Consultation on the way forward for the future use of the band 872 - 876 MHz paired with 917 - 921 MHz

Consultation

Publication date:	11 August 2009
Closing Date for Responses:	3 November 2009

Contents

Section 1

Executive Summary

Introduction

1.1 Ofcom has now re-activated its programme of work on the bands 872 – 876 MHz paired with 917 – 921 MHz (the 872/917 MHz bands) following a period during which it has been on hold in view of work on other spectrum awards. Since we last consulted on the band on 11 April 2006[1] (the April 2006 Consultation) there have been some significant changes in circumstances which could impact on the way in which this band might best be released. In particular:

- We need to consider the future use of the 900 MHz band by UMTS[2] as a consequence of work in Europe on amendments to the GSM Directive, Council Directive 87/372/EEC[3] and our own work on liberalising 900 MHz[4] and the government's proposals in the Digital Britain Report[5]. The possible implications of this are that transmission power in the 917 - 921 MHz band will need to be reduced and/or that better (and consequentially more expensive) filtering will be required in at least parts of the UMTS900 band;

- Greater interest in using the band for SRD (Short Range Devices) / RFID (Radio Frequency Identity Devices).

1.2 We now consider there are two general approaches to authorising use of the 872/917 MHz bands that may be suitable:

- A full licensing approach: under which a single or limited number of licences are awarded e.g. a national wide area licence that would support a wide area / network application such as mobile broadband type use, awarded via an auction;

- A light regulatory approach: in which individual transmitters are authorised without limitation on their numbers, e.g. suitable for SRD / RFID use (either under a licence exempt regime, or under a light licensing regime).

1.3 In consequence, there now exists a more open question as to which approach to follow. The purpose of this new consultation is therefore to gather input from stakeholders that will inform our approach to the manner in which these bands should be released. In particular, we are seeking stakeholder views on:

---

[1] "Award of available spectrum: 872 - 876 MHz paired with 917 - 921 MHz" published 11 April 2006 - http://www.ofcom.org.uk/consult/condocs/872-876/872-876.pdf

[2] Liberlisation would allow the band to be used for UMTS and other technologies. For the purposes of this consultation protection of UMTS has been used to create the technical licence conditions. UMTS was chosen as it is felt to give the best proxy for the future use (i.e. if the technical conditions are set using UMTS they should also protect future technologies such as LTE). The use of UMTS aligns with the technical work carried out in the "Application of spectrum liberalisation and trading to the mobile sector consultation" published February 2009.

[3] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0762:FIN:EN:PDF

[4] "Application of spectrum liberalisation and trading to the mobile sector" published 20 September 2007 - http://www.ofcom.org.uk/consult/condocs/liberalisation/ ; and
"Application of spectrum liberalisation and trading to the mobile sector" published 13 February 2009 - http://www.ofcom.org.uk/consult/condocs/spectrumlib/

[5] See http://www.culture.gov.uk/what_we_do/broadcasting/6216.aspx and paragraphs 2.28 and 2.68 below

- The technical conditions that would need to apply to the 872/917 MHz bands, both for the full licensing approach and for the light regulatory approach;

- The candidate uses for the band and the suitability of each approach, taking account of any associated technical conditions, and the potential values associated with these candidate uses (this will help to inform our assessment of whether a full licence approach or a light regulatory approach is likely to provide greater benefits to citizens and consumers).

1.4 These issues will influence a future decision on the appropriate authorisation approach in order to provide any necessary protection to existing and future adjacent band users e.g. GSM900 and UMTS900 services.

Technical conditions under a full licensing approach

1.5 Our current technical analysis is based on the initial view that, in order to comply with the EC Directive amending the current GSM Directive, the power limit in the 917 – 921 MHz band needs to be set at a level that would not unduly hinder use of the neighbouring spectrum for UMTS900.

1.6 In the band 872 – 876 MHz we propose that devices with performance equivalent to a current GSM mobile station[6] will give sufficient protection to adjacent band services.

1.7 Our technical analysis shows that if standard performance, as described in A6.62 – A6.62, is applied to a UMTS base station receive channel at 910 – 915 MHz (as with other UMTS900 channels), then the power level in the 917 – 921 MHz band would need to be restricted to a level lower than the levels previously consulted upon. We propose these powers could be in the range of 19 – 27 dBm EIRP. An alternative approach would be for the 910 - 915 MHz UMTS base station to be fitted with improved filtering, as described in A6.69. This would afford better protection from signals in the band 917 - 921 MHz and therefore allow higher powers in the 917 – 921 MHz band (A6.65 to A6.71 sets out an example that would allow 50dBm EIRP).

1.8 Higher power use of the 872/917 MHz bands could increase the value of this band but at the cost of requiring improved filtering of UMTS900 base stations. If this increased value is greater than the cost of the improved filtering needed, then allowing higher power use should be considered. In this case, we would also need to consider where the potential additional cost of improved filtering of UMTS base stations should fall (on the 872/917 MHz band operator or the future UMTS900 operator).

Technical conditions under a light regulatory approach

1.9 For a light regulatory approach, Ofcom's initial view is that, because of the fragmented nature of deployment this approach might encourage (i.e. the potential for multiple licensees to be distributed more or less randomly across the country), the only viable option would be for the 872/917 MHz band users to bear the burden of protecting adjacent users. This is likely to be best achieved through the technical constraints imposed. If viable technical constraints imply that relatively large separation distances are necessary in order to protect adjacent band users then our

[6] 3GPP TS 45.005 3rd Generation Partnership Project;
Technical Specification Group GSM/EDGE Radio Access Network; Radio transmission and reception (Release 8), http://www.3gpp.org/specifications

preference should be for a light licensing approach. On the other hand, if the separation distances are relatively small, then our preference should be for a licence exemption approach.

1.10 We have conducted an initial technical analysis to derive the possible technical conditions that could support SRD/RFID use of the band. This analysis is provisional as the characteristics for SRD / RFID have been taken from the ETSI system reference documents[7] [8] that set out ETSI's proposals for this type of service and are still under consideration in Europe.

1.11 We consider that the use of the band for applications such as SRD / RFID is feasible under a light regulatory approach, it should be possible to adopt a licence exempt approach for SRDs. But potential interference into GSM900, GSM-R and UMTS900 base stations from RFID devices may be a factor to be taken account of when deciding whether RFIDs should be licence exempt or light licensed.

1.12 Ofcom has made provisional estimates of approximate separation distances from an RFID installation to cellular base stations and GSM-R mobile stations. This analysis will require further assessment as and when the relevant equipment characteristics become better known. As noted above, further technical analysis on the size of the separation distances will influence which type of light regulatory approach may be appropriate

Timing

1.13 Ofcom invites written views and comments on the issues raised in this document, to be made by 5pm on 3 November 2009.

[7] TR 102 649-1 V1.1.1 (2007-04) Technical Report, Electromagnetic compatibility, and Radio spectrum Matters (ERM); Technical characteristics of RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) equipment; Part 1: RFID equipment operating in the range from 865 MHz to 868 MHz.

[8] ETSI TR 102 649-2 V1.1.1 (2008-09), Technical Report, Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRD and specific SRD.

Section 2

Introduction

2.1 In this section we cover the following:

- Background to this consultation;
- Reasons for protecting existing uses of adjacent bands and possible future UMTS900 services;
- An overview of the generic authorisation approaches ("full licensing approach" and "light regulatory approach");
- Description of the 872 - 876 MHz / 917 - 921 MHz bands;
- European and CEPT developments;
- Future use of adjacent bands;
- Statutory powers and spectrum management; and
- Citizen and consumer considerations.

Background

2.2 We first outlined our approach to the use of the 872/917 MHz bands in the Spectrum Framework Review: Implementation Plan (SFR:IP)[9], issued on 13 January 2005. The conclusions to this work were discussed in the Spectrum Framework Review: Implementation Plan – Interim Statement published on 28 July 2005[10] and indicated that a further consultation would be published which would discuss the technical issues.

