no current plans for more spectrum beyond these allocations to be made available for mobile telecommunications services.

Analogue and digital networks

3.19. The fundamental difference between GSM and TACS is that TACS uses analogue signals to carry voice to and from the phone, whereas for GSM the signal is digital. As a consequence, GSM offers a number of additional facilities not easily supported by TACS including:

— fax and data connections at up to 9,600 bits per second;

— short message service (SMS), which is a form of two-way paging;

— international roaming (allowing phones to be used on other networks overseas); and

— supplementary services such as Calling Line Identification Presentation (CLIP), whereby the number of the incoming caller is displayed on the phone.

GSM also has better security. All transmissions can be encrypted in order to ensure that eavesdropping on calls and 'cloning' of telephones (ie copying a telephone's identity and thereby making calls on someone else's bill) are much more difficult. In addition the capacity of GSM networks is greater than that of TACS, in that more subscribers can be supported to a higher quality of service for the same amount of radio spectrum.

The principles of mobile telephony

Overview

3.20. The fundamental difference between mobile phones and fixed phones is that mobile phones transmit and receive voice (and, for GSM, data) signals to and from the fixed network using radio connections whereas fixed phones use wired connections. The GSM network communicates through a number of transceivers to GSM handsets. The latter are basically miniature digital radio transceivers which include a SIM card containing details of a subscriber's network affiliations.

3.21. In order for a mobile phone to be able to make or receive a call, it must be within radio coverage of a network transceiver. The area of radio coverage of a transceiver is known as a 'cell', so named because the pattern of coverage formed by the transceivers is cellular (similar to a honeycomb).

3.22. A series of switches and their associated processors support the radio coverage provided by the cells and provide the intelligence for the network. The switches switch calls across the network until they reach their intended destination. The processors decide the location to which the call should be switched, whether this is just to the next switch or whether it is beyond the mobile network to a customer of another fixed or mobile network.

Interconnection

3.23. In the time since the full liberalization of the UK's telecommunications markets, the number of operators offering telecommunications services has rapidly increased. In order for these operators to allow their respective customers to contact each other, it is necessary to connect these networks physically, either directly or indirectly. This process is known as interconnection. Networks connect to other networks (including that of BT) at points of interconnection (POI).

3.24. Legislation, both in the UK and the EU, has imposed obligations on all telecommunications networks, including mobile operators. The most important development is the EC Interconnection Directive, which came into effect on 1 January 1998. Under the Directive, all operators are required to negotiate or offer interconnection to other operators who request it. Special conditions apply to operators who have significant market power (SMP), which broadly means a share of more than 25 per cent of the defined market. In the UK, two fixed networks (BT and Kingston Communications) and two mobile networks (Cellnet and Vodafone) have been designated as having SMP.

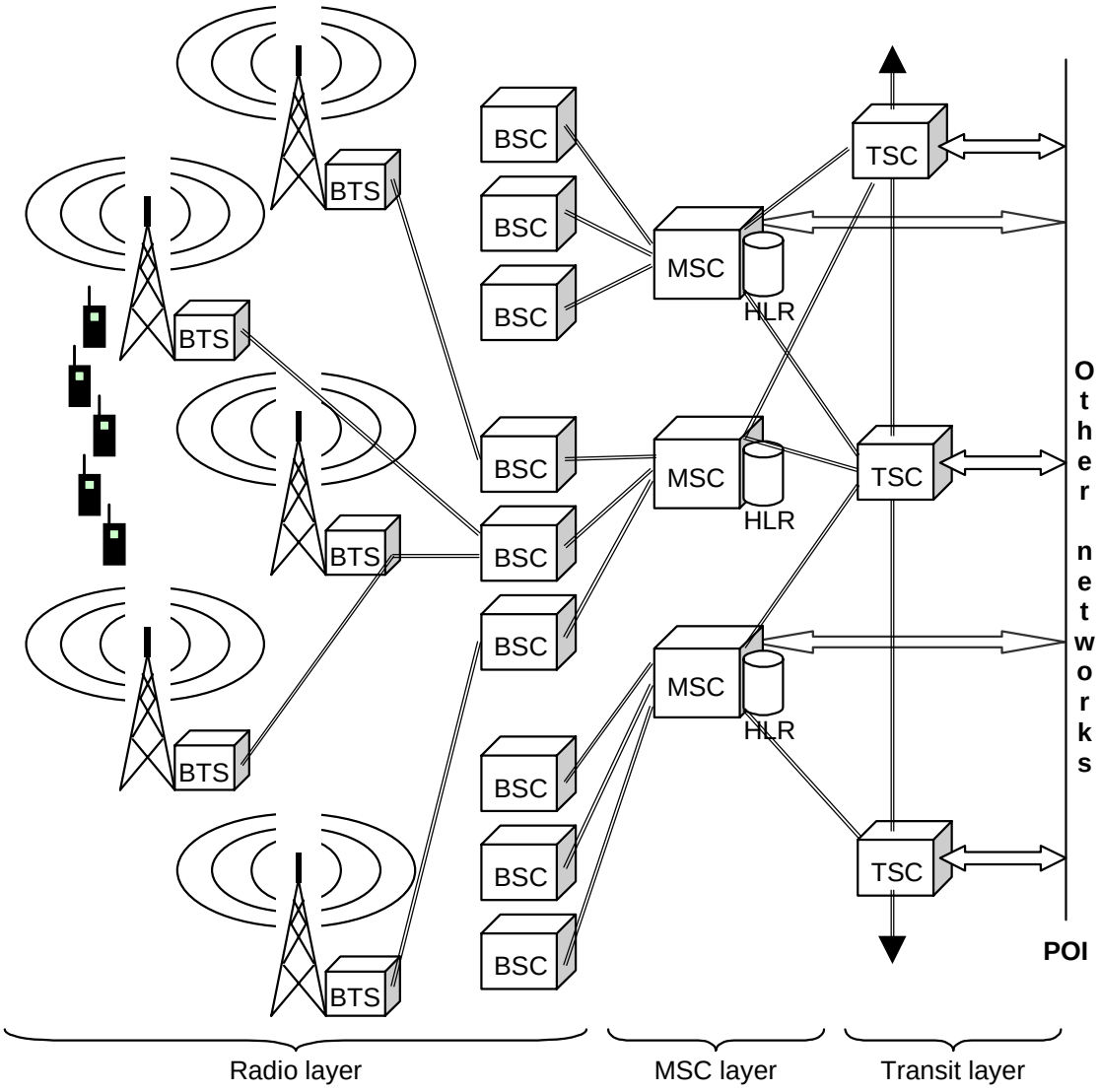
3.25. Hence, under the terms of their licences, BT and the MNOs are obliged to meet all reasonable requests for access to their networks. For further details see paragraphs 3.84 to 3.93.

