COSTS AND BENEFITS OF RELAXING INTERNATIONAL FREQUENCY HARMONISATION AND RADIO STANDARDS

APPENDICES TO FINAL REPORT

INDEPEN AND AEGIS SYSTEMS

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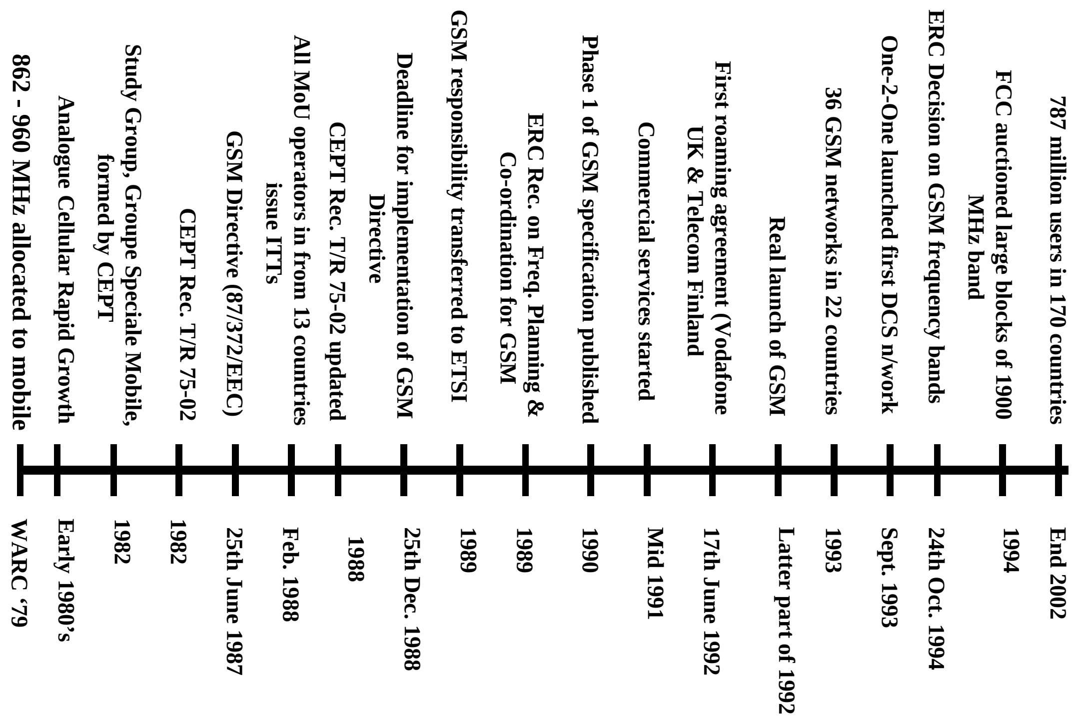
Appendix 1 GSM 900 and 1800 MHz

A1.1 Background

Figure A1.1 gives a timeline for some of the key regulatory and market events in the development of GSM 900 and 1800. The allocation of the 862-960 MHz band to mobile at WARC 1979 facilitated much of what followed. Also the rapid growth in demand in Europe in the early 1980s for analogue cellular telephone systems made clear the disadvantages of multiple systems in Europe.[1] This limited their operation to one or a small number of countries leading to a smaller market for each type of equipment and thereby limiting the extent of scale economies in equipment production.

Figure A1.1 GSM 900 and 1800 Time Line



A1.2 GSM 900

European harmonisation measures were first undertaken through CEPT aimed at creating a common European mobile system, including the creation of a committee named Groupe Speciale Mobile (GSM). In 1982 CEPT agreed Recommendation T/R 75-02 which identified that 890 – 915 MHz and 935 – 960 MHz should be used for a future integrated land and maritime-mobile system.[2] This Recommendation was revised in 1998 and 1990 and the bands were specifically identified for GSM. T/R75-02 gave the market and administrations early clarity of the intention to use the frequency band for mobile services. In some countries

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[1] Scandinavia, the UK, West Germany, France and Italy each deployed different analogue systems.

[2] T/R 75-02, "Use of frequencies in the band 862 – 960 MHz by the mobile except aeronautical mobile service".

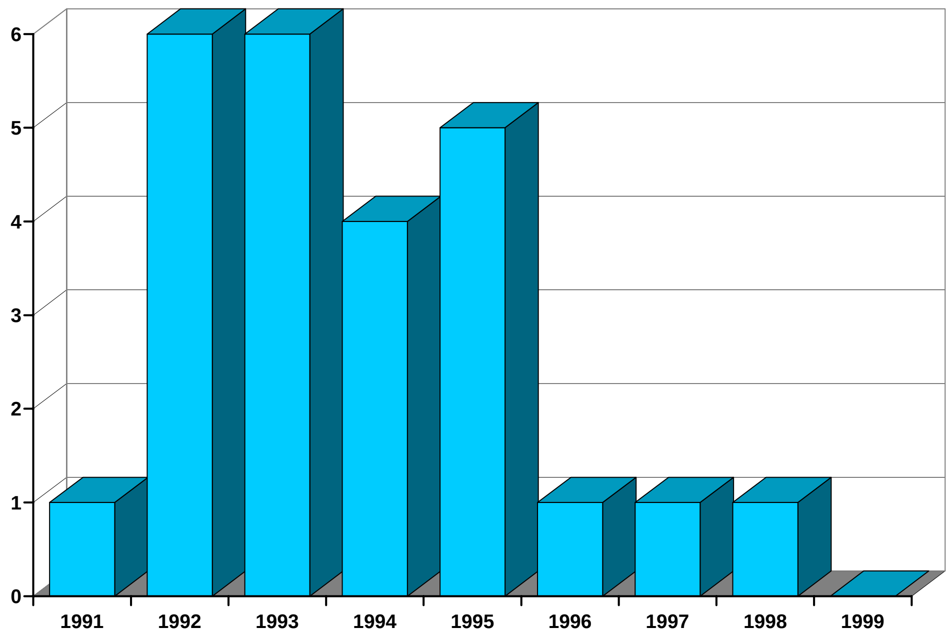
this and subsequent measures may have assisted the NRA in re-allocating the spectrum from the existing military use to use by civil mobile services.

In 1987 the Council of the European Communities adopted a Directive which required Member States to reserve part of the mobile spectrum (905 – 914 MHz and 950 – 959 MHz) for a pan-European cellular digital mobile system by January 1st 1991. Although not directly referenced, GSM was the only pan-European digital cellular system available. This Directive (referred to as the GSM Directive) was intended to speed up the licensing of GSM 900.

In 1989 an ERC Recommendation T/R 20-08 was agreed that specifically addressed the methodology for frequency planning and co-ordination for GSM and so facilitated the development of bi-lateral and multi-lateral agreements and the roll-out of GSM in neighbouring countries.[3] On October 24th 1994 an ERC Decision (94)01 was agreed which designated the frequency bands 890 – 915 and 930 – 960 MHz to GSM (equipment complying with the ETSI standard) from that date.[4]

Figure A1.2 shows the first GSM 900 launch dates in Western Europe whereas Figure 3 shows the first GSM 900 launch dates in the EU countries. Launch dates in the EU were slightly earlier than those elsewhere in Western Europe suggesting that the GSM Directive had the desired effect of speeding up GSM deployment in the EU.

Figure A1.2 GSM 900 Launch Dates in Western Europe[5]

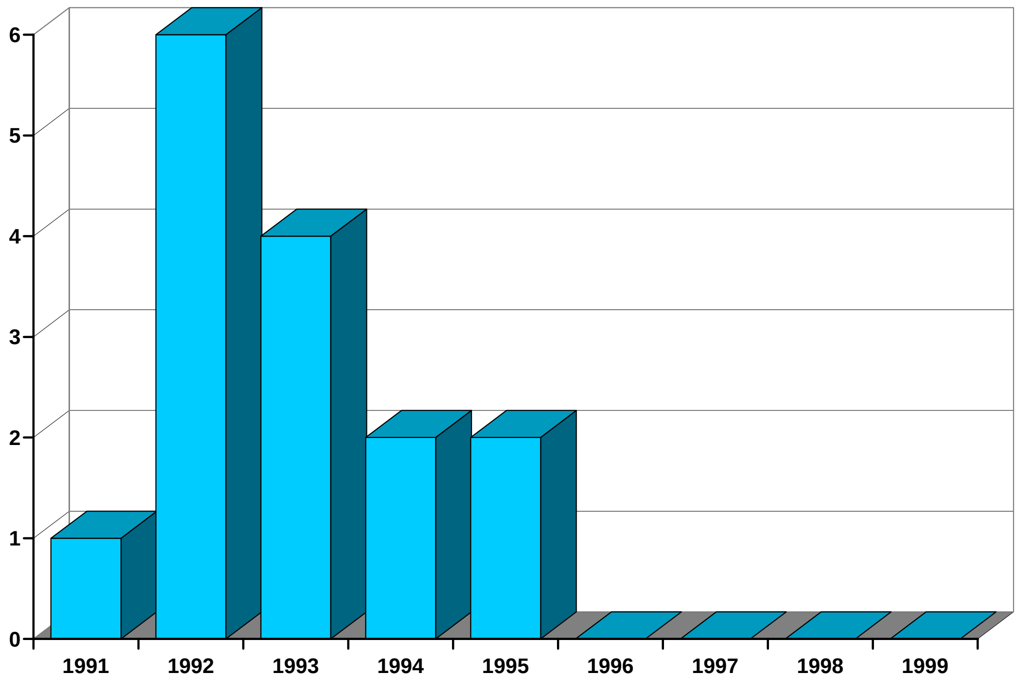


[3] T/R 20-08, "Frequency planning and frequency coordination for the GSM system".

[4] ERC/DEC(94)01, "ERC Decision of 24 October 1994 on the frequency bands to be designated for the coordinated introduction of the GSM digital pan- European communications system".

[5] Source: Mobile Communications magazine

Figure A1.3 GSM 900 Launch Dates in EU Countries



The launch of GSM was delayed or slowed by probably a year by quality problems in the standards that contributed to incompatibilities between the terminals and the network. These delays were aggravated by the regulatory approvals process for the terminals that encompassed both the full protocol aspects of interoperability with the network and voice quality (note these aspects no longer apply since 1999 when the R&TTE Directive came into force). The problem was that the need for testing due to the complexity of the air interface had been underestimated and there were numerous errors in the requirements and the tests used, as well as delays in the development of automatic test facilities. The regulatory nature of these tests meant that errors could not be corrected immediately but had to undergo a process of review that added to the delays. The critical GSM standards went through many versions as errors were identified and corrected and a very large number of change requests were produced.