2.3 On 11 April 2006 we issued a consultation[11] "the April 2006 Consultation" on whether, when and how Ofcom should award a licence for the 872 – 876 and 917 – 921 bands (the 872/917 MHz bands). The Consultation considered:

- The method of assignment – licensed or licence exempt;
- The award mechanism;
- The award design and timing; and
- The number of licences and geographical coverage.

2.4 The April 2006 Consultation proposed, based on the analysis of our statutory duties, auction design, market demand at the time and technical and co-ordination requirements to hold a single round sealed bid, second price auction in early 2007 for the award of an indefinite (minimum 15 years), tradable, technically defined,

[9] See http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/sfr-plan.pdf .
[10] See http://www.ofcom.org.uk/consult/condocs/sfrip/statement/statement.pdf
[11] "Award of available spectrum: 872 - 876 MHz paired with 917 - 921 MHz" published 11 April 2006 - http://www.ofcom.org.uk/consult/condocs/872 - 876/872 - 876.pdf

single national wireless telegraphy licence to use the spectrum band 872 - 876 MHz paired with 917 - 921 MHz with a minimum reserve price set at £50,000.

2.5 Twelve responses were received to the consultation (9 public and 3 confidential (1 part confidential)). There was limited support for our proposal, but overall the general view in the responses to the April 2006 Consultation was that we should not award the licence as proposed because:

- of the potential for interference to adjacent bands (e.g. GSM and GSM-R); or, conversely;
- that we were restricting the 872/917 MHz bands too greatly (by requiring to protect the adjacent bands and, as a result, not making optimal use of the 872/ 917 MHz bands).

2.6 Full details of the April 2006 Consultation and the responses received can be found in Annex 5.

2.7 Since we published the April 2006 Consultation the factors that need to be taken into account have changed. In addition to the proposed need to protect existing use of the bands adjacent to the 872/917 MHz bands (e.g. GSM and GSM-R) we are also proposing that we now need to consider protecting future UMTS900[12] use in these adjacent bands. A possible consequence of this, we now suggest, is that the power limits we previously proposed may need to be amended (possibly reduced). We further suggest that any such reduction in power limits would be likely to lead to a reduction in the value that can be created by use of the bands under a full licensing approach. In addition, interest in alternative uses of the bands (e.g. by SRD / RFID) has increased and may have a potentially greater economic value.

2.8 On 3 April 2008 we published "Progress on key spectrum initiatives – A review and update of the SFR and SFR:IP[13]". In this we compared the progress made with that suggested in the SFR and, where appropriate, provided revised plans and timescales. That document (Table 3.2) provided a revised timescale of FY 2008 – 2009 for the award of the bands 872 – 876 MHz / 917 – 921 MHz. However we subsequently took the decision to put work on this band on hold in light of other spectrum priorities.

2.9 We are now seeking updated views from stakeholders on what the best use of the 872/917 MHz bands might be in light of the proposed technical considerations and whether they should be authorised on the basis of a full licensing or light regulatory approach.

2.10 Since our first consultation on the 872/917 MHz bands we have published two consultations[14] on proposals to liberalise the spectrum currently used to provide 2G services to allow 3G services. The aim of these consultations is to facilitate use of

[12] Liberlisation would allow the band to be used for UMTS and other technologies. For the purposes of this consultation protection of UMTS has been used to create the technical licence conditions. It was chosen as it is felt to give the best proxy for the future use and aligns with the technical work carried out in the "Application of spectrum liberalisation and trading to the mobile sector consultation" published February 2009.

[13] http://www.ofcom.org.uk/radiocomms/sfr/sfrprogress/sfrprogress.pdf

[14] "Application of spectrum liberalisation and trading to the mobile sector" published 20 September 2007 - http://www.ofcom.org.uk/consult/condocs/liberalisation/ ; and
"Application of spectrum liberalisation and trading to the mobile sector" published 13 February 2009 - http://www.ofcom.org.uk/consult/condocs/spectrumlib/

wideband mobile services such as UMTS900 in bands currently reserved for 2G services including the bands 880 – 915MHz paired with 925 – 960 MHz. The technical work carried out in 2006 for the April 2006 Consultation did not take into account the possible need to protect this type of service.

2.11 In Section 4 of this consultation we detail the technical analysis we have carried out with a view to the protection of adjacent services to this band and propose possible technical conditions.

2.12 Our technical analysis in Annex 6 shows that if UMTS base stations using the band 910 – 915 MHz (base receive) are deployed with standard filtering (as described in Table 14) as would be deployed in channels between 880 – 910 MHz, then the power level in the 917 – 921 MHz band would need to be restricted to a lower level than the levels previously consulted upon. An alternative approach would be for base stations using the band 910 - 915 MHz to be fitted with improved filtering. This would afford the UMTS base stations better protection from adjacent band interference and therefore allow higher powers in the 917 – 921 MHz band.

2.13 If the power levels in the 917 - 921 MHz band are restricted to a low power, this may mean that a licensed national network in the 872/917 MHz bands is less viable, and that the value of the 872/917 MHz bands for licensed use may now be smaller than we had previously assumed. We have therefore considered other potential uses for the bands. The details of our current understanding of the potential uses are contained in Section 3.

2.14 A key development directly related to this issue is the amendment of the existing European GSM Directive, expected to come into force in around October this year. This will require us to make the entire 900 MHz band available for UMTS (as well as GSM and possibly other technologies).

2.15 Other applications that could make use of the 872/917 MHz bands include SRD and RFID. These uses have been proposed by ETSI in their System Reference Document TR 102 649-2[15] and are currently under consideration within CEPT. Additionally, work within CEPT is also considering the 872/917 MHz band for GSM-RE.[16]

2.16 We note that the work in Europe is still some way from being finished but, despite its outcome, there may be an advantage for the UK to use 917 – 921 MHz band for RFID as this is the band many RFID tags are currently optimised for rather than the current European band 863 – 870 MHz.

2.17 This consultation seeks stakeholders' views, in particular on the revised proposed technical conditions and on the most appropriate approach to making the bands available.

[15] ETSI TR 102 649-2 V1.1.1 (2008-09), Technical Report, Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRD and specific SRD.

[16] ETSI TR 102 627 V1.1.1 (2008-11), Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Land Mobile Service; Additional spectrum requirements for PMR/PAMR systems operated by railway companies (GSM-R).

Reasons for protecting existing uses of adjacent bands and possible future UMTS900 services

2.18 Ofcom considers that there is a need to protect existing GSM use and possible future UMTS 900 services, in the adjacent bands. Ofcom's initial view is that this is most likely to comply with our statutory duties and international obligations, including those derived from European legislation and, as far as possible, to secure optimal use of the relevant spectrum.

2.19 Currently the GSM Directive reserves the 900 MHz band for GSM use and requires that Member States shall make available "the whole of the 900 MHz band" for GSM systems for "public pan-European cellular digital mobile communications service[s]". It is to be amended, from around October, to remove the limitation on the use of the 900 MHz band to one service only and thereby open up the band to additional technologies.[17] In particular, this is to enable UMTS services to be deployed in the existing GSM spectrum allocations (880 - 915 MHz and 925 - 960 MHz (the 900 MHz band) and 1710 - 1785 MHz and 1805 - 1880 MHz (1800 MHz band))[18].

2.20 This amendment to the GSM Directive will be binding on the UK, and its implementation in the UK is mandatory. The changes set out in the GSM Directive form the background for Ofcom's published proposals for the 900MHz band in the 2009 Liberalisation Consultation.

2.21 The purpose behind the amendment to the GSM Directive is to allow the 900 MHz band to be used by other technologies than GSM, as there is a clear international recognition that to restrict its use to GSM is not in the best interests of consumers across the EU.