Network architecture

3.26. Figure 3.1 illustrates, in a general way, the main components which make up a GSM mobile network. The network is broken down into several layers, each with its own characteristics and purposes. The individual components are described below. The precise implementation differs between the MNOs. In particular One2One told us that its network differed in a number of significant respects from the description given below. An analogue TACS network is similar to a GSM network but there are some differences in functionality—in particular, it does not have any base station controllers (BSCs), whose function is integrated into the mobile switching centre (MSC).

FIGURE 3.1

Example GSM network architecture



The radio layer

3.27. The radio layer of the network comprises the BSCs and the base transceiver stations (BTSs). The BTSs provide the radio coverage and the BSCs act as concentrators and routers ensuring that calls from the MSCs are passed to the correct BTS. BTSs are either connected directly to a BSC, or in some cases may be 'daisy-chained' through other BTSs. Insurance against the loss of links may be provided by providing dual links between a BSC and its parent MSC (not shown in Figure 3.1 for clarity).

3.28. The region over which a transceiver provides coverage is known as a cell. It can cover a radius of anything from a few hundred metres to a maximum of 30 kilometres or more. Very small cells (particularly in-building cells) are often termed 'pico-cells', small cells 'micro-cells', and large cells 'macro-cells', although precise definitions vary between operators.

3.29. There is a limit to the amount of capacity that can be provided from a single cell site, because of the limited amount of radio spectrum available for the service and technical limitations in the design. For the GSM networks at 900 MHz, each cell provides a minimum of seven voice channels and can provide up to around 60. Hence, it may be possible for a single cell to provide sufficient coverage but not sufficient capacity. In this case, adjacently located cells are installed instead, effectively splitting the original cell into two or more smaller cells.

3.30. Coverage from cells is usually overlapped such that a mobile phone travelling from one cell to another will not lose coverage while the call is handed over to the new cell. In some circumstances coverage from two cells can overlap by as much as 100 per cent. For example, where a macro-cell has been installed to cover a town but where there is an additional capacity requirement in the town centre, a pico-cell may be installed within the macro-cell, not to increase coverage, but to provide additional capacity.

The mobile switching centre layer

3.31. The MSC layer comprises a number of MSCs and a series of databases known as HLRs. The HLRs store all the information concerning the network's subscribers with each subscriber only being registered on a single HLR.[1] The HLR also stores the location of mobile phones which are switched on and in coverage. The MSCs themselves are a combination of a switch to route calls around the network and a computer to search for and process information from the HLRs (in particular when incoming or outgoing calls are requested). Each MSC is usually connected to two transit switching centres (TSCs) to provide resilience.

The transit layer

3.32. The transit layer is made up of a number of TSCs which are linked to at least two neighbouring TSCs, usually forming a loop or mesh configuration. The role of the transit layer is to carry incoming calls from the POI to the MSCs and outgoing calls from the MSCs to the POI, and also to carry calls between MSCs. It effectively forms the long-haul backbone of the GSM network.

The point of interconnection

3.33. The POI is the point at which the network connects with other networks, be they fixed telecommunications networks (such as BT, CWC or Energis) or other mobile networks. The POI can be on the transit layer or may be directly at an MSC and it is common for interconnected parties to have two (or more) interconnect points for resilience.

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[1]Each HLR usually has, associated with it, an Authentication Centre which deals with access, security and the encryption keys required by the MSCs.

The service layer

3.34. The service layer (not shown in Figure 3.1) is a separate conceptual layer which exchanges information with MSCs and provides value-added services such as SMS, voicemail, billing and customer care.

Subscriber identity module

3.35. The only element of the network belonging to the operator and not to the subscriber which is carried by subscribers is the SIM card, which contains details of the subscriber's network affiliation.

Network functions

3.36. The network performs a number of fundamental activities including:

— routing outgoing calls;

— routing incoming calls; and

— location updates.

These activities, together with a number of other functions performed by a GSM network, are described in more detail below.

Routing of outgoing calls

3.37. When a mobile subscriber makes an outgoing call, the mobile phone sends a message to the nearest BTS[1] and passes to it details of the call (the called party's number etc). The MSC which controls the BTS providing coverage to the mobile is known as the visited MSC (VMSC). The VMSC checks to see that the subscriber is registered with that network or an approved roaming partner and has permission to make the call[2] by interrogating the HLR in which the subscriber's data is stored. In the majority of cases this HLR will not be associated with the VMSC.

3.38. Once permission to make the call has been established a connection from the mobile subscriber through a BTS and a BSC to the VMSC is made. The VMSC then either passes the call to the transit layer which then routes the call to the appropriate network or passes it to the appropriate network directly. In the case of Cellnet, all outgoing calls are passed first to the transit layer and then to the appropriate network (but see paragraph 3.55). In the case of Vodafone, if the call is to BT,[3] the VMSC passes the call directly to BT (this can be done as all Vodafone's MSCs are connected directly to BT) and the use of the transit layer is thus avoided. If it is to an other licensed operator (OLO) with whom Vodafone has a direct POI, the call is instead passed to the appropriate network via the transit layer.

Routing of incoming calls

3.39. An incoming call from another (fixed or mobile) network will pass from the originating network to the nearest POI as the originating network has no knowledge of the location of the mobile and so cannot pass the call over at a more appropriate point. The call is then passed to an MSC, either directly (for Vodafone) or via the transit layer (for Cellnet). This MSC, known as the gateway MSC (GMSC), will identify the VMSC by an enquiry to the appropriate HLR. In the majority of cases the VMSC will be different from the GMSC. If the VMSC and GMSC are different, the call is passed to

[1]In fact, it contacts the BTS which it senses has the best coverage in its area. This may not necessarily be the nearest.
[2]Network operators may bar subscribers from making certain types of call, such as international calls.
[3]Or to an operator with whom Vodafone does not have a direct interconnect.

the VMSC via the transit layer. If the GMSC and VMSC are the same, the call is dealt with internally by the MSC.

3.40. The VMSC then instructs the appropriate BSC and BTS to 'page' the mobile, ie to broadcast a message telling the mobile that there is a call for it. Once the VMSC receives a response to the page from the mobile, a radio channel to the mobile is established and the phone rings. Once the user answers the phone, a voice (or data) channel is established and the call commences.