A1.3 GSM 1800

In September 1993 One-2-One launched services over the first DCS 1800 network. This followed a decision at WARC 92, based on inputs from European administrations, to allocate the 1710 – 1880 MHz frequency band on a primary basis to Mobile. The UK made spectrum available to three potential new operators, two of whom combined leaving two operators, in the 1800 MHz band prior to the ERC Decision (95)03.[6] Recommendation T/R 22-07 (Montreux 1993) had recommended frequency bands, planning and co-ordination for systems

[6] ERC/DEC(95)03, "ERC Decision of 1 December 1995 on the frequency bands to be designated for the introduction of DCS 1800".

using the DCS 1800 standards but at that stage it was noted that DCS 1800 was not intended to be a pan European System[7].

ERC Decision (95)03 allocated the frequency bands 1710 – 1785 and 1805 –1880 MHz to DCS 1800 (equipment complying with the ETSI GSM standard for the 1800 MHz band). At least 2 x 15 MHz within the designated bands was to be made available by 1 March 1997 and an additional 2 x 5 MHz to meet market demand by 1 January 1998.

These measures were reinforced by the Mobile Directive (96/2/EC) which stated (in Article 2) that Member States could not refuse to allocate licences for mobile systems operating according to the DCS1800 standard once they signed up to ERC(95)03 and in any case by 1 January 1998.[8] This Directive was intended to have the effect of stimulating the provision of competitive mobile services using the frequencies specified in the ERC Decision 95(03).

A1.4 Autonomy Study Results for Refarming of 2G to 3G

The Autonomy Study calculated the areas affected in Southern England and Northern Ireland assuming the UK deploys 3G services and neighbouring countries deploy either GSM or 3G services in the 900 MHz and 1800 MHz frequency bands. In some cases the affected areas would have base station transmitter power restrictions and in others there are also interference effects from the neighbouring country that had to be considered. The results are summarised in the Tables A1.1 and A1.2:

Table A1.1 The area affected in Southern England due to the deployment of either GSM or 3G sites in France

	3G in the UK and GSM in France at 900 MHz	**3G in the UK and GSM in France at 1800 MHz**	**3G in France and the UK at 900 MHz**	**3G in France and the UK at 1800 MHz**
Area affected (km²)	4,500	300	7,200	7,200

Source: Autonomy Study

Table A1.2 The area affected in Northern Ireland due to the deployment of either GSM or 3G sites in Southern Ireland

	3G in Northern Ireland and GSM in Southern Ireland at 900 MHz	3G in Northern Ireland and GSM in Southern Ireland at 1800 MHz	3G in Northern and Southern Ireland at 900 MHz	3G in Northern and Southern Ireland at 1800 MHz
Area affected (km²)	14,000	14,000	14,000	14,000

Source: Autonomy Study

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7 T/R 22-07 (Montreux 1993), "Frequency bands, planning and coordination for systems using the DCS 1800 standards"

8 The EC Communication of November 1994 established DCS1800 as part of the GSM system family.

The Autonomy also calculated the additional tri-sectored sites and necessary exclusion zones that would be required in the affected areas. The results are summarised in the Table A1.3 and A1.4.

Table A1.3 The number of tri-sectored sites required in Southern England to provide contiguous coverage in the affected areas

	3G in the UK and GSM in France at 900 MHz	3G in the UK and GSM in France at 1800 MHz	3G in France and the UK at 900 MHz	3G in France and the UK at 1800 MHz
Number of sites with 316W ERP within area affected	35		55	
Number of sites with 1000W ERP within affected area		3		68
Number of sites with restricted powers within area affected	61	4		89
Number of sites with interference and power restrictions combined			77	
Exclusion zone (km²)	0	0	0	0

Source: Autonomy Study

In this case the cross-border co-ordination agreements vary for each of the different scenarios. The geographic areas affected in Southern England increase when France also deploys 3G networks as do the number of sites that need to be deployed to provide contiguous coverage. It could therefore be considered that there are advantages for the UK to refarm 2G spectrum in advance if there is no requirement to reconfigure the base stations when France starts to refarm their spectrum for 3G. For example in Southern England an additional 16 sites would need to be deployed in the 900 MHz band if there was a need to co-ordinate with 3G use rather than 2G use in France. This would increase infrastructure costs by £596,192.[9] Similarly in Southern England in the 1800 MHz band an additional 85 sites would need to be deployed and this would increase infrastructure costs by £3,167,270.

[9] This assumes that the cost of site acquisition and lease and base station equipment is equivalent to 2G macrocells and is £37,262 based on the costs used in the Analysys LRIC model.

However these are small numbers when compared with the total number of base stations that a mobile operator may deploy in providing both coverage and capacity across the UK. In this case there are likely to be more than 20,000 sectors installed across several thousand of sites.

Table A1.4 The number of tri-sectored sites required in Northern Ireland to provide contiguous coverage and also exclusion zones in the affected areas

	3G in Northern Ireland and GSM in Southern Ireland at 900 MHz	**3G in Northern Ireland and GSM in Southern Ireland at 1800 MHz**	**3G in Northern and Southern Ireland at 900 MHz**	**3G in Northern and Southern Ireland at 1800 MHz**
Number of sites with 316W ERP within area affected	67		67	
Number of sites with 1000W ERP within affected area		83		83
Number of sites with restricted powers within area affected	106	96		
Number of sites with interference and power restrictions combined			290	235
Exclusion zone (km^2)	4,800	4,800	4,800	4,800

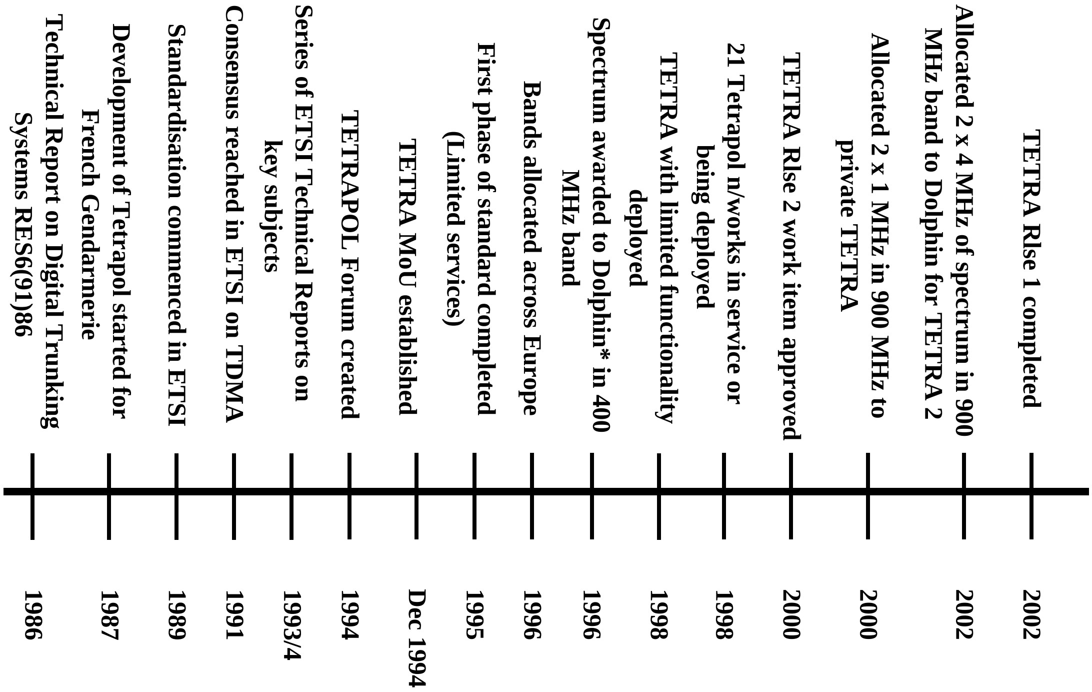
Source: Autonomy Study

In Northern Ireland the whole of the country would be affected and base stations would not be deployable in an exclusion zone of around 4,800 km^2. In the 900 MHz band the required number of sites for contiguous coverage in the remaining area increases from 106 to 290 when moving from co-ordinating with 2G to 3G systems in Southern Ireland. Similarly in the 1800 MHz band the required number of sites increases from 96 to 235.

Appendix 2 TETRA in 854-960 MHz

Figure A2.1 provides a time line for the market and standards development of all the frequency bands allocated to TETRA.

Figure A2.1 TETRA Time Line



* TETRA link and NB3 were awarded the spectrum and merged to form Dolphin in 1997

The standardisation activities within ETSI started around 1989, however, the air interface standard for TETRA was not approved until December 1995. There is now a large number of standards that make up Release 1 of the TETRA standard which can provide audio and data (4.8 kbit/s raw data) services. Release 1 includes the necessary information to allow interoperability between different vendors' base stations and terminals. Whilst Release 1 (2002) covers the majority of services originally planned manufacturers' implementation of these services is somewhat limited. In the UK, the network operated by Dolphin uses Release 1 and operates in the 410-430 MHz band.

ERC/DEC(96)04 identifies four frequency bands for TETRA systems[10]: 385 – 390 MHz paired with 395 – 399.9 MHz; 410 – 420 MHz paired with 420 – 430 MHz; 450 – 460 MHz paired with 460 – 470 MHz; 870 – 876 MHz paired with 915 – 921 MHz.

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[10] "ERC Decision of 7 March 1996 on the frequency bands for the introduction of the Trans European Trunked Radio System (TETRA)". Other relevant though arguably less important Recommendations and Decisions include:

ERC/DEC(99)02 "ERC Decision of 10 March 1999 on Exemption from Individual Licensing of Terrestrial Trunked Radio System (TETRA) Mobile Terminals"

ERC/DEC(99)03. "ERC Decision of 10 March 1999 on Free Circulation and Use of Terrestrial Trunked Radio System (TETRA) Mobile Terminals"

The first band is not currently available in NATO countries[11] and is used to extend the 380 – 385 MHz paired with 390 – 395 MHz band for emergency services in other countries. The Decision allows NRAs to adapt the frequencies listed to their specific national situations. The requirement to allocate at least 2 x 2 MHz by 1st January 1997 did not provide sufficient spectrum to implement a public network.