2.22 In addition to amending the GSM Directive, the European Commission mandated CEPT on 15 June 2009 to:

- Verify whether there are other technologies besides LTE developing equipment for 900/1800 MHz that would need to be studied concerning their coexistence with GSM at this stage;
- Study the technical conditions under which LTE technology can be deployed in the 900/1800 MHz bands; and
- Investigate compatibility between UMTS and adjacent band systems above 960MHz: Noting that compatibility with systems outside the 900/1800 MHz bands will be studied for LTE.

2.23 The purpose of the Mandate[19] is to contribute to putting into practice the concept of flexibility as advocated in the Opinion of the Radio Spectrum Policy Group (RSPG) on Wireless Access Policy for Electronic Communications Services (WAPECS), by developing least restrictive technical conditions which are sufficient to avoid harmful

[17] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0762:FIN:EN:PDF
[18] As well as for other potential terrestrial systems capable of providing electronic communications services, providing that they can co-exist with GSM and UMTS systems for example LTE or WiMAX. The amended GSM Directive will be accompanied by an RSC Decisions which will require Member States similarly to liberalise the 1800MHz band,
[19] Available at www.ero.dk The mandate is located in the ECC Activities folder under Meeting Documents, ECC 2009, 23 Douglas/Isle of Man – UK 2009, Meeting Document, Input Documents, ECC(09)056R1.

interference in the frequency bands that have been tentatively identified by the RSC for the implementation of the WAPECS approach. The result of the mandate will be a report to be delivered by 24 June 2010.

2.24 A second relevant factor is that new services, or increased capacity for existing services, represent a potentially valuable innovation and the development of a new market and/or advancement of existing markets for mobile communications. This would be another reason for considering the likelihood of the provision of future UMTS900 services and the possible need to protect them (and other services in the same band).

2.25 The importance of a liberalised 900 MHz band as a key part of a "Wireless Spectrum Modernisation Program" and its relationship with a "Broadband Universal Service Commitment" is underlined in the Government's recent Digital Britain report. For instance the report states that, "The mobile networks (3G and Next Generation Networks) could significantly extend their reach, at lower cost, if they used radio spectrum below 1 GHz."

2.26 We therefore propose that there is a need to protect the existing GSM and likely future uses (including UMTS) of the adjacent bands so as to comply with our statutory duties and international obligations, and to secure our objectives for the relevant spectrum (as set out in this document).

2.27 A consequence of this is that the power limits we previously proposed may need to be amended (reduced). We further suggest that this would be likely to lead to a reduction in the possible value that can be created by a full licensing approach to the 872/917 MHz bands.

2.28 In addition, interest in alternative uses of the bands (e.g. by SRD/RFID) has increased, and may now have a potentially greater value.

2.29 These points could in turn affect the judgement of whether the best use of these bands would be for applications under a full licensing approach or whether it might be better for users whose lower power requirements and/or other characteristics make them more suited to a light regulatory approach[20] such as SRD and/or RFID. We also note that new work has begun on SRD / RFID in CEPT which could influence the decision on the best use of this band.

2.30 Alternatively, it may be possible to use higher power limits within the 872/917 MHz bands under a full licensing approach, whilst still meeting the proposed need to protect GSM and UMTS services in the 900 MHz band. But, this would require either future UMTS900 services utilising improved filtering (which is potentially more expensive) on their base stations, and/or high levels of co-ordination would be needed between 872/917 MHz and UMTS900 users.

2.31 At present, however, we do not have information that would enable us to decide whether such a course would represent best use of the relevant spectrum in line with our statutory duties. So, we are asking stakeholders to provide us with information to support any view they take that the value of such higher power use would:

- more than offset the cost of coordination / mitigation; and/or

[20] We acknowledge that, in any event, Section 8 of the Wireless Telegraphy Act 2006 contains powers and duties in relation to licence exemption that we will consider further (see Section 5 of this document).

- likely result in higher value use of the 872/917 MHz bands than under a light regulation approach.

We also propose to consider further where any such costs of coordination/mitigation should be borne, bearing in mind our statutory duties. Stakeholders' comments on that are also welcome. Section 5 considers these issues further.

2.32 The proposed revised technical constraints set out in Section 4 and Annex 6 of this document indicate the technical constraints for licensed use of the 872/917 MHz bands necessary to provide the proposed protection of the adjacent bands. We will review our assessment of the appropriate technical constraints and power limits in light of responses to this consultation, amongst other things.

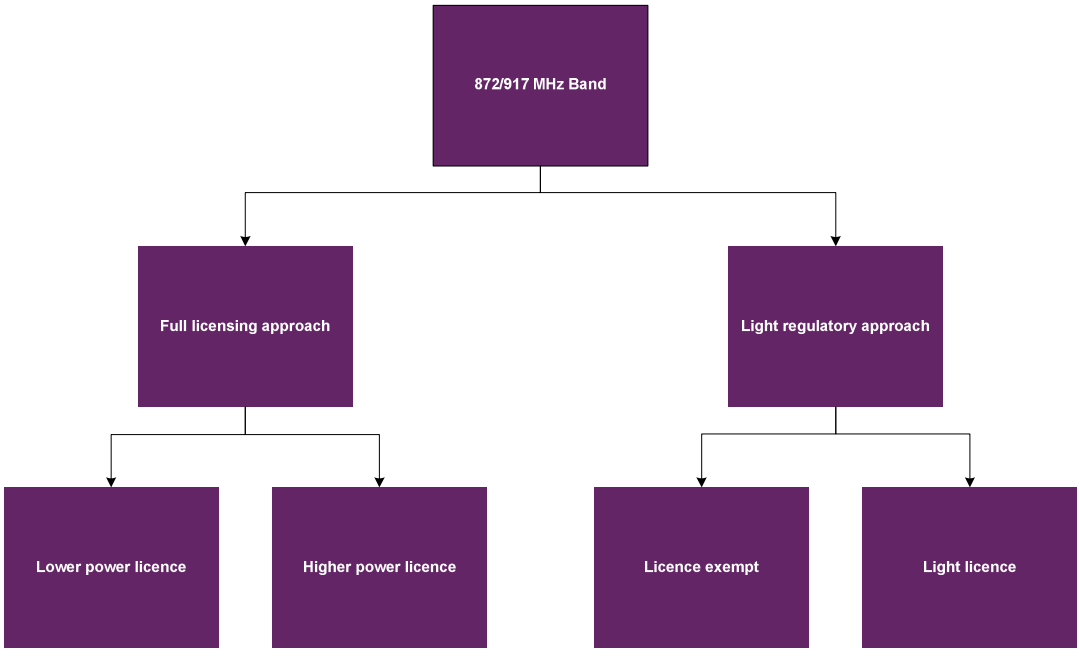
Authorisation approaches

2.33 We are aware of a number of potential uses of the 872/917 MHz bands; these potential uses have quite different characteristics that would need different and possibly mutually incompatible approaches to authorisation as follows:

- A full licensing approach: under which a limited number of licences are awarded e.g. a national wide area licence suitable for mobile broadband type use awarded via an auction;

- A light regulatory approach: in which individual transmitters are authorised without limitation on their numbers, e.g. suitable for SRD / RFID use (either under a licence exempt regime, or under a light licensing regime).

Figure 1: Potential ways to release the 872/917 MHz band



2.34 Since the April 2006 Consultation it has become clear that there is interest in the 872/917 MHz bands from a number of differing applications.

2.35 Ofcom is not in a position at present to make a judgement on the most appropriate authorisation route. We therefore invite stakeholders to indicate their preferred option, with supporting evidence for their view.

2.36 The potential uses for which a full licensing approach might be appropriate include:

- mobile broadband;
- digital PMR/PAMR; and
- GSM-R.

2.37 The potential uses for which a light regulatory approach might be appropriate include:

- SRD; and
- RFID.

2.38 There is also a third group of potential applications for which the choice of appropriate authorisation route depends on the technical nature of the application i.e. how much protection it requires, and its ability to co-exist with other applications etc. Examples of this include:

- Telemetry;
- meter reading; and
- Unmanned Aerial Vehicles.