Location updates

3.41. The significant difference between making a call to a fixed phone and making a call to a mobile phone is the need to locate the mobile phone. If the network knows where the mobile phone is located (in particular, which MSC controls the BTS providing coverage to the phone, the VMSC) an incoming call can be routed more quickly and more efficiently. This is achieved by a process known as location update, whereby the mobile phone informs the appropriate HLR of its present location. Location update is not essential, as it would be possible to locate the mobile phone each time that an incoming call arises by paging it across the whole network. However, this would tie up valuable network resources. Whether or not location update is more efficient than paging depends critically upon how many incoming calls there are and on how large the network is. For example, small mobile networks, with a single MSC, might not need to perform location updates.

3.42. A mobile phone advises its HLR of its location in one of three possible circumstances:

— when it is initially switched on or when it is switched off (note that mobile phones which are turned off or are out of radio coverage do not perform location updates);

— if it senses that it has moved from one area to another (the network transmits details of the area associated with each BTS, the mobile listens to a control channel on the BTS and if the area it senses is different from what it previously sensed, it informs the network). The network designer can control the size of the areas which typically consist of around 100 cells; and

— after a pre-set duration (so that the network knows that it is still operational and has not left the coverage area). The network designer can control the duration between such updates but it is typically about 30 minutes.

3.43. Network resources are used in the performance of location updates, in particular the MSCs must update the appropriate HLR.

Mobile-to-mobile calls

3.44. Mobile-to-mobile calls (on the same network) follow the routing used for an outgoing call to the point where the VMSC identifies the intended recipient at which point the routine for incoming calls is followed with the VMSC effectively playing the role of the GMSC.

3.45. Mobile-to-mobile calls where the called party is on another mobile network are outgoing calls so far as the calling party's network is concerned and incoming calls so far as the called party's network is concerned.

Premium rate services (Vodafone only)

3.46. Vodafone provides a number of PRS. PRS are usually recorded services for which a premium call rate is charged, such as weather forecasts, stock market prices or traffic updates. PRS use certain elements of Vodafone's mobile network to route the call. Incoming calls to PRS numbers are directed by the originator's exchange to a TSC. The TSC then recognizes this as a PRS call and routes it, using the transit layer, to the appropriate recorded message.

Roaming

3.47. In a similar manner to the way in which a mobile is allowed to make and receive calls in an area controlled on its own network by an MSC which is not the one with whose HLR it is registered, the same functionality allows mobiles to use an MSC of an overseas network. Such use is known as roaming and can take place between networks with roaming agreements and suitably interconnected HLRs.

3.48. Apart from interconnected HLRs, the other criterion for successful roaming is that the handset must operate on the same standard and frequency band as the network on to which the mobile wishes to roam. For example, a GSM 900 MHz handset cannot roam on to a GSM 1800 MHz network and vice versa.[1] There is no technical reason why roaming should not take place between UK operators but UK operators have not chosen to permit it.

Unanswered calls

3.49. Calls to a mobile phone may not be connected for a number of different reasons, including, *inter alia*:

— the mobile phone is busy;

— the mobile phone is switched off;

— the mobile phone is damaged;

— the mobile phone's battery is flat;

— the mobile phone is outside the network's coverage area; or

— the network has insufficient spare capacity for the call.

3.50. In any of these instances, the call to the mobile phone will not be connected. A number of different outcomes are possible:

— the calling party may hear an information (for example, 'busy' or 'number unobtainable') tone. No charge is made for this;

— the calling party may hear a network-generated recorded announcement informing him that the phone is unavailable (for example, 'the mobile you have called is currently switched off'). This message is charged for by both Cellnet and Vodafone;

— the calling party may be forwarded to a voicemail service. This may be preceded by a network-generated recorded announcement (for example, 'this call is being diverted to a voicemail service'), or by a subscriber-generated recorded announcement (for example, 'this is John, please leave a message after the tone'). In either case, as soon as the call is answered by the message, the call is charged for by both Cellnet and Vodafone; and

— the call may be diverted to another (pre-designated by the subscriber) number (see below).

Diverted calls

3.51. A subscriber has the option of setting up a call divert, whereby, if he does not answer a call after a certain number of rings (typically 2 to 10), is out of coverage, or has his phone switched off,

[1]Note that in the USA there are GSM networks operating at 1900 MHz which have roaming agreements with some UK networks. Roaming on to these networks requires either a dual-band, 900 MHz and 1900 MHz handset, or SIM card roaming—using an existing SIM card in a hired handset.

the call is automatically transferred either to another (fixed or mobile) phone number or to a voicemail service. Sometimes this is preceded by a network-generated recorded announcement (for example, 'this call is being diverted to another number'). In this case, both Cellnet and Vodafone begin charging from the beginning of the recorded message, even if the number to which the call has been diverted does not answer.[1] If the call is diverted directly to another number and no announcement is given, the call is not charged for until the number to which the call has been diverted is answered.

Differences between the mobile networks

Differences between Cellnet and Vodafone

3.52. There is one main difference between the network architectures of Cellnet and Vodafone: the use of the transit layer. There are also some differences in the services offered and minor differences in quality of service, coverage and network design.

The use of the transit layer

3.53. The purpose of the transit layer is to carry incoming calls from the POI to the MSCs, outgoing calls from the MSCs to the POI or to carry calls between the VMSC and GMSC as appropriate. The carriage of incoming calls from the GMSC to the VMSC is likely to occur for almost every call, unless the VMSC and GMSC happen to be the same.

3.54. For Vodafone, the transit layer is used additionally only for the purpose of carrying calls between an MSC and a POI with an OLO (ie not BT). This is because calls to BT (or to an operator with whom Vodafone does not have a direct interconnection) are passed directly from the MSC to BT. Vodafone can do this as all its MSCs are connected directly to BT's fixed network.

3.55. For Cellnet, all incoming and outgoing calls pass via the transit layer before being dealt with by an MSC. Cellnet told us that this, together with the design of its TACS location register, enabled the transit layer to separate calls between the TACS and GSM networks, avoiding the need for GSM MSCs and HLRs to handle TACS traffic. Cellnet said that, with the decline in TACS traffic, it was in the process of changing its network configuration so that GSM MSCs were connected directly to the POI.

3.56. We can consider the use of the transit layer in terms of a routing factor whereby a routing factor of 1 signifies that the transit layer is used once for that type of call. Table 3.1 details the routing factors that would therefore apply for Vodafone and Cellnet's transit layers.

TABLE 3.1 **Routing factors for the transit layer**

Operator	*Incoming calls*	*Routing factor*	*Outgoing calls*	*Routing factor*
Vodafone	Carriage between the GMSC and the VMSC	≈ 1	Carriage between the GMSC and the POI for some OLO calls only	≈ 0.2
Cellnet	Carriage between the POI and the GMSC Carriage between the GMSC and the VMSC	≈ 2	Carriage between the GMSC and the POI for all outgoing calls	≈ 1

Source: MMC.