The RA allocated 2 x 1 MHz of 900 MHz spectrum for private TETRA use in September 2000 (871 – 872 paired with 916 – 917MHz) on the basis of expressed interest. This approach has not been adopted by any other European NRAs. While there was no equipment available for the 900 MHz band, it was hoped this situation might alter as there was a market for TETRA at 800 MHz outside of Europe and manufacturers might use this as the basis for developing equipment at 900 MHz. The RA Public Consultation on the 900 MHz bands in August 2001 noted that manufacturers had not developed equipment and that the private TETRA market was too small and fragmented to drive down equipment costs and make systems economically viable.

Following this Consultation it was decided (in March 2002) to allocate 2 x 4 MHz of spectrum in the 900 MHz band to Dolphin for the implementation of TETRA Release 2 technology which would provide faster data speeds i.e. the TETRA Advanced Packet Service (TAPS). There is currently no equipment available (Release 1 or 2) for the 900 MHz spectrum and there appears to be a lack of interest in this band amongst the vendors.

ECC/DEC/(03)01[12] provides for a number of frequency bands (namely the 410-430, 450-470 and 870-876 and 915-921MHz bands) to be made available for wideband digital land mobile PMR/PAMR with 200 kHz spacing as quickly as possible in response to market demand. The Decision does not specify the technology that must be used.

In parallel to the TETRA standard, which was developed within ETSI, a proprietary trunked digital solution (TETRAPOL) was developed for the French Gendarmerie by Matra. The technical specifications were made available through the TETRAPOL Forum and can be used by any manufacturer to develop equipment that is compatible with TETRAPOL networks. Although the ERC Decision specifically refers to the use of the TETRA standard in the explanatory text, TETRAPOL networks have been implemented in a number of countries in the frequency bands where TETRA systems can be deployed. So far TETRAPOL has only been used for governmental and emergency systems.

ERC/DEC(99)04 "ERC Decision of 10 March 1999 on the adoption of approval regulations for radio equipment to be used in the land mobile service for Terrestrial Trunked Radio System (TETRA) based on the TBR 035"

[11] EPT TETRA will be asking for parts of this band for TETRA Release 2, TEDS, for the Emergency Services.

[12] "ECC Decision of 14 March 2003 on the availability of frequency bands for the introduction of 200 kHz Wide Band Digital Land Mobile PMR/PAMR in the 400 MHz and 800/900 MHz bands"

Appendix 3 Fixed Wireless Access in 2010 – 2025 MHz

A3.1 Introduction

Fixed wireless access (FWA) systems are seen to be important in delivering the vision of Broadband Britain as they can potentially provide cost-effective broadband delivery in rural areas. The preferred harmonised frequency bands for fixed wireless access are in the frequency range between 3 and 29.5 GHz.[13] These are 3.4 – 3.6 GHz, 10.15 – 10.3 GHz / 10.5 – 10.65 GHz, parts of 24.5 – 26.5 GHz and parts of 27.5 – 29.5 GHz. In addition Radio LANs and HIPERLANs can provide local broadband networks in the 2.4 GHz and 5 GHz frequency bands.

Industry has suggested that equipment that operates in the 1.5 – 1.8 GHz and the 2 GHz band, and is available in the US, could be used in the UK to provide local broadband services. It was agreed with the RA that the study should focus on the possible deployment of mobile broadband FWA systems in the 2010-2025 MHz band.[14] This spectrum is currently allocated (under European harmonisation measures) to 3G mobile licence-exempt use but there is no actual use of the band by this service. Allocation of the band to FWA would be a departure from the current harmonised European position.

A3.2 Background

The 2010 – 2025 MHz band is part of the spectrum identified for 3G/IMT 2000 at WARC 92. ERC Decision (97)07 identified the core frequency bands for UMTS and ERC Decision (99)25 established a harmonised approach to utilisation of the available spectrum. ERC Decision (99)25 states "that subject to market demand, Administrations make provision to allow the operation of UMTS self provided applications in a self co-ordinated mode in the frequency band identified in Annex 1" i.e. the 2010 – 2020 MHz band. Twenty-six administrations have signed up to the Decision.

At the time of the UK's decision to licence the 3G mobile spectrum there were a number of consultations on how the spectrum should be allocated. It was envisaged that there might be a market need for private 3G systems and this was the rationale for making 3 x 5 MHz of spectrum available for licence exempt use. Because the spectrum is not paired it requires the use of TDD technology. Release 3 of the 3GPP UMTS specifications specified UTRA TDD with a chip rate of 3.84 Mcps and release 4 of the specification added a second option which used a chip rate of 1.28 Mcps operating in a bandwidth of 1.6 MHz. It was reported[15] early in 2003 that the first commercial system using TDD technology from the UMTS standard was being demonstrated in Cannes at the 3GSM Congress. However, there have been no standards developed for self co-ordinated use, and the only UMTS technology that could be

[13] ERC Rec.13-04 (Tallin 1998)

[14] The 28 GHz band was considered and rejected on the grounds that there were not any European harmonisation or standardisation issues. The potential services that might use the band, namely satellite and fixed link, are already permitted under European regulation. The 3.4 GHz band was also considered and rejected. This was on the grounds that it would be difficult to isolate the impact of market conditions from regulatory factors that led to the failure of early attempts to deploy FWA in the band. In 1993 the band was licensed to Ionica to provide narrowband competition to BT in the local loop.

[15] Total Telecom, 20 February 2003.

deployed at present in the 2010 – 2025 MHz band is the TDD standard developed for licensed use[16].

In 2001, a group of US industry players, including broadband wireless service providers and equipment makers, announced the formation of "The TDD Coalition" whose purpose was to promote use of the TDD air-interface technology in the building of more efficient wireless broadband networks and services.[17] This grouping has lobbied for the allocation of unpaired spectrum for wireless services. The FCC allocated additional spectrum for new wireless services on December 28, 2001. The bands 1390 – 1392 MHz, 1670 – 1675 MHz and 2385 – 2390 MHz were allocated to the fixed and mobile services and would be available on an unpaired basis. This spectrum would be suitable for TDD broadband wireless systems. Subsequently the spectrum in the band 1670 – 1675 MHz was auctioned on April 30[18], 2003, on a nation-wide basis. There were two bidders for the licence and after two rounds it was won by a bid of $12,628,000.

TDD technologies 802.16e and 802.20 also offer high speed data and mobility. These technologies are said to provide data rates of more than 1 Mbps and will operate in bands such as 2010 – 2025 MHz. The 802.16 and 802.20 standards are not yet complete but manufacturers have developed some systems.[19] For example, ArrayComm produces a product called iBurst that uses a single channel TDMA approach as well as adaptive beamforming antennas.[20] This combined technology is reported to support more than 2,000 subscribers per base station with 5 MHz of spectrum and provides per-user data rates of 1 Mbps downlink and 345 kbps uplink in a fully loaded system.[21]

Navini, who use a proprietary S-CDMA system and a phased-array antenna, are quoted as providing non line of sight access at broadband rates for up to 1,000 users per antenna face. This solution is said to provide "up to 50% lower total cost of ownership than DSL or cable networks, and up to 70% lower total cost of ownership than previous fixed wireless systems."[22]

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[16] For example IPWireless has a commercial product that operates in the 2010 – 2025 MHz 3G band. The technology is a packet data implementation of the international 3GPP Universal Mobile Telecommunication System (UMTS) standard and uses time division duplex (TDD). It was announced on 29th October 2003 that German communications provider Airdata had commercially launched broadband wireless services based on the UMTS TD-CDMA variation of the 3G standard. This was claimed to be the first deployment in Europe and uses the IPWireless Mobile Broadband system. It has been reported in Total Telecom that Airdata has obtained spectrum licences in all major areas of Germany.

[17] April 03, 2001 – San Jose

[18] Auction No. 46

[19] The 802.16e standard was planned to be published by 1/10/2004.

[20] This is proprietary standard but work going on in the IEEE to develop 802.20 will include this technology.

[21] Information provided by ArrayComm's IntelliCell to Daily Wireless for their article "4G War in Sydney" posted on August 26th 2003.

[22] Op. cit.

A3.3 Assumptions and Modelling

A3.3.1 Cost of BFWA

BFWA is currently been deployed in other countries and we use data from these countries to in form our estimates of the costs of BFWA.

In New Zealand Vodafone supported by "Woosh Wireless" have rolled out a network covering approximately 70 per cent of Auckland (a low density city of just over 1 million people).[23] The service operates in the 2053-2082 MHz band, and equipment costs and capabilities should therefore be comparable with equipment operating in the 2010-2025 MHz band. The service is currently been offered for NZ$65 (approximately £24) per month for 250 kbps, and a modem costs NZ$200 (approximately £74). The wireless modem is portable.

In Germany it was announced in "Total Telecom" in October 2003 that "German communications provider Airdata has announced the commercial launch of services built on the IP Wireless Mobile Broadband system. The firm claims that the network in Stuttgart is Europe's first commercial deployment of broadband wireless services based on the data-optimised UMTSTD-CDMA variation of the 3G standard." IPWirelss operates in the 2010-2025 MHz 3G band. Airdata's partner Next Generation Internet (NGI) offers two services: PortableDSL 128 at a flat rate of only euro 9.95 (£6.88) per month, plus a connection fee of euro 14.95 (£10.34) per month, and PortableDSL 768 costs euro 19.95 (£13.80) for the Internet flat rate, euro 24.95 (£17.26) for the monthly connection fee.

Finally Ogier Electronics Ltd has developed low cost subscriber equipment for NTL which works in the licensed 10 GHz band. Business plans suggest that operators can make money when charging as little as £19.99 per month.

We assume that the cost of providing BFWA is comparable to the pricing of the "Woosh Wireless" service in New Zealand i.e. £24 per month. This is comparable to the cost of ADSL in the UK.

A3.3.2 Wired broadband availability

Broadband access is currently available to around 67% of UK households. There are different methods of delivering broadband access, the most common being digital subscriber lines (DSL), cable, and fixed wireless access (FWA). Availability of broadband is still technically constrained. For example, even a DSL-enabled exchange will be unable to serve about 3% of the population covered.

Broadband availability is highest in urban and suburban areas (where 75% of the UK population live), where economies of density make the deployment of broadband relatively cost effective. In market towns, rural villages and remote areas broadband availability falls significantly.

The availability of broadband fixed wireless access technology may speed up the process, since

[23] www.woosh.com

- ADSL is confined to higher-density areas and technical constraints mean that a proportion of the UK may not have ADSL.
- Cable operators focus on in-fill rather than network expansion in urban and suburban areas.
- Fibre has been rolled out in central business districts within major urban centres and any further roll-out will be confined to areas where there is a high density of large corporations.
- Satellite broadband is available in the UK, but is relatively expensive when compared to ADSL and cable offerings. It is not expected to impact the market for some time.