2.39 The uses described above are discussed in more detail in Section 3.

2.40 We believe that it is likely that the full licensing and light regulatory approaches will be mutually exclusive (e.g. if the band were awarded under a full licensing approach for mobile broadband use it is very unlikely that we could also authorise SRD under a light regulatory approach without either, there being unacceptable interference between the two uses, or, the technical conditions needed to protect one use from the other being so restrictive as to make that use un-viable).[21]

Description of the 872 - 876 MHz / 917 - 921 MHz bands

2.41 The 872/917 MHz bands consist of 2 x 4 MHz of spectrum with a 45 MHz duplex gap, (i.e. 872 - 876 MHz paired with 917 - 921 MHz) and are available nation wide. This spectrum is adjacent to the GSM900 band. It is free of incumbent users and is thus available immediately to support new uses.

2.42 Two ECC Decisions are relevant to this band: ERC/DEC/(96)04[22] on the frequency bands for the introduction of TETRA; and ECC/DEC/(04)06[23] on the availability of

[21] Although we will also consider whether there are licence exempt uses we are required by section 8 of the WTA 2006 to permit and which can sit alongside any other applications under either a full licensing or light regulatory approach because they do not cause undue interference to wireless telegraphy

[22] http://www.erodocdb.dk/Docs/doc98/official/pdf/DEC9604E.PDF

[23] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCDEC0406.PDF

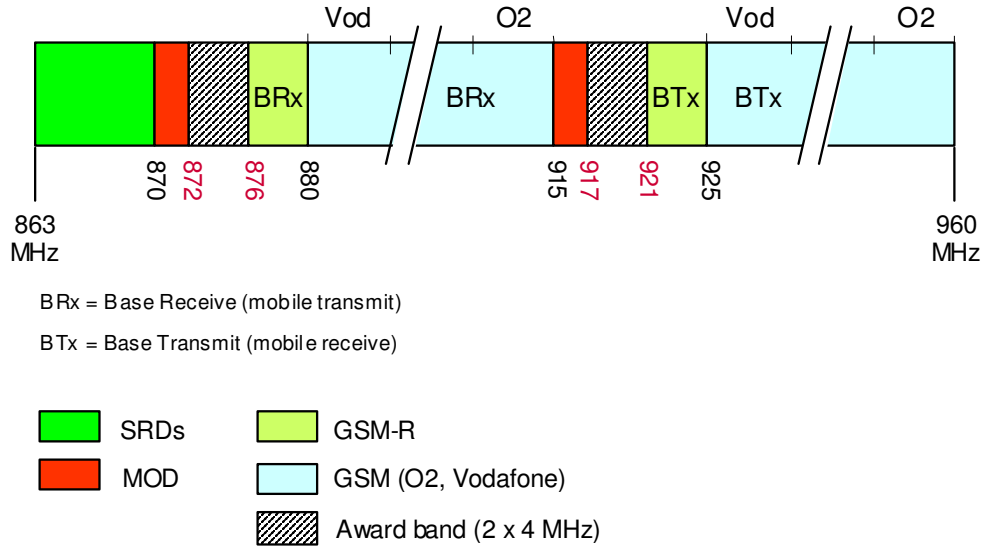
frequency bands for the introduction of wide band digital land mobile PMR/PAMR systems in the 400 MHz and 800/900 MHz bands. The UK has not adopted either of these ECC Decisions.

2.43 A number of technologies are used in the bands adjacent to the 872/917 MHz bands under consideration, namely:

- Below 915 MHz - GSM uplink;
- Above both 876 MHz and 921 MHz – UIC (GSM-R);
- Below 872 MHz – military use;
- Below 870 MHz – Short Range Devices.

2.44 Figure 2 below provides an illustrative band plan of the frequency allocations above and below the 872/917 MHz bands:

Figure 2: Spectrum use in the neighbourhood of the 872/917 MHz bands.



2.45 Our proposal is that any future use of the 872/917 MHz bands should take into account the need to protect existing and new future services (including UMTS900), in the adjacent bands, from harmful interference.

2.46 Several adjacent band compatibility studies have been conducted in CEPT PT SE7[24] [25] [26] [27] (all these studies are available on the ERO website www.ero.dk) and, where appropriate, we have taken account of these studies in our own analysis.

[24] ECC report 38, The techical impact of introducing CDMA-PAMR on the UIC DMO and GSM-R Radio systems in the 900 MHz Band. Granada February 2004.
[25] ECC Report 41, Adjacent band compatibility between GSM and CDMA-PAMR at 915 MHz Granada, February 2004.
[26] ECC report 82, Compatibility study for IMT-2000 operating within the GSM 900 and GSM 1800 frequency bands Roskilde, May 2006.
[27] ECC report 96 Compatibility between IMT-2000 900/1800 and systems operating in adjacent bands, Krakow, March 2007.

European developments

2.47 Across Europe a number of Administrations have authorised the deployment of mobile broadband networks in the 872/917 MHz band. Although to date networks have not been rolled out intensively in urban areas, coordination with established GSM operators has not been reported as a difficulty.

2.48 There is a possibility that CEPT may recommend use of this band for SRD/RFID or GSM-R, although such a proposal would only be voluntary and non mandatory on the UK (and the other CEPT Member States) to implement. This Decision could be based on the existing ECC Decision of 19 March 2004 on the availability of frequency bands for the introduction of Wide Band Digital Land Mobile PMR / PAMR in the 400 MHz and 800/900 MHz bands – ECC/DEC/(04)06[28].

CEPT developments

2.49 In July 2008 CEPT WGFM issued a questionnaire to Member States which was sent out in response to ETSI System Reference Document (SRDoc)[29] TR 102 649-2 on additional spectrum for RFID and SRD at UHF band (870 – 876 MHz and 915 – 921 MHz) . Twenty-six Administrations replied to the questionnaire. These responses can be found in document FM(08)098Rev1 available on the European Radio Office (ERO) website (www.ero.dk - in the ECC Activities Documents section under: FM Working Group; 2008; Baku; September; Input Documents; FM(08)098Rev1).

2.50 The results from the CEPT questionnaire showed that the two bands are predominantly designated in CEPT countries for digital land mobile applications in accordance with ERC/DEC(96)04 and ECC/Dec(04)06, particularly to the PMR/PAMR type of applications. Most of the Administrations replied that due to existing use it is not possible to consider the band for SRD or RFID at present.

2.51 At the meeting of CEPT WGFM in Baku, 22 – 26 September 2008, it was argued that there are a number of other users in these bands and that actual use of these bands within CEPT countries needs to be fully investigated before considering the SRDoc and the request by ETSI[30]. WGFM proposed that a monitoring exercise be carried out to get a better understanding of the current activity in the existing licence exempt bands. This work is ongoing.

2.52 These issues have been further discussed by CEPT WG FM PT22 at their meeting on 31 March – 3 April 2009. WG FM PT22 has been asked to carry out a monitoring campaign in the frequency range 863 - 870 MHz and propose that their monitoring campaign should be continued for at least a further 6 months. The goal is to deliver additional input on measurement methodology as well as measurement data for comparison.

2.53 Any future compatibility study carried out by CEPT project team SE24 will be of interest as it will allow us to assess the benefits of these devices at a technical level,

[28] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCDEC0406.PDF
[29] www.ero.dk - in the ECC Activities, Documents section under FM Working Group / 2008/ Brussels May / Input Documents / FM(08)048Rev01.
[30] ETSI TR 102 649-2 V1.1.1 (2008-09), Technical Report, Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRD and specific SRD.

but without the harmonisation of the band across Europe the ETSI SRDoc TR 102 649-2 proposal for additional spectrum for RFID and SRD at UHF band (870 – 876 MHz and 915 – 921 MHz) is unlikely to be adopted.