3.57. It can be seen, therefore, that Cellnet's transit layer is used significantly more than Vodafone's thereby necessitating additional infrastructure to support the additional traffic. There are some balancing savings, however, as Cellnet does not require connections from each of its MSCs to BT and there are significantly more MSCs than TSCs.

[1]The party being called meets the cost of the onward diversion from the number being called by the subscriber.

Services offered

3.58. Vodafone uses its TSCs and MSCs to provide PRS. The costs associated with PRS are not included when calculating the cost of incoming calls. Whilst Vodafone's network is used to transit PRS calls, the actual service is provided by Vodafone Value Added & Data Services Ltd (VVAS), a member of the Vodafone Group. Cellnet did not provide PRS.

3.59. Both networks offer voicemail, an electronic answerphone which is provided by the mobile network or an external supplier. However, Vodafone outsourced its service to VVAS, and its costs were, therefore, separately identified. Cellnet's service was part of its network and the costs were included in network costs.

Quality of service and coverage

3.60. Quality of service is usually measured by means of a number of standard tests, which relate to the ability of the network to establish and hold a call and to the quality of the call once established. Increasing the capacity of a network (by adding additional cell sites and associated infrastructure) will generally increase the quality of service. Other factors such as radio frequency planning can reduce interference and also assist in improving quality. We saw little evidence to suggest that the quality of service provided by Cellnet and Vodafone is significantly different. Survey evidence produced by Vodafone showed that, across the UK as a whole, a caller to a Vodafone phone had a 90.4 per cent chance of success, while a caller to a Cellnet phone had a 90.1 per cent chance of success. Similarly, a Vodafone subscriber had a 90.2 per cent chance of making a successful call, while a Cellnet subscriber had an 89.5 per cent chance.

3.61. It is inevitable, due to the way in which operators procure sites on which to install their cells, that the coverage provided by the networks will be different. For example, being the first into an area can give an operator the pick of the available sites, with latecomers being left a more difficult job to find suitable locations. Some sharing of sites does take place. Both Cellnet and Vodafone claimed coverage of 99 per cent of the UK population (estimated at around 90 per cent of the area), but the uncovered areas were not identical.

Orange and One2One

3.62. Orange's and One2One's network architecture follows the same basic design concepts as those of Vodafone and Cellnet, but they operate at different frequencies. At the time of our inquiry Vodafone and Cellnet used frequencies around 900 MHz, whereas Orange and One2One used frequencies around 1800 MHz, although Cellnet told us that it was about to introduce an 1800 MHz service in London.

3.63. The difference in frequency has the following consequences:

— *Coverage:* Radio signals at 900 MHz are capable of travelling further than at 1800 MHz. As a consequence, more 1800 MHz cells are required to cover the same area than for 900 MHz. This is a significant disadvantage, particularly during the early stages of extending a network. However, having more cells in the same area gives greater capacity. Therefore, for rural areas where wide area coverage is required the 900 MHz operators continue to have an advantage (although this can be mitigated by topography, site location and site design). In urban areas where greater capacity is necessary, this advantage disappears.

— *Cost of infrastructure:* 1800 MHz technology was developed more recently than 900 MHz technology. In addition, whilst 900 MHz technology is used almost universally across the world, there are only a limited number of countries which have licensed operators at 1800 MHz. Orange and One2One were the first operators to construct 1800 MHz networks. As a consequence, the cost of the BTSs has been greater for 1800 MHz than for 900 MHz. 1800 MHz technology is becoming better established, but price differentials may persist for some time, although Cellnet argued that these were more likely to be caused by different

degrees of success in commercial negotiations with suppliers. The rest of the infrastructure (BSC, MSC, TSC etc) is identical for 1800 and 900 MHz networks.

— *Cost of handsets:* As for BTSs, the cost of 1800 MHz handsets has been greater than for 900 MHz. Many handsets now being produced are dual-band, that is to say they can operate at both 1800 and 900 MHz. There are several reasons for this, including roaming (see below) and the increasing number of operators who operate on both sets of frequencies.

— *Roaming:* Whilst 900 and 1800 MHz technology are fundamentally the same, a 900 MHz handset cannot operate on an 1800 MHz network and vice versa. This has severely limited the potential for customers of 1800 MHz networks to use their handsets in other countries, as only a limited number of countries have had operational 1800 MHz networks (the latest available information at the time of our inquiry was that 19 countries operated GSM networks at 1800 MHz, compared with 109 at 900 MHz). It seems likely that, over the coming two years, dual-band handsets will become increasingly the norm, thereby gradually mitigating many of the problems associated with 900/1800 MHz roaming.

3.64. Cellnet told us that One2One and Orange had had two major advantages offsetting the disadvantages of operating at 1800 MHz compared with 900 MHz. First, Cellnet and Vodafone had already purchased a significant amount of GSM infrastructure by the time One2One and Orange had commenced operations and, as a consequence, costs had already started to fall. The latter were able to take advantage of these cost reductions on the common equipment (which was the majority). Secondly, One2One and Orange had been allocated 30 MHz of spectrum in one block in the 1800 MHz band. Cellnet and Vodafone each had only 12.5 MHz in the 900 MHz band and 5.5 MHz in the 1800 MHz band for GSM. They also had 10 MHz in a separate 900 MHz band for TACS. Some of this would have to be returned to the Government for allocation when the TACS service closed but the rest would be available for GSM. The end result would be that Cellnet and Vodafone would have 23.5 MHz split into three bands, compared with One2One and Orange who had 30 MHz in a single band. Cellnet said that the effect of this on network costs was particularly acute in city areas, where it and Vodafone were already having to install significant numbers of micro-cells to increase capacity, capacity which could be provided at under half the cost by adding carriers to existing cells, if more spectrum were available.

Future developments

Mobile telephone number portability

3.65. The fact that subscribers historically had to change their number if they wished to transfer from one network operator to another was considered by the DGT to be a major obstacle to competition. Accordingly, he sought to introduce telephone number portability, whereby subscribers could retain their number if they changed networks. Number portability was introduced into fixed networks in June 1996. In January 1997 the DGT commissioned consultants to carry out a study into the costs and benefits of introducing number portability into mobile networks, the results of which are summarized in Appendix 3.2. As a consequence, the MNOs' licences have been amended, requiring the introduction of MNP by 1 January 1999.

3.66. A proprietary technical means of implementing MNP, which results in calls to numbers which have moved to other networks being routed via both the donor and recipient operators' networks, has been developed for use in the UK. A detailed description is given in Appendix 3.2. Vodafone stressed the extra costs that would be incurred in handling such rerouted calls.