We have made an assumption regarding the availability of wired broadband in the UK, modelled using a logistic curve. This has an ‘s’ shape, where the take up is initially by a small number of early adopters, followed by an faster increase due to network effects, and then gradually tapering off. From the current coverage levels we have assumed the target coverage levels are as shown in Table A3.1.

Table A3.1 Household coverage by broadband by area type

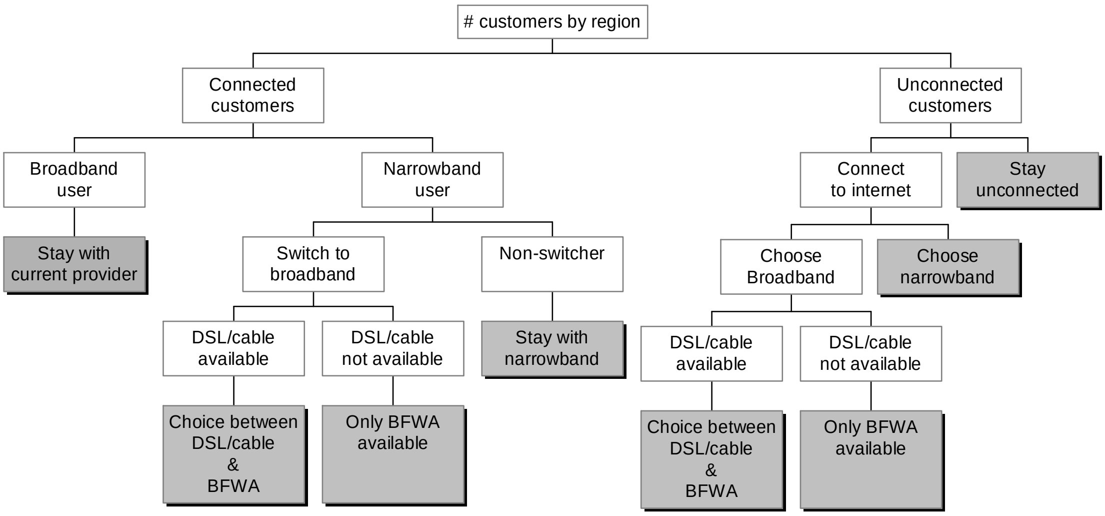
	% of UK popn	DSL	Cable	Total coverageQ 2 2003	Target coverage	Target year
Urban centres	50%	89%	60%	95%	100%	5
Suburban centres	25%	52%	33%	58%	100%	10
Market towns	15%	21%	11%	26%	100%	10
Rural villages	7%	6%	1%	7%	100%	10
Remote rural	3%	1%	0%	1%	100%	10
Total	100%	61%	40%	67%		

Source: “Broadband in Rural Areas”. Broadband Stakeholder Group Submission to EFRA Committee, 2003

A3.3.3 Forecasting methodology

We consider residential and business customers, differentiated by region, where the availability of the wired broadband alternatives will impact on the take up of BFWA. An overview of the forecasting methodology is provided in Figure A3.1.

Figure A3.1 Overview of forecast methodology



The decision to connect to broadband will depend on the availability of broadband (both cable and DSL), and its price compared to un-metered narrowband access. Customers outside the coverage area of existing broadband providers will be able to derive a surplus through the services provided by mobile broadband technology. In this study, we shall not assume any switching behaviour by those who are already receiving broadband but it is assumed there will be some switching by narrowband customers to BFWA. The availability of BFWA gives unconnected customers an additional choice, whether they are within the service area of existing broadband providers or not. Competition between the providers will play an important role in the take up of the services.

Three demand scenarios are considered on the basis of the monthly charges for the BFWA compared to competing broadband offerings. When the charges are similar, the consumer is indifferent between the two services, and therefore those who do switch to broadband will be divided equally between the wired and wireless access. When one charge is higher than the other, the switchers will choose the lower price service. Where DSL/cable broadband is not available, BFWA will be the only choice. The scenarios for the uptake of BFWA are summarised in Table A3.2:

Table A3.2 BFWA uptake assumptions

	Scenario 1	Scenario 2	Scenario 3
	BFWA = DSL	BFWA > DSL	BFWA < DSL
Current narrowband users			
Switch to broadband	Same, based on projected take up curves		
DSL/cable broadband available			
MBFWA	50%	0%	100%
DSL/cable	50%	100%	0%
DSL/cable broadband not available			
MBFWA	100%	100%	100%
Stay with narrowband	1 – proportion that switch to broadband		
Current broadband users			
Stay with DSL/cable broadband	100%	100%	100%
Non-internet customers			
Choose narrowband	Same, based on projected take up curves		
Choose broadband	Same, based on projected take up curves		
DSL/cable broadband available			
MBFWA	50%	0%	100%
DSL/cable	50%	100%	0%
DSL/cable broadband not available			
MBFWA	100%	100%	100%
Not connect	1 – proportion that choose narrowband and broadband		

The Office of National Statistics provides information on regionally disaggregated data on the number of households in the UK, with forecasts to 2021 on a five-year basis. In between the forecasts, linear interpolation is used. This forms the basis for our forecasts of BFWA uptake. Regional data on household access to the internet is also available from 1999 to 2003. The ONS also provides information on the number of enterprises, disaggregated by number of employees from 1998 to 2002. Forecasts of small and medium enterprises (SMEs) are based on the average annual change in registered businesses in the UK experienced of 0.6% between 1985 and 2003.

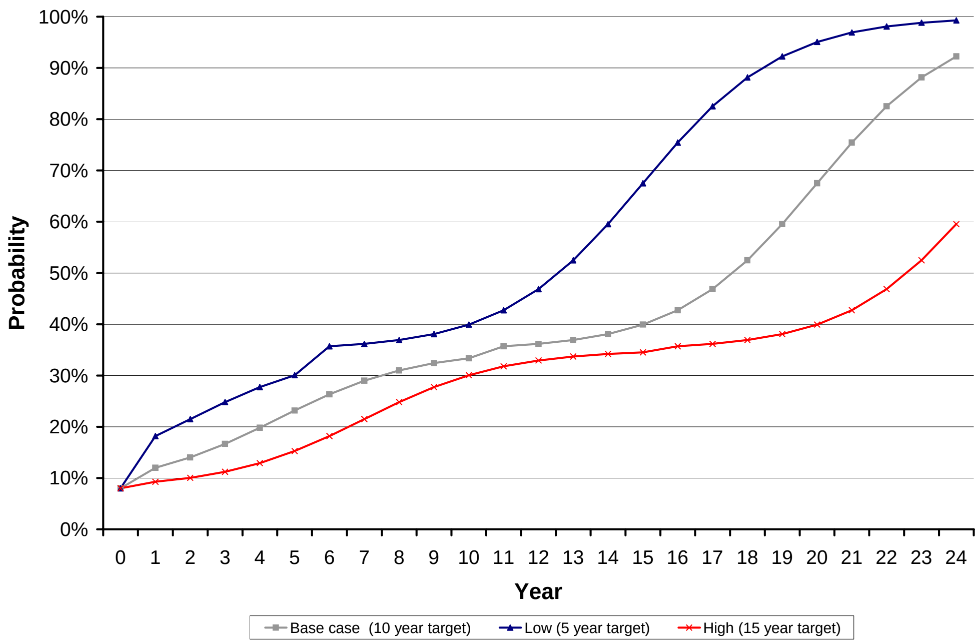
Oftel provided data on household and SME access to the internet, split by the methods of connection (narrowband metered/unmetered, and broadband), although on an irregular basis. Using Oftel’s estimates as starting values, we have made assumptions on the take up of internet access and the degree of switching by narrowband customers to broadband using the logistic curve. Table A3.3 shows the base case assumptions.

Table A3.3 Internet and broadband take up base case assumptions

	Starting value	Target value	Target year
Households			
Current narrowband users switching to broadband	8%	35%	10
Unconnected households taking up internet	0%	50%	5
Unconnected households taking up broadband	0%	35%	10
Small businesses			
Current narrowband users switching to broadband	25%	100%	10
Unconnected businesses taking up internet	64%	100%	10
Unconnected businesses taking up broadband	25%	100%	10
Medium businesses			
Current narrowband users switching to broadband	25%	100%	10
Unconnected businesses taking up internet	92%	100%	10
Unconnected businesses taking up broadband	25%	100%	10

In two alternative scenarios we have considered accelerating the take up by halving the target year, as well as reducing the time to the target year by 50%. Figure A3.2 shows the degree of switching by narrowband customers to broadband.

Figure A3.2 Projections of degree of switching by narrowband customers to broadband



A3.3.4 Willingness to pay

The benefit of BFWA and DSL/cable broadband is in its 'always-on' and high speed connection to the internet, and therefore we assume that the willingness to pay for both types of services will be the same. In effect, we assume that the flexibility to operate away from a fixed location with BFWA offsets the lower data rate compared to the majority of ADSL connections in terms of willingness to pay.

Analysys has estimated that the residential willingness to pay for broadband services will be around £40 a month.[24] This compares with current charges of around £15 to £28 a month, depending on the speed of the connections. However, increased awareness and experience of the services available on broadband in the future would increase consumers' willingness to pay. We have assumed a constant consumer willingness to pay of £40 per month per household. The Oftel survey on 'UK awareness and usage of advanced telecom services' showed that the willingness to pay for DSL services ranged from £66 a month for small businesses to £108 a month for medium businesses.

A3.4 Autonomy Study Results

If the UK deploys BFWA[25] in the 2010-2025 MHz band while 3G services are deployed elsewhere the number of BFWA sites in Southern England would increase by 50%, assuming there was a requirement to provide contiguous coverage in the co-ordination area, which is interference limited, of 35,000 km². This affected area is approximately 14% of the UK total geographic area. On the other hand there are only serious restrictions on the output powers that could be used by the BFWA base stations in an area of 4,000km², which is less than 2% of the UK geographic area although the area over which interference would have some effect is 35,000 km². Figure A3.3 from the Autonomy report shows the affected areas. In Northern Ireland the increase in number of sites is likely to make BFWA impractical because of the increased infrastructure costs.

A3.5 Number of customers supported by 15 MHz of 3G TDD spectrum

We have used the worst case busy hour traffic value in the UMTS Forum Report 33, "3G Offered Traffic Characteristics", November 2003 to develop an estimate of the number of customers that 15 MHz of 3G TDD spectrum may support. Table 11.7 in this report indicates that the average subscriber worst case value is 198.4 kBytes in the up-link and 454.9 kBytes in the down-link across all service categories. Therefore for each user there needs to be a traffic capacity of 653.3 kBytes.