Ofcom involvement in the CEPT process

2.54 Ofcom have responsibility for the management and licensing in the UK of the civil radio spectrum. The UK works closely with regulatory agencies and stakeholders in other countries, particularly in Europe. In pursuing a multilateral approach, we have in particular been working with the European Conference of Postal and Telecommunications Administrations (CEPT www.cept.org) and its Electronic Communications Committee (ECC) which is the top level body considering issues of spectrum standards and regulation.

2.55 The ECC makes Recommendations and Decisions on spectrum usage. The Recommendations and Decisions are not mandatory for Member States but, when implemented, form the basis for an approach that Member States could (and preferably should from a harmonisation approach) take to spectrum usage across the whole of Europe, not just the European Union.

2.56 We have a statutory obligation to represent the UK in the CEPT (with some exceptions) and the spectrum committees of the European Union (EU). We are also involved in several other EU international organisations (e.g. the European Telecommunication Standardisation Institute (ETSI)), in pursuit of our objectives and the interests of Government and our stakeholders.

2.57 We support the introduction of new services that provide benefits to citizen and consumers and this has been the guiding principle for our engagement with CEPT on this subject.

2.58 Before we can take a decision as to whether and how to proceed in our decision making process for the 872/917 MHz bands and whether to adopt a non mandatory ECC requirement, we need to take steps to ensure that any planned introduction and implementation is technically and legally robust, defensible and in accordance with our statutory and regulatory duties.

2.59 The ECC also works closely with the European Commission in support of its role in implementing various communication Directives. The European Commission's Radio Spectrum Committee (RSC) is empowered to make Decisions which are binding legal obligations on Member States and which Ofcom must acted in accordance with.

Mobile liberalisation

2.60 In the Mobile Liberalisation consultation 2009[31] (section 2.12) it was stated that mobile communications play an important role in any modern society and economy. In the UK, the mobile sector is now larger by revenue than the fixed voice and fixed broadband sectors combined, with total retail revenues of £15.1bn in 2007. We estimated that in 2007 84 per cent of people aged 8 or over used, or had access to, mobile services, and that mobile accounted for 51 per cent of UK household spend on telecoms. Mobile services are also a critical input for business, with mobile communications now a vital element in an increasingly services-based economy.

[31] "Application of spectrum liberalisation and trading to the mobile sector" published 13 February 2009 - http://www.ofcom.org.uk/consult/condocs/spectrumlib/

2.61 Liberalisation is a critical part of our spectrum management framework and we consider that liberalisation would be likely to lead to significant benefits for mobile network operators, consumers, citizens and the environment in terms of provision of mobile broadband services.

2.62 The Mobile Liberalisation consultation 2009 built on Ofcom's previous liberalisation consultation "Application of spectrum liberalisation and trading to the mobile sector" published on 20 September 2007[32]. This consultation considered the benefits of liberalisation and looked at the measures that we could take to implement the then draft RSC Decision[33].

2.63 Ofcom published a further consultation on 13 February 2009[34] (the 2009 Liberalisation Consultation) that expands on our proposals to liberalise the 900 MHz and 1800 MHz bands.

2.64 Due to the adjacency of the 872/917 MHz bands to the 900 MHz spectrum considered in the 2009 Liberalisation Consultation, stakeholders may wish to note the options proposed in the 2009 Liberalisation Consultation, and responses received, alongside those in this consultation.

Digital Britain

2.65 The Government on 29 January 2009 published the Interim Digital Britain Report. This set out a spectrum modernisation programme to address a range of key issues in the transition to next generation mobile services in the UK. Following this, in February 2009, the Government appointed an Independent Spectrum Broker (ISB) to determine whether a series of market led spectrum trades between operators could be achieved to facilitate this objective. The ISB published his conclusions in a report and accompanying statement on 13 May 2009.

2.66 On 16 June 2009 the Government published "The Digital Britain Report (White Paper) [35]". This builds on the initial Interim Digital Britain Report and responds to the proposals put forward in the ISB Report. In particular, the report sets out the Government's intention (subject to ongoing technical arbitration work) to adopt the ISB's proposal that the 900MHz band should be liberalised in the hands of the existing licensees.

2.67 The Digital Britain Report details the government's strategic vision for maximising the social and economic benefits of digital technology and how it would drive future industrial competitiveness.

2.68 In considering the proposals and questions in this consultation and responding to them, stakeholders may wish to consider the proposals put forward by Government on its plans for Digital Britain[36] and the Report from the ISB[37].

[32] "Application of spectrum liberalisation and trading to the mobile sector" published 20 September 2007 - http://www.ofcom.org.uk/consult/condocs/liberalisation/
[33] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0762:FIN:EN:PDF
[34] "Application of spectrum liberalisation and trading to the mobile sector" published 13 February 2009 - http://www.ofcom.org.uk/consult/condocs/spectrumlib/
[35] http://www.culture.gov.uk/what_we_do/broadcasting/6216.aspx
[36] http://www.culture.gov.uk/what_we_do/broadcasting/5631.aspx/
[37] http://www.culture.gov.uk/reference_library/publications/6147.aspx

Ministry of Defence (MOD) use of the 800/900 MHz Spectrum Bands

2.69 On 5 December 2008 the MOD published "UK Defence Spectrum Management – A Statement on: An Implementation Plan for Reform[38]". In this Statement the MOD sets out how it plans to reform UK Defence spectrum management in 2008 - 2012, and plans to extend market principles to the MOD's use of the radio spectrum.

2.70 Section 4 of the MOD's document looks at how the MOD plans to introduce and take advantage of market mechanisms and release spectrum and details the relevant dates as to when it plans to ask Ofcom to make the necessary Recognised Spectrum Access (RSA) regulations for specific bands.

2.71 Table 2 in the MOD document indicates that the MOD will ask Ofcom to make RSA regulations for 870 - 872 MHz and 915-917 MHz by March 2012. Table 3 summaries the MOD's priority and timetable for when it aims to release some spectrum from within 870 – 872MHz and 915 – 917 MHz bands to the market.

2.72 The MOD may change the phasing and timetable for asking Ofcom to make the regulations needed for grants of RSA and the MOD's timetable may therefore be subject to adjustment. If the MOD changes the plans that are set out in its December 2008 Statement, for example if it decides to alter the priority of releasing or sharing bands in response to changes in military or civil demand, it may publish further information on these issues.

2.73 Given the adjacency of the MOD bands to the 872/917 MHz bands stakeholders may want to consider the potential uses that may be introduced in the MOD bands and the potential impact this may have on the 872/917 MHz bands.

The Regulatory and Spectrum Management Context

2.74 The following sub-sections describe our main statutory powers and duties in relation to spectrum management and our approach in carrying them out. These informed the April 2006 Consultation and are relevant for this consultation and will inform our further work in this matter.

Statutory powers and duties

2.75 We have powers under the Wireless Telegraphy Act 2006 (WT Act 2006)[39] to grant licences for wireless telegraphy and, if we consider it appropriate, to do so through an auction. Our specific duties in relation to the award of Licences are set out in the WT Act 2006, and are derived from the requirements of European Union (EU) legislation.

2.76 In exercising our powers to manage spectrum, we are required to meet a number of general and specific statutory duties and to take into account other considerations. Annex 10 sets out our statutory duties in more detail.

[38] http://www.mod.uk/NR/rdonlyres/40622FC9-DC7B-40FC-B48A-90408F6F7676/0/spectrumstatement_051208.pdf
[39] http://www.opsi.gov.uk/Acts/acts2006/ukpga_20060036_en_1

2.77 In particular, under the Communications Act 2003 (the 2003 Act)[40] (Section 3(1)) it is a principal duty of Ofcom, in carrying out its functions to:

- further the interests of citizens in relation to communications matters; and
- further the interests of consumers in relevant markets, where appropriate by promoting competition.

2.78 In doing so, we are required to secure a number of more specific things. They include, amongst other things, securing the optimal use for wireless telegraphy of the spectrum. They also include ensuring that a wide range of electronic communications services is available throughout the UK.