3.67. A consequence of the introduction of MNP is that the inherent link between the four- (or five-) digit prefix to the telephone number and the network (and therefore to tariffs) is lost. The DGT told us that he believed customers should, in principle, be able to deduce the tariff for all calls to mobile phones. Given that, in future, prefixes will not be specific to network operators, this could be achieved in three ways:

(a) Calls from fixed to mobile phones on all four networks could be charged at the same tariff. This is the option preferred by the DGT. The solution has the attraction of simplicity, but the MNOs argued that it removed any prospect of using the price of incoming calls as an area of

competition. Moreover, unless the charge was uniform throughout the day and the week, the actual average revenues of the network operators would differ if they had different profiles.

(b) Calls could be charged according to the tariff appropriate to the network operator to which the number was originally allocated. This is the simplest solution requiring no changes to be made to the billing systems of the FNOs. The fixed network would continue to pass on the termination charge relating to the original network to the MNO. However, the MNOs might have different termination charges, in which case there would be an excess or shortfall in the termination rate received by the MNO for calls to mobile phones that had moved networks. If increasing numbers of subscribers were to change networks, an increasing number of calls would be charged at a rate not set by the subscriber's network operator. This might reduce the incentive for the operators to lower rates in a similar way to the way a harmonized rate would.

(c) Technical means could be developed for determining the ultimate destination of the call, and billing systems and procedures altered accordingly. Possible requirements include the establishment of a central database of numbers which have moved to a different network and the exchange of information in real time, either at call set-up or during the call. One potential solution based on IN technology is described in more detail below. Any such solution would have to be supported by all FNOs, and could not be in place by 1 January 1999.

3.68. INs represent a new generation of telephony routing technology, building on the introduction of digital switches in the 1980s. INs allow switches in large networks to be controlled from one (or more) central points using data and processing power that is available at that point. This has the advantages of, *inter alia*, allowing control of the network from a central point, removing the need to upgrade software on all switches when new services are to be introduced, improved performance and resilience, as well as offering a range of new services that can be hosted on a central computer system. A variety of potential solutions exist for the implementation of number portability based on IN technology, most of which involve the interrogation of a central database containing details of ported customers, and subsequent rerouting of calls to ported numbers under the control of the central point.

3.69. However, an IN solution would tackle only the routing part of the problem. It would not address the changes needed to billing systems to enable calls to subscribers who had changed network to be charged at the appropriate rate, or the task of informing customers that the price of a call may be different from what they would expect on the basis of the prefix. BT told us that it was currently exploring the opportunities to be gained from IN-based technology. Indeed it was already using INs for some services. However, the cost of IN technology is high, and it is generally recognized that its introduction solely for the implementation of number portability could not be justified. The DGT said that it seemed that the roll-out of a number portability solution based on IN technology within the next five years was unlikely.

Mobile satellite services

3.70. A number of satellite-based mobile communication systems, known as mobile satellite services (MSS), are about to be launched worldwide by organizations such as Iridium LLC, ICO Global Communications and Globalstar LP. These will offer GSM-style services but, as they are satellite based, they will work in any part of the world if there is a clear view of the sky. The International Maritime Satellite Organisation (Inmarsat) has offered such services on an international basis for many years but has not achieved large penetration because of the size and cost of the terminal equipment required. The new MSS operators intend to offer a service to hand-held terminals such as those required for terrestrially-based networks as well as to fixed, ground-based payphones.

Universal Mobile Telecommunications System

3.71. The rapid uptake of mobile phone services has spawned the development of a third generation of mobile service, known as UMTS. The details are still to be finalized but it is expected that the main advantage of UMTS will be that it will offer much faster data transmission speeds than GSM. This will allow high bandwidth data services including multimedia services such as real time video and broadband access to the Internet. It may also improve integration between different fixed, cordless and fully mobile telephony applications.

3.72. UMTS also has the potential to offer other advantages such as wider international roaming (despite GSM's widespread presence, other mobile communications technologies are in place in Japan and the USA which are incompatible with GSM handsets). UMTS is the European component of International Mobile Telecommunications 2000 (IMT 2000), which it is hoped will eventually be implemented worldwide and will offer full handset compatibility, as well as including a mobile satellite component for global coverage.

3.73. At the time of our inquiry the UMTS and IMT 2000 standards were far from being finalized. Discussions were still taking place between ETSI, the International Telecommunications Union and other regional standardization bodies on a large number of issues.

3.74. During our inquiry the EC mandated every member state to establish an authorization system for UMTS by the end of 1999, in order to ensure that the commercial services would be launched by 2002 throughout Europe (although there is the possibility of deferral by up to one year). The UK was one of the first countries in Europe to start the preparation for the licensing process and UMTS licences were expected to be awarded by auction during 1999. It is unclear how many UMTS licences will be awarded in the UK, but the DGT told us that his current working hypothesis was four. It is, therefore, possible that not all the existing MNOs will be awarded a UMTS licence.

3.75. Existing network operators told us that they viewed the new technology as a natural evolution from GSM that would enable them to provide better-quality and more value-added services to their customers. They said that successful bidders were likely to wish to begin investment in UMTS as soon as possible after the award of licences.

Indirect access and carrier pre-selection

Indirect access to BT's network

3.76. 'Indirect access' (or carrier selection) has been a feature of competition since the telecommunications market in the UK was first liberalized. In essence, it means that one operator allows another to interconnect to its switches, thus allowing its customers 'indirect access' to the second operator's facilities and service. Opportunities for indirect access did not arise until the passing of the 1984 Act and the issuing under it of a new licence to BT. This allowed Mercury to seek to interconnect to BT's switches in order to offer competition for long-distance and international calls.

3.77. Indirect access is an interconnection service which can be requested from both SMP (see paragraph 3.24) and other operators. Offering this service is mandatory in the case of fixed network SMP operators but not for mobile network SMP operators or for any operators which do not have SMP.

Indirect access to mobile networks

3.78. The DGT told us that customers making calls from mobile phones were in a similar position to fixed network customers before 1984; that is, the routing of calls was determined solely by the organization providing the exchange line. Thus, a mobile customer did not have the facility available to, for example, BT's customers of choosing an alternative (and possibly cheaper) operator to deliver calls once they had left the originating network.

3.79. In practice, many companies do offer de facto indirect access to users of mobile phones for outgoing calls, generally by dialling a freephone number to route calls towards ISR operators, but such operations generally offer no reciprocal service allowing competitive call rates to mobile phones, and therefore their presence in the market has had little impact on the price of fixed-to-mobile calls.