The maximum traffic capacity for each 5 MHz TDD channel is 2 Mbit/s and therefore if 3 TDD channels were deployed at a single base station the traffic capacity would be 6 Mbit/s but this has to be divided between the up-link and the down-link. The worst case busy hour traffic that the 3 TDD channels could support is 2,700,000 kBytes. Therefore the number of users a TDD base station with 15 MHz of available spectrum can support during the busy hour is 4132.

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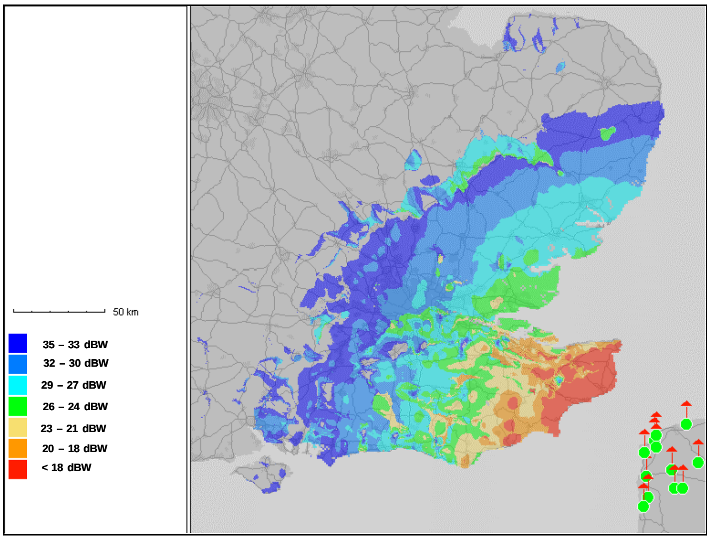
[24] See p18 in UK Online: The broadband future, February 2001, www.e-envoy.gov.uk/assetRoot/04/00/08/25/04000825.pdf

[25] The Autonomy Study has assumed the use of Portable Wireless DSL.

Figure A3.3 Geographic restrictions on deployment of BFWA due to EIRP level allowed to radiate towards France



Source: Autonomy Study.

If values are taken from table 11.6 in the UMTS Forum Report 33 then the average of the total traffic aggregate traffic during the busy hour would be 184.4 kBytes in the up-link and 432.4 kBytes in the down-link. The number of users that could be supported within the busy hour would be 4377.

However these figures do appear to be optimistic. If we adopt a different approach by assuming that 10% of the users at any one time in the busy hour want to use the service and also assume that the average data rate required is 30 kbit/s (this takes into account the combined up-link and down-link requirements) the total number of users would be 2,000. Clearly the traffic requirements, and also the percentage of users that might want to access services, have a significant impact on the total number of users 15 MHz of TDD spectrum can support.

In summary these rough calculations suggest that 2,000-4,000 users might be supported by each base station in a network using 15 MHz of TDD spectrum.

Appendix 4 32 GHz Fixed Band

A4.1 Background

The 32 GHz fixed allocation was confirmed at WRC 2000 and was identified as available for high-density applications in the fixed service through ITU-R RR footnote S5.547. Harmonised CEPT channel arrangements were developed with channel spacings the same as in the fixed service bands below and above this band to provide opportunities to use similar equipment and systems. The ITU-R Rec. F1520 provides similar channel arrangements.

The relevant recommendation is ERC/REC 01-02 "Preferred channel arrangement for digital fixed service systems operating in the frequency band 31.8 – 33.4 GHz". In addition to the UK, Slovenia, Norway and Germany have indicated that they plan to implement the Recommendation. Germany intend to use it in support of 3G roll-out. The Netherlands have also indicated that they are "committed" to the recommendation.

The standards that apply are the generic standards that have been developed within ETSI TM4 and cover a wide range of frequency bands; EN 301 751 is for point to point links and EN 301 753 for point to multipoint. They both contain the necessary parameters to meet the provisions of article 3.2 of the R&TTE Directive, which covers the need to avoid harmful interference. However for the actual values of the parameters reference is generally made to the individual standards such as EN 300 197 for the 38 GHz band.

In the UK one-third of the band has been allocated for fixed links and the rest to general fixed services.[26] However, there is no existing use of the 32 GHz band.

The Government's Response to the Cave Report stated that "the Radiocommunications Agency intends to conduct a pilot scheme possibly in currently unassigned spectrum in the fixed link bands at 32 GHz". This would potentially allow the company responsible for managing the spectrum, for their own or third parties' use, to define the radio equipment parameters necessary to avoid harmful interference. These parameters would not necessarily be the same as those in the fixed link generic standards for point to point and point to multipoint antennas and equipment.

Demand analysis is given in the following sections based on the results reported in the RA in Paper prFLCC02. This paper reports the outcome of a questionnaire sent to 3G operators in 2001 and which was intended to achieve a realistic forecast for the fixed service requirements of 3G operators in the UK.

It is expected that a number of these forecasted links may have already been assigned in alternative frequency bands to 32 GHz (23, 26 and 38 GHz) but these figures have been used to develop a measure of the amount of spectrum that might be required at 32 GHz.

Two different scenarios are considered:

- Links are assigned in the 32 GHz band based on the RA's minimum link length policy

[26] The RA has not specified the nature of these services but rather has asked for suggestions from industry.

- All links that can meet the required performance objectives are assigned in the 32 GHz band. This is expected to be the scenario requiring the largest number of 32 GHz links.

A4.2 Potential Demand

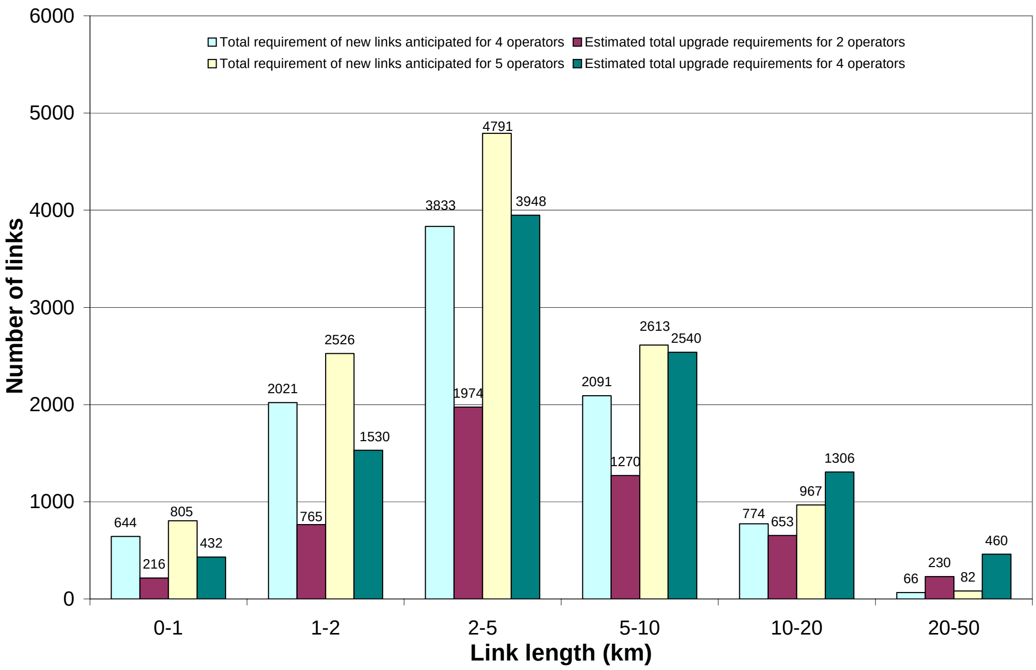
A4.2.1 Potential Demand Assuming Minimum Link Length Policy

The minimum link lengths allowed in the 32 GHz band are:

- 2 kms for links with a capacity of 2, 2x2, 8, 2x8, 34 and 51 Mbit/s
- 1.5 kms for links with a capacity of 140 / 155 Mbit/s.

Figure 3 from the document prFLCC02 (repeated below as Figure A4.1) gives the hop lengths for new links and upgrades. It is assumed that the 32 GHz band can potentially meet the requirements of links in the range 2 to 10 kms[27], taking into account the minimum link policy. This would mean a total of 7404 new links would need to be assigned in the 32 GHz band to meet the calculated requirements of the 5 3G operators.

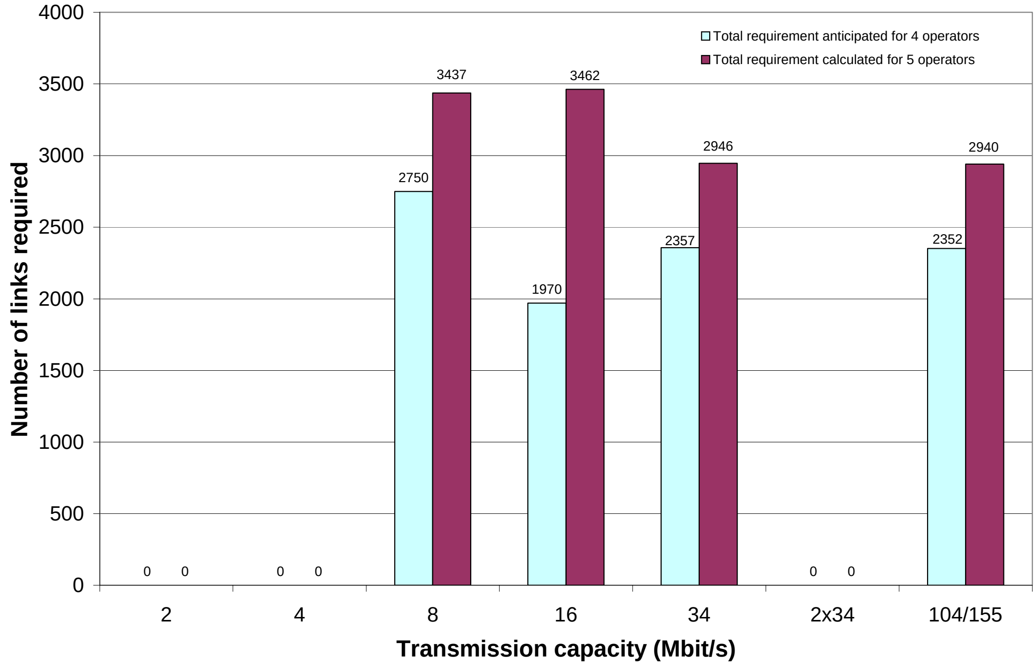
Figure A4.1 Hop length requirements for new links and upgrades



However a number of the 140/155 Mbit/s links from the 1 –2 km link length range will also need to be assigned in the 32 GHz band. Figure 1 of prFLCC02 (repeated below as Figure A4.2), provides information on the mix of transmission capacity estimated for new fixed links.