2.79 In addition, in exercising our powers to manage the spectrum, we are required to take into account other considerations. These include the need to have regard to

- the desirability of promoting competition;
- the different needs and interests of all users or potential users of spectrum;
- the extent to which the spectrum is available for use or further use;
- the demand for use of spectrum;
- the likely future demand for spectrum;
- the efficient management and use of the spectrum;
- the economic and other benefits that may arise from the use of wireless telegraphy;
- the development of innovative services; and
- competition in the provision of electronic communications services.

2.80 We also have duties relating to European Community obligations. These are especially relevant here because of the amendments to the GSM Directive described above.

2.81 Section 4 of the 2003 Act requires Ofcom to act in accordance with the "six community requirements" set out in that section when managing the wireless spectrum in the UK. Of particular relevance are the following:

- the requirement to promote competition (section 4(3));
- the requirement to secure that Ofcom's activities contribute to the development of the European internal market (s4(4));
- the requirement to promote the interests of all persons who are citizens of the European Union (s4(5));
- the requirement to act, so far as practicable, in a 'technology neutral' way (section 4(6)); and

- the requirement to encourage such compliance with international standards as is necessary for- (a) facilitating service interoperability; and (b) securing freedom of choice for the customers of communications providers (section s4(9) and (10)).

2.82 If there is a conflict between Ofcom's various duties, those under section 4 of the 2003 Act will prevail over each of the others.

2.83 Directly related to these specific duties and considerations, we must also consider the Regulatory Principles of:

- seeking the least intrusive regulatory mechanisms to achieve our policy objectives;
- researching markets constantly and aiming to remain at the forefront of technological understanding; and
- consulting widely with all relevant stakeholders and assess the impact of regulatory action before imposing regulation upon a market.

2.84 Also relevant is that when Ofcom impose terms, provisions or limitations on a wireless telegraphy licence we must be satisfied they are:

- objectively justifiable in relation to the networks and services to which they relate;
- not such as to discriminate unduly against particular persons or against a particular description of persons;
- proportionate to what they are intended to achieve; and
- in relation to what they are intended to achieve, transparent.

Approach to spectrum management

2.85 We have set out our approach to spectrum management, in fulfilment of the above powers and duties, in the Spectrum Framework Review Statement[41] published on 28 June 2005. Its central theme is that the management of the radio spectrum can be carried out most effectively through the use of market forces. In summary, we consider that this approach will:

- promote efficient use of the radio spectrum by allowing spectrum to be transferred to, and used by, the user who values it most highly;
- promote competition by increasing the availability of spectrum for use by the most valuable service; and
- facilitate economically valuable innovation as new users enter the market to offer new services.

[41] http://www.ofcom.org.uk/consult/condocs/sfr/sfr/sfr_statement

2.86 This approach is primarily implemented by us through the development and delivery of three policies:

- spectrum trading;
- spectrum liberalisation; and
- prompt release of unused or under-used spectrum into the market, allowing maximum flexibility for its subsequent use.

2.87 Our proposals in the April 2006 Consultation and the proposals in this consultation are based on the fulfilment of the above duties within the framework of this approach to spectrum management. It is not Ofcom's objective to raise revenue by means of spectrum auctions nor, given our statutory duties, is this a consideration that we would take into account.

Citizen and consumer interest

2.88 One aspect of the above duties worth specific comment is that relating to the citizen and consumer interest.

2.89 Our starting proposal is that releasing available spectrum into the market is likely to further the interests of citizens and consumers as it is could offer opportunities for additional capacity for existing services and/or provide spectrum for additional innovation and competitive services. In other words, releasing spectrum is likely to promote competition.

2.90 We begin with the proposed position that so long as there is any reasonable prospect of the spectrum coming into use, with benefits greater than the administrative costs of release, it would not be in the interests of citizens and consumers to leave the spectrum unavailable. This, however, is of course subject to complying with our legal duties and evaluating and seeking to secure, as far as possible, the optimal use of the spectrum as a whole (or at least across all relevant/potentially affected or linked bands).

Optimal spectrum use and competition

2.91 We also have particular regard, to the extent it will apply, to our duty to secure optimal use of the spectrum and its relationship with our duty to further the interests of consumers by promoting competition. In doing so we are seeking, to the extent possible, to reach a position that combines optimal use of the spectrum and the promotion of competition where appropriate.

2.92 We are therefore mindful that the need to secure optimal use of the spectrum means optimal use of all frequency bands, not just individual specific bands. In relation to this award it means, in particular, optimal use of the 872/917 MHz bands and the adjacent bands, not just one or the other.

2.93 Most relevant, we propose, because of the adjacency of the 872/917 MHz bands to the 900 MHz spectrum considered in the consultation "Application of spectrum liberalisation and trading to the mobile sector[42]" published on 13 February 2009, this means consideration must be paid to the use and significance of the adjacent bands

[42] http://www.ofcom.org.uk/consult/condocs/spectrumlib/

and the effect on them of assigning the 872/917 MHz bands in particular ways. This, in our emerging thinking set out below, is one reason why we think it is appropriate to consider present and likely future use of the adjacent bands and the possible need to protect them.

2.94 Our aim is to work towards a position that meets our statutory duties to optimise the use of spectrum as a whole for the benefits of citizens and consumers, whilst where appropriate making use of the 872/917 MHz bands in a way that promotes competition.

Issues covered in this document

2.95 This consultation outlines our current and emerging thinking about the future use of the 872/917 MHz bands. Among the aims of the consultation is to consider the issues that will need to be determined before proceeding with any authorisation process.

2.96 One particular aim of this consultation is to indicate our proposals for the possible protection of the bands and services adjacent to the 872/917 MHz bands. In doing this we propose possible new technical conditions that services may need to meet to protect existing GSM and future new services (including UMTS) in the adjacent bands.

2.97 In addition to the proposals for how to protect both existing and future services in the bands adjacent to the 872/917 MHz bands, the consultation also provisionally looks at the possible methods by which the 872/917 MHz bands could be made available. The options considered are full licensing and light regulatory approaches. These options are discussed in Section 5.

2.98 These issues are discussed in detail in Sections 3 - 6.

2.99 Annex 1 – 3 details Ofcom's consultative approach and how to respond to this consultation.

2.100 Annex 4 provides a summary of the questions asked in this consultation.

2.101 Annex 5 reviews the previous responses to the April 2006 consultation;

2.102 Annex 6 provides a detailed technical analysis of the proposed revised technical requirements to protect both existing and UMTS900 services in the adjacent bands to the 872/917 MHz bands;

2.103 Annex 7 sets out Ofcom's powers to manage spectrum, the statutory obligations and duties that we must comply with and other considerations that we must take into account when exercising our powers; and

2.104 Annex 8 provides a glossary of terms used in this document.

Impact assessments (IAs)

2.105 We have a duty under Section 7 of the 2003 Act to carry out IAs wherever we make a proposal we consider important, unless instead we consider and set out why an IA is unnecessary. A proposal is important if it would be likely to have a significant effect on businesses or the general public, or when there is a major change in our activities.

2.106 As far as we put forward proposals, we have in this consultation document sought to assess their impact. That is, where we make a proposal, or a preliminary or possible proposal, or indicate a current line of emerging thought, we have, considered what might be its impact. Because some of the proposals are at a relatively early stage and some of Ofcom's thinking is emerging, a full IA is neither possible, nor in our opinion, necessary at this stage. In the future a full IA will be made in connection with any firm proposals we make for the authorisation of the 872/917 MHz bands and the options for such authorisation.

Section 3

Potential uses of the spectrum

Introduction

3.1 This section summarises the potential applications for the 872/917 MHz bands that we are aware of. We have grouped potential applications under separate headings depending on whether we propose they would require a full licensing approach, a light regulatory approach or whether they might be compatible with either authorisation approaches. This section concludes by asking for stakeholder input on potential applications.