3.80. As noted above, MNOs do not have to offer indirect access and, as indirect access to mobile phones is not yet available, it is difficult to know how it would be routed. However, the DGT said that he was considering a dispute arising from an application from an operator for indirect access to one of the mobile networks, which had been refused. The request was for access both by entering a four-digit access code and by freephone (0800) numbers, although only the first was now disputed. The DGT said that there would be some attraction for the indirect access operator, in order to justify the expense of interconnecting to the mobile network, in stimulating incoming calls to the MNO's customer. However, it was not possible to quantify this effect or the timetable on which it might arise, and hence it was not possible to quantify its effect on the market.

3.81. Indirect access operators would not only wish to offer cheaper calls to the customers of the mobile networks, but would also wish to offer specially designed and packaged value-added services. These could be put together by the indirect access operator using his own system's intelligence, or the intelligence in other service providers' systems, or the intelligence built into the operators' networks, both mobile and fixed. These developments, however, are still being perfected in terms of the technical, commercial and regulatory requirements. On the principle of encouraging innovation and the provision of choice for end-user customers, the DGT told us that he supported these developments. It is not yet clear, however, how these developments will affect the competitive pressures on BT and MNOs, in particular in the market for fixed-to-mobile calls.

Carrier pre-selection

3.82. Indirect access is sometimes referred to as carrier selection to reflect the choice the customer exerts by dialling the access digits. A further step (carrier pre-selection) is possible, in which mobile phone subscribers instruct the network operator to route all outgoing calls of a specific type (for example, international calls) automatically to a pre-selected alternative indirect operator. The advantage provided by carrier pre-selection over indirect access is that there is no need to dial indirect access digits, thus removing one of the barriers to the use of the indirect operator's services.

3.83. The DGT said that carrier pre-selection was expected shortly to become mandatory for SMP fixed service operators under the terms of an amendment to the Interconnection Directive and would apply in the UK from 2000. However, there were currently no mandatory requirements on MNOs to supply indirect access so there was no mandatory requirement to provide carrier pre-selection on mobile networks. In so far as indirect access added to the competition in markets, he said, carrier pre-selection would enhance it by reducing the barriers to its adoption.

Regulation

3.84. The MNOs are regulated under their respective licences in a number of ways. These affect, *inter alia*, their relationships with their customers and with other telecommunications operators. In addition the licence provides the basis on which the MNOs report to the DGT for regulatory purposes. BT's licence includes similar provisions, together with a number of matters specifically relevant to it. These include requirements relating to the accounting information of its constituent businesses and for interconnection.

3.85. The licences of the MNOs include detailed provisions governing the operation of their respective networks. A brief summary of the main provisions of Vodafone's licence is at Appendix 3.3. Cellnet's licence is in almost identical terms. References in the following paragraphs are to Vodafone's licence.

3.86. Conditions 5 and 6 require Vodafone to enter into agreements with other operators to interconnect their systems with the Vodafone network.

3.87. Condition 7 obliges Vodafone to allow other people to provide services over its network and Condition 9 prohibits Vodafone from showing undue preference to, or exercising undue discrimination against, individuals or classes of persons when carrying out certain of its telecommunications business activities.

3.88. The present reference to the MMC arose initially from determinations by the DGT of the terms and conditions for the interconnection of the Vodafone and Cellnet systems with CWC. The DGT's proposed order envisaged that Vodafone and Cellnet would offer not to charge more to BT than they charged to CWC.

3.89. Vodafone and Cellnet equalized the charges to CWC and BT by raising the CWC charges to the level charged to BT, rather than lowering the charges to BT. This provoked further interest on the part of the DGT in the area of charges for termination of fixed-to-mobile calls, which culminated in this reference.

Interconnection

3.90. BT has the largest and most comprehensive telecommunications network in the UK. A large number of phone calls make some use of BT's facilities and considerable regulatory attention has been paid to the terms and conditions for interconnection between BT and other operators.

3.91. Condition 13 of BT's licence requires BT to enter into agreements (or to amend existing agreements) with certain other licensed operators to interconnect their systems with the BT network. This obligation applies not only to operators authorized to construct their own networks but also operators who are licensed to resell the facilities of network providers such as BT and do not construct their own network.

3.92. BT's main interconnection obligations are now to offer to enter into an agreement with any licensed operator, or to amend an existing agreement, to interconnect its system with that of the OLO. BT must also provide other telecommunication services to enable the OLO efficiently to provide its own services. BT has to ensure that the terms of interconnection agreements are 'reasonable' and is required to offer the same charges and associated terms to all operators and must charge itself the same as it charges OLOs for standard services.

3.93. Interconnection is also regulated by the EC Interconnection Directive,[1] which has been implemented in the UK by the Telecommunications (Interconnection) Regulations 1997.[2] The main provisions relevant to this inquiry are as follows:

(a) Article 1 sets out the scope and aim of the Directive, namely the establishment of a regulatory framework for securing the interconnection of telecommunications networks. It states that the Directive concerns the harmonization of conditions for open and efficient interconnection and access to public telecommunications networks and publicly available telecommunications services.

(b) Article 3 requires member states to remove restrictions preventing telecommunications network operators and service providers from negotiating interconnection agreements. Technical and commercial arrangements are to be a matter for agreement between the parties, subject to the Directive and the competition rules of the Treaty.

(c) Article 6 imposes requirements of non-discrimination and transparency for organizations notified by NRAs as having SMP. Cellnet and Vodafone have been so notified.

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[1]97/33/EC.
[2]SI 1997/2931.

(d) Article 7 sets out provisions on interconnection charges to be applied to FNOs which have been notified by NRAs as having SMP. Article 7.2 requires that charges for interconnection follow principles of transparency and cost orientation. MNOs which have been notified by NRAs as having SMP on the national market for interconnection are also subject to this requirement. Cellnet and Vodafone have not been notified as such but have been determined as having SMP in the mobile market for interconnection.

(e) Article 9 sets out the general responsibilities of NRAs. Article 9.1 provides that the NRAs are to encourage and secure interconnection, exercising their responsibilities in a way which provides maximum economic efficiency and gives the maximum benefit to end-users. They must take account of a number of matters including the principles of non-discrimination and proportionality and the need to stimulate a competitive market. Article 9.3 provides that in pursuance of the aims in paragraph 1 NRAs may intervene on their own initiative at any time, and shall intervene at the request of a party, to specify issues to be covered in an interconnection agreement or lay down specific conditions to be observed by a party to such an agreement. NRAs may, in exceptional cases, require changes to be made to existing interconnection agreements 'where justified to ensure effective competition and/or interoperability of services for users'.