[27] This is very much a worse case scenario as we understand that, based on assignments in other bands, link lengths of between 2 and 4 kms are more likely to be assigned.

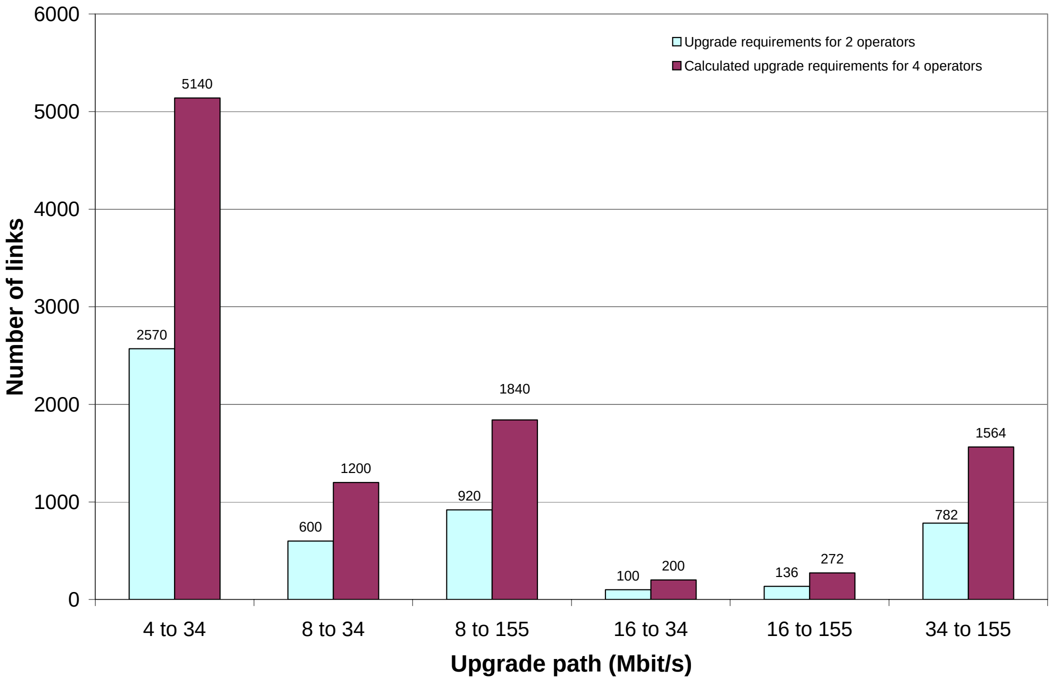
Figure A4.2 Transmission capacities based on estimation of new fixed link requirements for 3G



Assuming the same ratio between the different transmission capacities applies for all link length ranges then 25% of the links in the range 1- 2 kms will be 140/155 Mbit/s. Further assuming a random distribution of link lengths then half of the links in the 1 – 2 km range will be above 1.5 kms. This means an additional 316 links will need to be assigned.

In addition it would be sensible to assume that a proportion of the links that will need upgrading will need to be assigned in the 32 GHz band. For the purposes of this calculation it is assumed that half of the estimated total of links that will need upgrading (6488) are assigned in the band. Therefore in the link length range 2 – 10 kms an additional 3244 links will need to be assigned. In the range 1.5 – 2 kms the number of links that are required with 34 Mbit/s and 155 Mbit/s capacity are based on Figure 2 from prFLCC02 (repeated below as Figure A 4.3).

Figure A4.3 Existing links that will require upgrading in transmission capacity



This figure shows that 3680 of the upgrade links will require a capacity of 155 Mbit/s and 6540 links a capacity of 34 Mbit/s. Therefore for the 1-2 km range, assuming a similar ratio in transmission capacity, there will be 861 155 Mbit/s links. Assuming only half will be assigned in the 32 GHz band and a random distribution of link lengths then the total number of links will be 215.

Therefore the calculated total number of 32 GHz links is:

- 7404 new links in the link length range 2 – 10 kms
- 316 new 140/155 Mbit/s links in the link length range 1.5 – 2 kms
- 3244 upgraded links in the link length range 2 – 10 kms
- 275 upgraded 140/155 Mbit/s links in the link length range 1.5 – 2 kms.

This gives a total of **11,239** links to be assigned in the 32 GHz band.

A4.2.2 Potential Demand Assuming No Minimum Link Length Policy

In this case it is assumed that all link length ranges between 0 and 10 kms and that 50% of the upgraded links will be assigned in the 32 GHz band.

Therefore the calculated total number of 32 GHz links is:

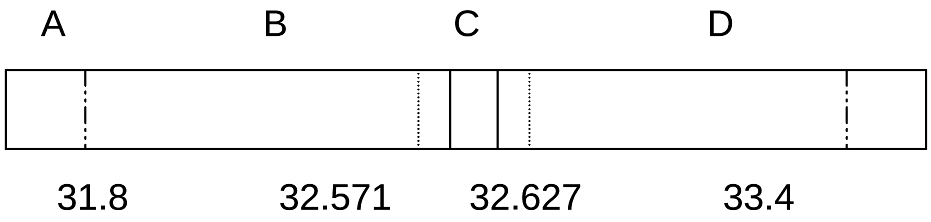
- 10735 new links
- 4225 upgraded links

Giving a total of **14,960** links to be assigned in the 32 GHz band.

A4.3 Channel Plan at 32 GHz

The channel plan at 32 GHz is shown in Figure A4.4.

Figure A4.4 Channel plan at 32 GHz



If channel spacings of greater than 28 MHz are required then the guard and edge bands need to be increased as shown in Table A4.1.

Table A4.1

Channel Spacing	56 MHz	3.5, 7, 14, 28 MHz
A	71 MHz	15 MHz
B	28 MHz	0
C	56 MHz	0
D	45 MHz	17 MHz

It is assumed that the channel spacings will be a maximum of 28 MHz and therefore the band can support 27 two-way 28 MHz channels.

The RA has released one third of the band for fixed point to point assignments, which provides a total of 9 two-way 28 MHz channels.

A4.3.1 Required Bandwidth

The required bandwidth for the fixed link requirements for the 3G mobile operators depends on the ability to re-use the frequencies, the location of the links and the capacity and therefore required bandwidth of the individual links.

The easiest method to calculate the required bandwidth would be to consider a typical geographic area (urban) where the maximum number of links will need to be deployed and based on re-use figures for the 26 GHz band in the same geographic area calculate what amount of spectrum will be required to serve this worst case scenario. This is not feasible from the information that is available.

Another option, which it was intended to use for these calculations, is to assume that the geographic distribution of 32 GHz links will be similar to the distribution of 26 GHz links. Then the actual re-use figure for one 28 MHz channel, with the most assignments, in the 26 GHz band could be used for the 32 GHz band. This will be assuming a worst case situation as the re-use figure for 32 GHz would be higher due to the shorter interference distances. However re-use figures are not currently available and it has been necessary to refer to the re-use figures used in May 1997 in a consultation document on administrative pricing for fixed links; “Implementing Spectrum Pricing”. The re-use figure used for 22 GHz was 200 for a 28 MHz channel but it was stated that this was on the low side at the time. At 13 GHz the re-use figure was 202 for two of the 28 MHz channels. A re-use figure of **300** has been assumed.

The other input into required total bandwidth is the bandwidth required for each link. Clearly 8 Mbit/s links will not require a bandwidth of 28 MHz. As the 32 GHz band has only recently been made available it is assumed that any equipment deployed will use the most efficient modulation techniques and therefore the following bandwidth requirements will apply to each link:

Table A4.2

Capacity	**Bandwidth**
8 Mbit/s	3.5 MHz
17 Mbit/s	7 MHz
34 Mbit/s	14 MHz
140/155 Mbit/s	28 MHz

A4.4 Number of 28 MHz Channels

A4.4.1 Number of 28 MHz Channels Assuming Minimum Link Length Policy

From the estimates of potential demand assuming a link length policy there are 7404 new links in the link length range 2 – 10 kms. If the ratio of transmission capacities is the same across all link length ranges then there will be:

- 2159 links with 8 Mbit/s capacity requiring 3.5 MHz bandwidth
- 1547 links with 17 Mbit/s capacity requiring 7 MHz bandwidth
- 1851 links with 34 Mbit/s capacity requiring 14 MHz bandwidth
- 1847 links with 140/155 Mbit/s capacity requiring 28 MHz bandwidth

It is assumed that 8 x 3.5 MHz channels are equivalent to 1 x 28 MHz channel and similarly for the other channel bandwidths. This will provide a best case situation.

Therefore the equivalent of (2159/8 + 1547/4 + 1851/2 + 1847 = 3430) 28 MHz bandwidth links will need to be assigned in the 32 GHz band to meet the requirements of the calculated new links in the link length range 2 – 10 kms.

There are also 3244 upgraded links in the link length range 2 – 10 kms. If the ratio of transmission capacities for upgraded links is the same across all link length ranges then there will be:

- 2076 links with 34 Mbit/s capacity requiring 14 MHz bandwidth
- 1168 links with 140/155 Mbit/s capacity requiring 28 MHz bandwidth

Therefore the equivalent of (2076/2 + 1168 = 2206) 28 MHz bandwidth links will need to be assigned in the 32 GHz band to meet the requirements of the upgraded links in the link length range 2 – 10 kms.

Also there are 316 new 140/155 Mbit/s links in the link length range 1.5 – 2 kms and 275 upgraded 140/155 Mbit/s links in the link length range 1.5 – 2 kms.

The total number of equivalent 28 MHz bandwidth links is **6227.**

On the basis of a re-use value of 300 then there would need to be twenty one 28 MHz bandwidth bothway channels leaving a further six 28 MHz channels available in the entire frequency band.

A4.4.2 Number of 28 MHz Channels Assuming No Minimum Link Length Policy

Similarly from the calculations on potential demand where there is no minimum link policy there are 10735 new links in the link length range 0 – 10 kms. If the ratio of transmission capacities is the same across all link length ranges then there will be:

- 3131 links with 8 Mbit/s capacity requiring 3.5 MHz bandwidth
- 2243 links with 17 Mbit/s capacity requiring 7 MHz bandwidth
- 2684 links with 34 Mbit/s capacity requiring 14 MHz bandwidth
- 2677 links with 140/155 Mbit/s capacity requiring 28 MHz bandwidth

It is again assumed that 8 x 3.5 MHz channels are equivalent to 1 x 28 MHz channel and similarly for the other channel bandwidths. This will provide a best case situation but this should potentially compensate for a lower re-use figure.