Candidate services for a full licensing approach

3.2 The following details the current services that we are aware of that may be candidates for a full licensing approach.

Mobile broadband

3.3 Mobile broadband is a generic name for technologies that provide internet access on the move. By connecting a device (i.e. a laptop) to a USB modem or data card containing a SIM card, you can access the internet at broadband speeds whilst on the move.

3.4 Mobile Broadband is used to describe various types of wireless high-speed internet access through a portable modem, telephone or other device. Various network standards may be used, such as GPRS, 3G, WiMAX, UMTS900 /HSPA, EV-DO and some portable satellite-based systems.

3.5 In the UK all of the major mobile phone networks provide mobile broadband services. The mobile phone networks have to some extent focused on marketing the service to laptop users, who have a choice of USB hardware to enable their laptops to use the mobile broadband service, but many other applications can also benefit from mobile broadband technology.

3.6 Devices that can access mobile broadband services include: mobile data cards, USB modems, USB sticks, phones with data modems and laptops with the ability to use mobile broadband built-into them (Built-In 3G Broadband laptops).

3.7 Over recent years there has been an increase in the variety and application of data services. These applications exist in various frequency bands and utilise varying technologies such as WAP (Wireless Application Protocol), GPRS (General Packet Radio Services) and UMTS900 (Universal Mobile Telephony System). These technologies were developed to bring Internet content to mobile phones and other wireless devices. This means that users can easily access Web-based interactive information services and applications from their mobile phones or PDAs (Personal Digital Assistants).

3.8 Applications such as mobile location and navigation services, including maps and graphics, benefit significantly from high speed data, as they become more practical and easier to use. Also, by using compression techniques, high speed data is capable of supporting completely new applications, such as mobile video. Computer

data cards allow users to keep their existing mobile phones for voice, and connect the card to their laptop to access high-speed data.

Digital PMR / PAMR

3.9 Private Mobile Radio (PMR) and Public Access Mobile Radio (PAMR) in the UK are field radio communications systems which use mobile, base station, and dispatch console radios and are sometimes based on such standards as MPT-1327 and TETRA and which are designed for dedicated use by specific organisations. Typical examples are the radio systems used by police forces and fire brigades. Key features of professional mobile radio systems can include:

- point to multi-point communications (as opposed to cell phones which are point to point communications);
- push-to-talk, release to listen - a single button press opens communication on a radio frequency channel;
- large coverage areas;
- closed user groups; and
- use of VHF or UHF frequency bands.

3.10 However, a recent ETSI publication[43] shows that there is no current demand for the 872/917 MHz bands from the Technical Committee (TC) TETRA Management Committee.

GSM-R (GSM Railway).

3.11 GSM-R, Global System for Mobile Communications - Railway or GSM-Railway is an international wireless communications standard for railway communication and applications. A sub-system of European Rail Traffic Management System (ERTMS), it is used for communication between train and railway regulation control centres. The system is based on GSM and EIRENE - MORANE (European Integrated Railway radio Enhanced Network - Mobile Radio for Railways Networks in Europe) specifications which guarantee performance at speeds up to 500 km/h (310 mph), without any communication loss.

3.12 In Europe, GSM-R uses a specific frequency band:

- 876 - 880 MHz: used for data transmission (uplink)
- 921 - 925 MHz: used for data reception (downlink)

3.13 In 1993, the worldwide organization of railway cooperation (UIC, Union Internationale des Chemins de fer www.uic.org/spip.php?rubrique851) decided on a new system of railway communication. The decision was taken to use a slightly modified GSM 900 technology. 32 railway operators from 24 European countries agreed in the EIRENE MoU to roll out GSM-R networks. GSM-R was finally specified in 1999 by ETSI and in 2000 by EIRENE.

[43] Annex D ETSI TR 102 627

3.14 GSM-R is a TDMA (Time Division Multiple Access) system built on GSM technology, and benefits from the economies of scale of its GSM technology heritage, aiming at being a cost efficient digital replacement for existing, often incompatible in-track cable and analogue railway radio networks. Over 35 different such legacy systems are reported to exist in Europe alone. The technology was mandated in a European Directive on 23 July 1996 (96/48/EC).

3.15 Decision 2001/260/EC on the characteristics of the European Rail Traffic Management System (ERTMS) stressed the importance to develop a common standard for command-control, signalling subsystem and railway operations; in order to ensure interoperability.

3.16 The 872/917 MHz bands lie just below the GSM-R allocation and could possibly be used for this application, in addition to the existing 876 – 880 MHz and 921 – 925 MHz assignment.

3.17 ETSI has sent a System Reference document (SRDoc) to CEPT requesting the ECC to designate the bands 873 – 876 MHz / 918 – 921 MHz for railway purposes[44]. The request is for the ECC to designate these as GSM-R extension (GSM-RE) bands by means of an ECC decision. This request is being considered by CEPT WG FM.

3.18 ETSI SRDoc on GSM-RE also suggests that it may be possible for GSM-RE to share spectrum with SRD under a licensed use scheme[45]. To allow sharing ETSI suggests that the characteristics of the SRD and RFID would be restricted. How such sharing would be carried out in practice has not been finalised. One option could be a light licensing regime for the RFID interrogators to ensure any exclusion zones around GSM-RE base stations were implemented.

3.19 GSM-RE is designed to protect adjacent band users, and would only require a 2 x 3 MHz block of spectrum, not the full band consisting of 2 x 4 MHz. Based on our understanding, there is unlikely to be an alternative frequency band for GSM-RE in the UK, given existing GSM-R use in the neighbouring 876 - 880 MHz and 921 - 925 MHz spectrum bands.

Candidate services for a light regulatory approach

3.20 The following paragraphs detail the current services that we are aware of that may be candidates for a light regulatory approach.

RFID / SRD (Radio Frequency Identification / Short Range Devices)

3.21 These types of applications were not considered in detail in the April 2006 consultation. The following is our understanding of their current status.

3.22 Increased interest has developed as a consequence of the SRDoc from ETSI to ECC for proposals to use the 872/917 MHz bands for RFID / SRD.

3.23 It is worth noting that these uses do not require paired frequencies: SRD would not require spectrum in the 917 - 921 MHz band, and RFID would not require spectrum in the 872 - 876 MHz band.

[44] Page 5 ETSI TR 102 627.
[45] Annex C ETSI TR 102 627.

3.24 There are various sources and studies which give an indication of the potential value of light regulatory uses of spectrum. Some of these estimates suggest a high value for light regulatory use but are likely to have considerable uncertainty attached to them. For example:

- Indepen, Aegis and Ovum (2006)[46] were commissioned by Ofcom to provide an independent view on the economic value of licence exempt spectrum. The study examines ten representative licence exempt applications, and researches each in terms of technology, demand, supply, congestion, interference, and scope for international harmonisation. A generic methodology was devised to generate estimates of incremental economic value for the ten applications. The figures produced in the report represent unconstrained values, in that the costs of congestion and interference are not accounted for. The Indepen, Aegis and Ovum figures indicate potentially significant benefits from licence exempt use of spectrum;

- ETSI work on licence exempt uses of spectrum. Recent ETSI work has discussed RFID performance requirements from leading manufacturers and users. Tags that are used globally are typically manufactured with their centre frequencies tuned to around 915 MHz. There is likely to be a degradation in performance quality if these tags are read by interrogators complying with the present European standard EN 302 208. This is due to the frequency off-set of approximately 45 MHz and the higher transmit powers permitted in other non-European countries. In order for Europe to achieve comparable performance to the rest of the world, interrogators should operate at around 915 MHz and at power levels up to 4W ERP. To illustrate, ETSI compares the 2W ERP limit in the current 865 - 868 MHz range to the new proposed frequency range 915 - 921MHz at 4W ERP. ETSI considers that:

    - the read range in free spaces increases by a factor of 1.4;

    - the power absorbed by tags in a pallet is doubled for a given range; and,

    - if the reading performance for tagged items reaches 70% at 2W then the reading performance increases to 100% at 4W.