Financial results

3.94. The four MNOs are Vodafone, Cellnet, Orange and One2One.[1] Vodafone and Cellnet were licensed in 1983 and commenced operating in 1985 with an analogue service. Subsequently both Vodafone and Cellnet were awarded digital licences and their networks are now a combination of digital and analogue capacity. Orange and One2One operate digital networks, though using a slightly different technology with 1800 rather than 900 MHz radio links. One2One began operating in September 1993 and Orange in April 1994. A summary of the group structures of Vodafone and Cellnet and their recent financial results are given below. The results of BT and of Orange and One2One are considered later in this chapter.

Vodafone

3.95. Vodafone, the company which holds the UK mobile licence and operates the network, is a wholly-owned subsidiary of Vodafone Group plc (Vodafone Group). In addition to Vodafone, the Vodafone Group includes companies dealing with value-added services, mobile phone retailing, mobile service provision and paging as well as overseas companies providing mobile telephony networks. In the financial year 1997/98 the consolidated turnover of Vodafone Group was £2,471 million, of which 72 per cent arose in the UK (mainly from the Vodafone network), 20 per cent in Continental Europe and 8 per cent in the Pacific Rim. Vodafone was originally a wholly-owned subsidiary of Racal Electronics plc (Racal), but in 1988 a Stock Exchange listing was obtained for a minority of the shares in Vodafone Group and in 1991 the remaining shares were distributed to shareholders in Racal, so that Vodafone Group became independent of Racal. At 31 October 1998 the market capitalization of Vodafone Group was £24.8 billion.

3.96. Profit and loss accounts and balance sheets for Vodafone for the five years from 1993/94 to 1997/98 are shown in Appendices 3.4 and 3.5 respectively. The financial results of Vodafone Group and of Vodafone for the five years to 31 March 1998 are summarized in Table 3.2.

[1]A further mobile licence was awarded to Dolphin Telecommunications Ltd on 12 December 1997.

TABLE 3.2 **Vodafone: summary financial details of Vodafone Group plc and Vodafone**

£ million

	1993/94	*1994/95*	*1995/96*	*1996/97*	*1997/98*
Vodafone Group					
Turnover	851	1,153	1,402	1,749	2,471
Operating profit*	338	353	466	530	686
Pre-tax profit	363	371	475	539	650
Post-tax profit	245	238	310	367	447
Dividends	84	102	123	147	170
Fixed assets*	720	1,102	1,432	1,927	1,912
Shareholders' funds	698	817	1,022	770	283
Net debt	(111)	160	207	681	1,117
Vodafone					
Turnover	695	930	1,090	1,186	1,342
Operating profit†	335	407	474	500	580
Pre-tax profit	345	416	490	518	597
Post-tax profit	237	284	334	353	418
Dividends	160	208	250	300	360
Tangible fixed assets	463	510	580	660	806
Shareholders' funds	574	650	734	788	846
Net external debt	11	6	3	(1)	5
Expenditure on tangible fixed assets	102	120	155	179	268
Depreciation	70	74	85	99	122
Net	32	46	70	80	146
					per cent
Operating profit return:					
On turnover	48.2	43.8	43.5	42.2	43.2
On average shareholders' funds	58.3	66.5	68.5	65.7	71.0

Source: Vodafone.

*Includes intangible assets.

†In 1997/98 interest paid by associated companies was shown separately in the accounts of Vodafone Group, instead of being included within the results of associated companies as part of operating profit. If the new basis had been applied in 1996/97 the operating profit for that year would have been £539 million; the pre-tax profit was unaffected by the change.

Cellnet

3.97. Cellnet, the company which holds the PTO licence and operates the network, is a wholly-owned subsidiary (via an intermediate holding company, Cellnet Networks Ltd) of CGL. CGL is in turn owned as to 60 per cent by BT and 40 per cent by Securicor. Cellnet holds investments in a number of companies involved with mobile telephony including Link Stores Ltd (40 per cent), DX Communications Ltd (26 per cent), Cellular Operations Ltd (40 per cent) and The Mobile Phone Store Ltd (40 per cent). Another subsidiary of CGL—Cellnet Services Ltd—owns Cellnet Solutions Ltd, Cellnet Transactions Ltd and Call Connections Ltd.

3.98. Profit and loss accounts and balance sheets for Cellnet for the five years from 1993/94 to 1997/98 are shown in Appendices 3.6 and 3.7 respectively. The financial results of CGL and of Cellnet (as the company operating the mobile network) for the five years to 31 March 1998 are summarized in Table 3.3.

TABLE 3.3 **Cellnet: summary financial details of CGL and Cellnet**

£ million

	1993/94	*1994/95*	*1995/96*	*1996/97*	*1997/98**
CGL					
Turnover	468	685	919	997	
Operating profit	168	200	231	187	
Pre-tax profit	128	155	183	145	
Post-tax profit	93	100	119	97	
Dividends	47	50	36	-	
Fixed assets†	567	744	851	915	
Shareholders' funds	189	239	322	403	
Net debt	407	453	440	426	
Cellnet					
Turnover	451	657	874	932	
Operating profit	166	206	241	188	✂
Pre-tax profit	125	160	193	147	
Post-tax profit	91	104	125	98	
Dividends	46	50	36	-	
Fixed assets*†	562	738	845	924	
Shareholders' funds	171	225	315	413	
Net debt	413	472	449	541	
Expenditure on tangible fixed assets	133	207	227	260	
Depreciation	71	85	115	139	
Net	62	122	112	121	
					per cent
Operating profit return:					
On turnover	36.8	31.4	27.6	20.2	✂
On average shareholders' funds	97.1	104.0	89.3	51.6	

Source: Cellnet.

*The 1997/98 accounts to be filed at Companies House will include a change in accounting policy to write off the cost of acquisition of subscriber bases immediately.

†Includes intangible assets representing the cost of purchased subscriber bases, amortized over lives of up to three years.

3.99. The operations of Cellnet form the major part of CGL. All CGL subsidiaries are UK based and there are no overseas operations comparable with those of Vodafone Group. A substantial part of the net debt of Cellnet is provided by BT. The construction of the analogue network was funded by a finance lease from Cellular Radio Ltd (formerly BT Cellular Radio Ltd): borrowing by Cellnet at 31 March 1998 included finance leases of £[✂] million owing to BT group companies. The majority of the employees of Cellnet are employed by BT, with the employment costs being recharged. In 1996/97 there was an exceptional charge of £65 million in Cellnet in relation to an abortive billing and customer care project.

Fixed-line operators

BT

3.100. BT is a major international telecommunications operator which in the year to 31 March 1998 generated turnover of £15.6 billion and whose shareholders' funds at 31 March 1998 were £10.8 billion. As noted in paragraph 3.11, BT owns 60 per cent of CGL which is the holding company for Cellnet, one of the MNOs.