Therefore the equivalent of (3131/8 + 2243/4 + 2684/2 + 2677 = 5363) 28 MHz bandwidth links will need to be assigned in the 32 GHz band to meet the requirements of the calculated new links in the link length range 0 – 10 kms.

There are also 4225 upgraded links in the link length range 0 – 10 kms. If the ratio of transmission capacities for upgraded links is the same across all link length ranges then there will be:

- 2704 links with 34 Mbit/s capacity requiring 14 MHz bandwidth
- 1521 links with 140/155 Mbit/s capacity requiring 28 MHz bandwidth

Therefore the equivalent of (2704/2 + 1521 = 2873) 28 MHz bandwidth links will need to be assigned in the 32 GHz band to meet the requirements of the upgraded links in the link length range 0 – 10 kms.

The total number of equivalent 28 MHz bandwidth links is **8236.** On the basis of a re-use figure of 300 then twenty seven 28 MHz bandwidth two-way channels will be required (the calculations come to slightly more than 27)[28] which can just be met within the current channel plan.

[28] As the 300 figure is an estimate based on historic data for frequency bands higher than 32 GHz it has been assumed to be approximate.

A4.5 Conclusions

The worst case scenario, which assumes that there is no link policy and all feasible new links are assigned in the 32 GHz band as well as 50% of the upgraded links, can be assigned within the full bandwidth available. This assumes a re-use figure of 300 for a national 32 GHz channel.

In practice the number of links that will be assigned in the band are likely to be considerably less even than the scenario above that assumes the RA link length policy is applied. In this scenario there are six 28 MHz two-way channels that are free. This allows considerable flexibility in the use of non-harmonised channel plans. For example if three operators / service providers were each awarded a national licence of eight 28 MHz two-way channels there would still be one 28 MHz two-way channel that could be used between each of the allocations. This could allow the operators / service providers the flexibility to use different channel bandwidths.

Appendix 5 Private Mobile Radio – 450-470 MHz

A5.1 Historical Developments

The development and availability of commercially available technology triggered the introduction of mobile systems into the UHF bands in the mid-1960s. Prior to this, 410-450 MHz was used in most countries by military radiolocation and 450 – 470 MHz was used by the fixed service.

The UK plan for 450 – 470 MHz (UHF 2) had existed for some time before the CEPT plan was developed in 1968.[29] In the UK the band was used and planned specifically for public (Post Office) and private fixed links and scanning telemetry systems. In addition, 3 MHz of spectrum at 467 – 470 MHz was treated as a guard-band (in effect sterilized) to protect Channel 21 TV reception. The sub-bands that exist today were originally engineered to provide a choice of duplex spacing and transmit frequencies so that multiple or tandem links between common sites could be planned without mutual interference (i.e. sites were designated "high transmit/low receive" and vice versa).

For the purposes of this study, it is proposed to assume use of UHF 2 by mobile systems started in the early 60s - the first systems were probably used by the police (hand portable systems). By the mid 60s, two mobile sub-bands for PMR were available with national channels designated for nationalised fuel and power industries, CAA airport ground movements, British Rail etc. National wide area and local area paging systems were also introduced.

Fixed services (mainly for control of PMR base stations) were withdrawn progressively starting around the late 1970s, although the scanning telemetry still remains in a special sub-band. The fixed service sub bands were made available for PMR although the public (Post Office/BT) fixed link sub-band was transferred to the police. The spectrum released by removal of the fixed services would have given an opportunity to align with the CEPT. However, this option was not considered (CEPT harmonisation was a minor factor in UK spectrum planning at that time) and interference from neighbouring countries was not a problem.

The public mobile telephone system, NMT450, began to rollout across Europe starting from the Scandinavian countries from 1982. Serious consideration of the UK aligning with the CEPT UHF plans did not occur until the mid 80s when interference from NMT450 became a major problem for police services in the North of England. An interdepartmental committee was established circa 1985 to review the possibilities but it was concluded that there was little room for changes to the UK plan. For example, a unilateral base/mobile transmit "reversal" by the police would have resulted in worse interference between other UK systems. However, by the late 80s and early 90s, NMT 450 systems had been completed throughout the UK's neighbouring countries (except France and Ireland) and severe interference had now spread to PMR and scanning telemetry users in Eastern and Southern England. A new

[29] Recommendation T/R 25-08 covers the planning criteria and coordination of frequencies in the land mobile service and recommends harmonised use of frequency bands and considers coordination issues. ERC Rec. T/R 25-08 Annex 1 includes a figure which details the recommended spacing, use and location of upper, lower and simplex bands based on the ERC Report 25.

interdepartmental committee was set-up in 1991 to consider the options e.g. smart technology, detailed frequency co-ordination and CEPT alignment.

In 1993, the ERC approved Recommendation T/R 02-02 designating sub-band 380-400MHz for the "Emergency Services" (now ERC Decision DEC/(96)01). After due consideration, the UK Home Office decided that the police forces of England and Wales should relocate to this spectrum, thus vacating spectrum in the 450-470 MHz band which would be returned to RA for re-use. This provided the RA with sufficient unused spectrum to re-engineer 450-470 MHz to align with CEPT and it has been decided to proceed with an alignment project, beginning in 2005 and to be completed by 2010.

A5.2 Future Developments

ECC Report 25 proposes that "Narrowband PMR/PAMR (analogue as well as digital) is introduced from the lower end of the band and wide band PMR/PAMR is introduced in frequency bands above 453/463 MHz. The upper part of the band should in the future be used for existing and future PMR/PAMR systems and allow for new technologies to be introduced. The spectrum to be used for wide band systems on the one hand and new technologies on the other hand should be defined by market demands".

Work is currently ongoing within ETSI to develop a Digital Mobile Radio (DMR) standard and the aim is to complete the air interface standard by April / May 2004. This date assumes that the intellectual property right problems that effectively "killed" DIIS[30] will not reappear for DMR. It is expected that products will be available about 18 months after completion of the air interface standard i.e. around 2006.

The transmitter mask for the digital mobile standard will fit within the analogue 12.5 kHz mask (EN 300 113 and EN 300 086, which are the two main standards for PMR) and also conforms to the adjacent channel parameters. This means the digital equipment will be able to "live" alongside analogue equipment. This standard is intended to cover all applications; paging, CBS, PAMR and PMR. As this digital equipment is also narrowband and will be compatible with analogue PMR it is likely that as part of the re-alignment exercise some users will invest in new narrowband digital radio equipment, if it is available in time, rather than modifying or replacing their existing analogue equipment. The digital equipment is expected to be low cost so it is expected there will be benefits to users in terms of cost of ownership as well as cost of support.

A5.3 Autonomy Study Results for Unrestricted Wide Band PMR

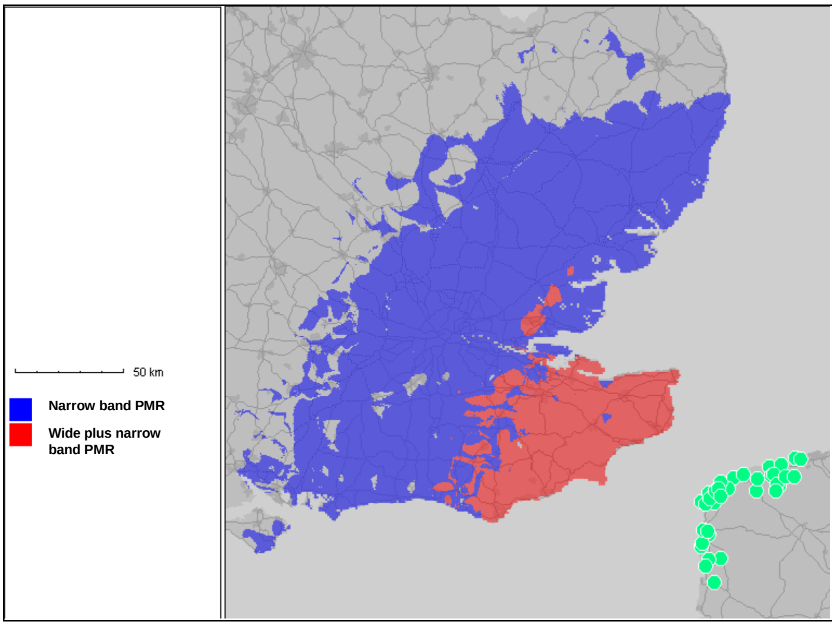
The Autonomy Study calculated the areas over which radiated powers from narrow band[31] and wide band sites would have to be controlled assuming that both types of systems had the same maximum output powers. These co-ordination areas were 4,500 km² for wide band systems and 24,400 km² for narrow band systems and comprise 1.8% and 10% respectively

[30] The ETSI Standard for DIIS (Digital Information Interchange Signalling) reached an impasse on IPR because the company that held the IPR would not licence it until the end of the standardisation work. The standards work folded because there were no inputs.

[31] Wide band base station parameters were based on the TETRA Advanced Packet Service (TAPS) standard which has a channel spacing of 200 kHz.

of the total geographic area of the UK. The areas are shown in Figure A5.1 which was produced by the Autonomy Study.

Figure A5.1 The co-ordination areas over which radiated powers have to be reduced below 25W ERP*



Source: Autonomy Study

* The red areas are for wide band systems and red plus blue for narrow band systems.

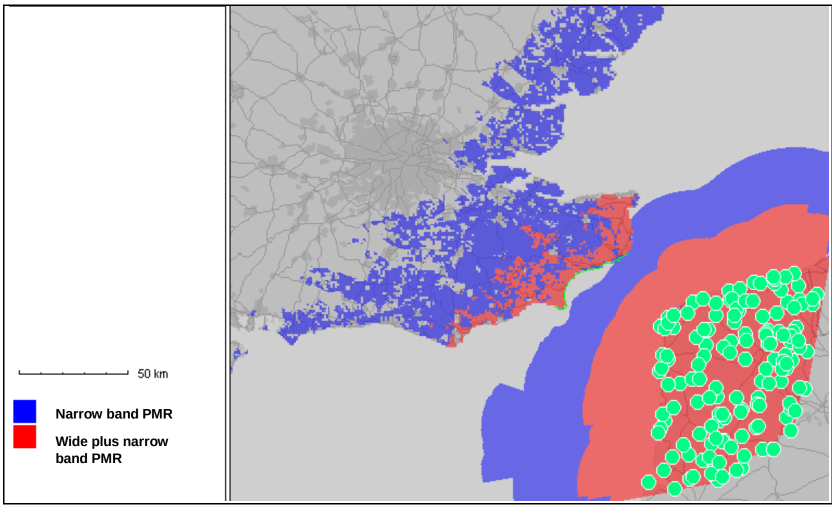
Based on current deployment of PMR sites in the 450 to 470 MHz band[32] then approximately 4,000 wide band sites are within the geographic area where it may be necessary to operate with reduced radiated powers and 11,500 narrow band sites. On the basis that there are approximately 32,500 PMR sites[33] then in the case of wide band around 12% could be affected by limitations and for narrow band around 35%. These are worst case figures as a number of the existing PMR base stations may operate with lower transmitter powers as administrative pricing of the spectrum encourages users to minimise their coverage areas.

Figure A5.2, also from the Autonomy Study, shows the areas where interference from France into UK mobiles could be detectable. The areas are 1,200 km² in the case of wide band systems and 7,800 km² for narrow band systems, which equate to 0.5% and 3% respectively of the total UK geographic area.

[32] The information was provided by Ofcom and relates to the number of base stations per Grid Square. For the purposes of these calculations it has been assumed that the base stations are evenly spaced geographically. We assume that this coverage is not contiguous.

[33] Information provided by Ofcom from their data base for the 450 – 470 MHz band

Figure A5.2 Areas within the UK where interference from narrow band digital PMR systems in France would be noticeable by users of wide and narrow band PMR mobiles in the UK



Source: Autonomy Study

The Autonomy Study also calculated the number of sites required to provide contiguous coverage in the co-ordination areas in Southern England and also Northern Ireland. The values differ from the figures above, which were based on the number of sites actually deployed and multiple users, because the calculations were carried out as if there was a single user in the co-ordination areas. In the case of narrow band systems in the UK for Southern / South Eastern England 39 omni-directional sites would need to be deployed rather than 14 to provide contiguous coverage, which is nearly a trebling of infrastructure costs in the 24,400 km² co-ordination area. If tri-sectored sites are used then there would be less than a doubling in the number of sites. In Northern Ireland, assuming a sterilised area of 4,800 km², 53 narrow band sites would need to be deployed rather than 5. This might significantly limit the potential for deployment of digital PMR narrow band systems in Northern Ireland. In comparison, assuming the same output ERP for wide band systems, then the number of sites in Southern England to provide contiguous coverage would need to be increased from 5 to 9. A doubling of sites in the 4,500 km² co-ordination area would therefore be necessary. In Northern Ireland, assuming a sterilised area of 4,800 km², the number of sites in the remaining co-ordination area need to increase from 10 to 29, which is a trebling of infrastructure costs.

Table A5.1 summarises the results for Southern / South Eastern England and Table A5.2 summarises the results for Northern Ireland.

Table A5.1

	Narrow band		Wide band	
	25 W ERP	Transmitter powers restricted	25 W ERP	Transmitter powers restricted
Number of sites[34]	14	39	5	9
Sterilised area	0 km²	0 km²	0 km²	0 km²
Area affected	24,400 km²		4,500 km²	

Source: Autonomy Study

Table A5.2

	Narrow band		Wide band	
	25 W ERP	Transmitter powers restricted	25 W ERP	Transmitter powers restricted
Number of sites[35]	5	53	10	29
Sterilised area	4,800 km²	4,800 km²	4,800 km²	4,800 km²
Area affected[36]	9,200 km²		9,200 km²	

Source: Autonomy Study

[34] Assumes omni-directional sites

[35] Assumes the use of tri-sectored sites

[36] Excludes the exclusion zone

Appendix 6 UHF TV

A6.1 Introduction

The transition from analogue to digital TV will release spectrum that may be used for services additional to the six multiplexes of digital TV services currently supplied. It is assumed that fourteen national channels will be released and that these channels could be used for a variety of services including mobile services. The case study addresses the costs and benefits of the UK allowing use of spectrum released by digital switchover for 3G services.

A6.2 Background

DVB standards have been set within ETSI (ETS 300 744). Coded Orthogonal Frequency Division Multiplex (COFDM) modulation has been chosen for the system, as used in the EUREKA-147 DAB specification. The choice of this technique allows the system to tolerate multi-path (reflections or 'ghosting') and permits the use of single frequency networks.

The DVB-T specification is intended for application in the existing television broadcast spectrum allocations at Band III (174-216 MHz) and Bands IV/V (470 – 860 MHz), and therefore caters for 6, 7 or 8 MHz channel spacing. As DTT will have to be introduced alongside existing analogue services, particular attention is paid in the specification to adjacent channel protection and filtering.

A European plan for terrestrial digital television services is to be decided at two sessions of a Regional Radiocommunication Conference (RRC) to be held in 2004 and 2006. The RRC is likely to plan on the basis of allotment areas, and the assumption that services will conform to the DVB-T 'mask'. Allotment areas are any areas in which a frequency has been co-ordinated and can be the area, for example, of Scotland or a much smaller area such as a specific area in London.

However, because the DVB standard allows flexibility of a wide range of parameters (modulation, coding rate, etc) it is unlikely that the UK would not be able to submit a 'paper' requirement for a DVB network that would adequately protect most other envisaged uses of the released channels. The caveat remains, however, that the utility of individual 8 MHz channels will vary on a geographical basis, with severe restraints likely on the South and East coasts. These constraints would, of course, apply equally if the channels were to be used for DVB-T.

A6.3 Autonomy Study Results for 3G TDD in Spare DVB-T Channels

The Autonomy Study concluded that it would be possible to operate a 3G TDD network on a DVB-T frequency anywhere within the corresponding DVB-T coverage area without exceeding acceptable interference levels.[37] The number of additional 3G TDD base stations required in Southern England was one. In Northern Ireland an additional 4 base stations would be required but there would also be an area of around 3,400 km² within which base stations would not be deployable. The 3G TDD network would require a bandwidth of 5 MHz

[37] The Autonomy Study assumes the use of UTRA TDD parameters.

whereas the DVB-T frequency would have a bandwidth of 8 MHz therefore it could be considered for the purposes of this Study that 37.5% of the available spectrum is not used.

The Autonomy Study also considered the approximate impact of co-ordinating 3G TDD network deployment with that of neighbouring countries if they also used the same DVB-T frequency. It is interesting to note that in this case, due to the requirement to meet cross border signal strengths that are likely to apply to 3G TDD networks, there might need to be an additional 14 base stations deployed in Southern England, compared with 32 if there are no constraints.[38] In Northern Ireland there might need to be an additional 22 base stations, compared with 28 if there are no constraints. In addition, there would be an area of around 7,000 km² along the Irish border within which base stations could not be deployed. However, when compared with the total number of sites that might be deployed in the total network, this increase in costs is probably less than 0.5% of the total network capital expenditure.

Based on these outputs, the Autonomy Study has concluded that the introduction of "a low power system into spectrum planned for high power wide area use can work well".

[38] The Autonomy Study assumes that in the unrestricted case the ERP is 160W.

Appendix 7 Short Range Devices

CEPT Recommendation 70-03 relating to the use of short range devices describes the "spectrum management requirements for SRDs relating to allocated bands, maximum power levels / magnetic fields, channel spacing and duty cycle". For the different applications there are annexes that provide information on the required parameters. The recommendation also provides information on the relevant ETSI standards. It is intended that as additional applications are developed for SRDs then additional annexes will be added to the recommendation as necessary.

Radio car keys and telemetry potentially come under the heading of "non specific Short Range Devices" for which there are a number of frequency bands identified in Rec. 70-03 including the 433 MHz band. Alarms are covered in Annex 7 and here the frequency bands are around 868 MHz.

Appendix 8 Programme Making and Special Events

A8.1 Video links

There have been no standards or harmonised allocations for analogue video links and so broadcasters procure against their own internal specifications. In the UK the key bands used by this application are: 2.39-2.69 GHz, 3.4-3.6 GHz, 5GHz, 7GHz and 10.3 GHz. To maximise use of the available spectrum, digital video link standards are being developed in ETSI and this will cover issues such as channel plans, transmitter and receiver characteristics to avoid harmful interference and optimise adjacent channel and co-site working. It is intended these links will operate in the 2025-2110 and 2200-2290 MHz bands.

ERC Report 38 provides some basic information on suitable frequency bands and antennas for different applications and some guidance on eirps. It is not an equipment standard.

A8.2 Wireless microphones

At present the main bands used by wireless microphones are: 174-216 MHz, 582-614 MHz, 766-862 MHz and 2470-2860 MHz. ERC Recommendation 70-03, in Annex 10, covers the three professional bands, which require authorisations for the use of wireless microphones (174 – 216 MHz, 470 – 862 MHz and 1785 – 1800 MHz). It specifies the maximum power (eirp), duty cycle and channel spacing. In addition there are two standards (EN 300 422 for the bands 174 – 216 MHz and 470 – 862 MHz and EN 301 840 for the digital band 1785 – 1800 MHz). These current standards quote minimum characteristics to avoid harmful interference (frequency error, carrier power, channel band width and transmitter and receiver spurious emissions).

A8.3 Harmonised tuning ranges

The use of harmonised frequency bands is now being implemented by CEPT. ERC Rec. 25-10, in Annex 2, provides a table of recommended frequency ranges with preferred sub-bands for use by audio and video SAP/SAB links. Part of the table is replicated in Table A8.1. In the case of radio-microphones the recommended bands are already used in the UK, with the exception of the 1785-1800 band. Similarly only one of the recommended bands for video links, namely 2025-2300 MHz is not currently used by PMSE services.

Table A8.1

Type of link	**Recommended Frequencies**		**Technical parameters**
	Tuning ranges	**Preferred sub-bands**	
Radio microphones	174 – 216 MHz 470 – 862 MHz 1785 – 1800 MHz	1785 – 1800 MHz	ERC/REC 70-03
Portable video links	2025-2110/2200-2500 MHz 2500- 2690 MHz 10 – 10.6 GHz	10.3 – 10.45 GHz	ERC REP 38
Mobile video links	2025-2110/2200-2500 MHz 2500- 2690 MHz 3400 – 3600 MHz		ERC REP 38
Temporary pt-pt video links	Fixed service bands 10 – 10.68 GHz 21.2 – 24.5 GHz	10.3 – 10.45 GHz 21.2 – 21.4 GHz, 22.6 – 23 GHz and 24.25 – 24.5 GHz	ERC REP 38

Source: ERC Recommendation 25-10