3.101. Table 3.4 shows the summarized consolidated financial results of BT for the five years to 31 March 1998.

TABLE 3.4 **BT: summarized financial results of BT plc**

£ million

	1993/94	*1994/95*	*1995/96*	*1996/97*	*1997/98*
Profit and loss account					
Turnover	13,675	13,893	14,446	14,935	15,640
Operating profit	2,982	2,663	3,100	3,245	3,657
Pre-tax profit	2,756	2,662	3,019	3,203	3,219
Post-tax profit	1,805	1,736	1,992	2,101	1,731
Profit for the year	1,767	1,731	1,986	2,077	1,706
Balance sheet					
Tangible fixed assets	15,584	16,012	16,496	16,802	17,252
Shareholders' funds	13,026	11,997	12,678	11,116	10,785
Net debt	1,226	2,153	948	176	3,977
					per cent
Operating profit return:					
On turnover	21.8	19.2	21.5	21.7	23.4
On average net assets	19.7	17.6	20.5	23.2	25.0
Gearing (debt:debt+equity)	8.6	15.2	7.0	1.6	26.9

Source: BT.

3.102. The shareholders' funds were reduced in 1996/97 by a special dividend of £2,244 million and in 1997/98 by the charge for the windfall tax of £510 million. BT's investment in MCI Communications Corporation was included in fixed asset investments at 31 March 1998 at £813 million, goodwill of £2,214 million having been written off to reserves in prior years in respect of the investment. In November 1997 BT agreed to sell the shareholding to WorldCom International Limited; the potential consideration was equivalent to £4,137 million at the exchange rate ruling at 31 March 1998. The transaction was completed after the year end.

3.103. BT's calls to mobile business is accounted for within its Retail Systems business. The results of the call activities of this business are summarized in Table 3.5.

TABLE 3.5 **BT Retail Systems business: summary of financial results of call activities**

£ million

	1994/95	*1995/96*	*1996/97*	*1997/98*
Turnover:				
Local calls	2,081	2,028	1,987	1,983
National calls	1,778	1,709	1,580	1,472
International calls	1,673	1,694	1,543	1,279
Calls to mobile	389	458	532	657
	5,921	5,889	5,642	5,391
Return	2,427	2,339	2,471	2,258
Including calls to mobile	(43)	(103)	25	50
Mean net assets	992	1,651	2,115	1,374
Including calls to mobile	(74)	(109)	12	11

Source: BT.

3.104. Calls to mobile represented 12.2 per cent of the calls activities of BT's Retail Systems business turnover in 1997/98 and 2.2 per cent of the return. Net assets employed were less than 1 per cent of the total for the business. It is relevant to note that about 75 per cent of the turnover of calls to mobile represents the payment to the OLO (POLO) element.

Other operators

3.105. Other fixed-line operators include CWC, a number of cable television companies, Energis and companies which operate as buyers and sellers of fixed network capacity.

Other mobile operators

Orange

3.106. The principal business of Orange plc and its subsidiaries is the operation of the Orange PCN telecommunications network in the UK which is carried on by a subsidiary company, Orange Personal Communications Services Ltd (Orange). In addition to operating the Orange network, Orange plc provides a range of other mobile telecommunications services in the UK and has mobile telephony interests in France, Germany, Austria, Switzerland and Belgium. Orange was originally a wholly-owned subsidiary of HTUK, which immediately prior to an offer for sale in March 1996 was owned by HW (68.4 per cent) and British Aerospace (31.6 per cent). Following flotation, the market capitalization of Orange plc on 31 October 1998 was £6.7 billion. 30 per cent of the share capital is now publicly held, HW and British Aerospace holding 49 per cent and 21 per cent respectively.

3.107. A summary of the financial results of Orange plc and Orange for the five years to 31 December 1997 is shown in Table 3.6.

TABLE 3.6 **Orange: summary financial details of Orange plc and Orange**

£ million

	Years ended 31 December				
	1993	*1994*	*1995*	*1996*	*1997*
Orange plc					
Turnover	124	143	229	619	914
Operating loss	(46)	(92)	(121)	(177)	(51)
Loss for the year	(231)	(119)	(140)*†	(229)	(139)
Fixed assets‡	278	416	579	750	986
Shareholders' deficit	(316)	(435)	(575)	(121)	(261)
Net debt	484	740	969	704	1,078
Orange					
Turnover	-	34	119	375	634
Operating loss	(6)	(78)	(126)	(188)	(52)
Loss for the year	(6)	(77)	(110)*†	(255)	(163)
Fixed assets‡	235	399	549	719	935
Shareholders' deficit	29	(48)	(181)	(435)	(599)
Net debt	182	401	608	1,060	1,421
Expenditure on tangible fixed assets	129	145	167	217	307
Depreciation	2	7	26	60	98
Net	127	138	141	157	209

Source: Orange.

*In 1995 the accounting policies for the amortization of subscriber acquisition costs and capitalization of interest costs associated with the construction of mobile network assets were changed. Had the accounting policies not changed the net loss of Orange would have been decreased by £40 million.

†The loss for the year in 1995 was arrived at after taking account of an exceptional gain on defeasance of finance leases of £64 million.

‡Includes intangible assets.

3.108. It can be seen that the net debt of both the parent and the subsidiary have risen over the five-year period as a result of operating losses and expenditure on fixed assets.

One2One

3.109. MPC, a company which is ultimately equally owned by Media One International (see paragraph 3.11) and C&W, has been granted a licence to provide personal communications services in the UK. Together with USW PCN Inc (a company wholly owned by Media One International) and MPC 92 Ltd (a company wholly owned by C&W), MPC set up a partnership called Mercury Personal Communications (which trades as One2One) for the purpose of operating the licence to build and operate a national PCN network in the UK. One2One is ultimately a 50:50 joint venture between Media One International and C&W.

3.110. A summary of the financial results of the One2One partnership for the five years to 31 March 1998 is shown in Table 3.7.

TABLE 3.7 **One2One: summary financial details of the One2One partnership**

£ million

	1993/94	*1994/95*	*1995/96*	*1996/97*	*1997/98*
Turnover	28	95	164	262	548
Operating loss	(63)	(115)	(106)	(217)	(125)
Loss for the year	(66)	(123)	(133)	(276)	(229)
Fixed assets*	203	320	436	686	938
Partners' capital/(deficit)	138	172	49	(227)	(456)

Source: MPC.

*In 1996/97 deferred customer acquisition costs and deferred revenue expenditure totalling £96.4 million was reclassified in the balance sheet from current assets to intangible fixed assets.