- The International Air Transport Association ("IATA") analysis of the value of RFID in baggage handling. IATA examined the main cost saving drivers and the industrial saving opportunities per stakeholder on the assumption of a big bang rollout of RFID tagging at the top 400 (in terms of passengers) airports in the world .

3.25 We identified a number of different applications of SRD and RFID on the 872/917 MHz bands. These are listed in Table 1. We discuss each of these light regulatory uses in turn.

[46] Indepen, Aegis and Ovum (2006), 'The economic value of licence exempt spectrum' http://www.ofcom.org.uk/research/technology/research/exempt/econassess/

Table 1: Potential RFID / SRD uses for the 872/917 MHz band

Class of LE use	Potential applications	Frequency (MHz)
Short Range Devices (SRD)	• Aviation and maritime • Home and building automation • Multimedia • Telemetry	872 - 876
Radio Frequency Identification Devices (RFID)	• Data transfer • Logistics • Medical and hospital • Security and home automation • Transport	917 - 921

Source: Adapted from ETSI TR 102 649-2

SRD use at 872 - 876 MHz

3.26 TR 102 649-2 suggests that there are a number of potential SRD uses at 872 - 876 MHz. However, SRD applications already have access to a significant amount of spectrum, so incremental value from SRD use of 872 - 876 MHz would in principle stem from alleviating congestion, harmonisation benefits, or superior performance on 872 - 876 MHz over the next best alternative frequencies.

3.27 We have considered the evidence for congestion and any potential benefits of harmonisation from SRD use of the 872 - 876 MHz band. We do not consider that other bands where SRDs are utilised are currently congested. Put differently, we propose that the value currently estimated for other bands is not a reasonable basis from which to derive the value from SRD at 872 - 876 MHz because our understanding is that there is not unmet demand given the availability of spectrum in those other bands.

3.28 Further, we do not consider that there would be significant harmonisation benefits from SRD use on 872 - 876 MHz: there already is harmonisation of SRD use in the 863 - 865 MHz and 868 - 870 MHz bands within Europe. As a result, it seems unlikely that there would be incremental value which could arise from harmonisation; such as lower per unit equipment prices or costs. Based on our understanding we do not believe that there would be an improvement in performance of SRD at 872 - 876 MHz.

3.29 In the absence of evidence of existing congestion of bands currently used by SRD, harmonisation benefits or an improvement in performance of SRD use in the UK, we suggest that there is unlikely to be incremental value from SRD use of 872 - 876 MHz.

RFID use at 917 - 921 MHz

3.30 Table 1 suggests that there are a number of potential RFID uses at 917 - 921 MHz. However, RFID applications already have access to spectrum, so incremental value from RFID use of 917 - 921 MHz would in principle stem from alleviating congestion, harmonisation benefits, or superior performance on 917 - 921 MHz over the next best alternative frequency.

3.31 We have considered the evidence for congestion and any potential benefits of harmonisation from RFID use of the 872 - 876 MHz band. We do not consider that other bands where RFID are utilised are currently congested. Put differently, we propose that the value currently estimated for other bands is not a reasonable basis from which to derive the value from RFID at 872 - 876 MHz because to the best of our knowledge there is not at present unmet demand given the availability of spectrum in those other bands.

3.32 Further, we do not consider that there would be significant harmonisation benefits from RFID use on 917 - 921 MHz: there already is harmonisation of RFID use in the 865 - 868 MHz bands within Europe. As a result, we propose that it is unlikely that there would be incremental value which could arise from harmonisation; such as from lower per unit equipment prices or costs.

3.33 However, as discussed above, recent ETSI work suggests that there could be a significant improvement in RFID performance when operating near 915 MHz compared to 865 - 868 MHz. Such a performance improvement by itself could be a source of potential incremental value. Further, such a performance improvement might act as a catalyst for further RFID use in the UK economy, and some of the indicative values of RFID use suggested by Indepen, Aegis and Ovum, and the IATA might be realised as a result.

Other applications that could be used in the 872/917 MHz bands under either the full licensing approach or light regulatory approach

3.34 The choice of the appropriate authorisation approach depends, amongst other things, on how much protection is required, and on the ability to co-exist with other applications. If one stakeholder (or grouping of stakeholders via a coordinating agent) needs exclusive access to the band(s) then it may be appropriate to authorise this access through a full licensing approach (e.g. create the opportunity for a band manager to obtain rights to manage use of the spectrum). Alternatively, if there is no need for coordination and if an alternative service can co-exist with other users then a light regulatory approach may be more appropriate.

3.35 In the case of the applications described in this section we do not have enough information yet to judge which authorisation approach would be appropriate.

Data applications

Telemetry

3.36 Telemetry can be described as machine-to-machine communication for the purpose of monitoring and control. In its simplest form telemetry consists of the sending and receiving of data between electronic devices. Monitoring is the typical telemetry function, but a telemetry system can also be used for controlling devices, e.g. switching on/off a process or opening /closing valves.

3.37 Technologies for the transmission of data include GSM, GPRS, UMTS900, short range radio (such as Bluetooth) and wireless LAN.

Remote meter reading

3.38 Remote meter reading is a technology for automatically collecting data from metering devices (water, gas, electricity etc) and transferring that data to a central database for billing and/or analysis. For utility companies this saves employee trips, and

means that billing can be based on actual consumption rather than on an estimate based on previous consumption, giving customers better control of their use of electric energy, gas usage, or water consumption etc.

3.39 Remote meter reading may also be used for other applications such as research or industrial purposes (for monitoring and/or recording information from locations that may be difficult or dangerous to access).

3.40 Metering technologies include handheld, mobile and network technologies based on telephony platforms (wired and wireless), radio frequency (RF), or powerline transmission.

3.41 In the UK, spectrum allocations exist in the 183 – 184 MHz band for this particular application, but globally a range of different technologies and frequency bands are used and the 872/917 MHz spectrum could be seen as a viable option for this technology.

3.42 The primary driver for the automation of meter reading is not so much to reduce labour costs, but to obtain data that is otherwise unattainable. Many meters, especially water meters, are located in areas that require an appointment with the homeowner. Gas and Electricity tend to be more valuable commodities than water, and the need to offer actual readings instead of estimated readings can drive a utility to consider automation. Construction practices, weather, and the need for information drive utilities in different parts of the world towards remote metering at different rates.

3.43 It is our understanding that meter reading applications could be used in either a full or a light regulatory approach. We would like to hear from interested stakeholders whether this is the case.

Unmanned aerial vehicles (UAVs)

3.44 An unmanned aerial vehicle (UAV) is an unpiloted aircraft. UAVs can be remote controlled or fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. UAVs are currently used in a number of military roles, including reconnaissance and attack.

3.45 They are also used in a small but growing number of civil applications and perform a wide variety of functions such as fire fighting when a human observer would be at risk, police observation of civil disturbances and crime scenes, and reconnaissance support in natural disasters. The majority of these functions are some form of remote sensing; this is central to the reconnaissance role most UAVs fulfil. Less common UAV functions include scientific research, search and rescue and freight transport.

3.46 Some UAV's (mainly in America) use data modems that operate in the 900 MHz band to receive and relay data streams / telemetry and send high-level commands to the UAVs autopilot. The 900 MHz band is used due to the distances this frequency band can cover.

3.47 It is our understanding that UAV applications could be used in either a full licensing or light regulatory approach. We would like to hear from interested stakeholders whether this is the case.

PMSE (Program making and Special Events) and Channel 69

3.48 We published a consultation document[47] on 2 February 2009 proposing that we clear the whole 800 MHz band (790 - 862 MHz) to align part of the UK's digital dividend with the spectrum being identified for release by an increasing number of other European countries. Among other things, this would require us to move PMSE from Channel 69 in UHF Band V to suitable alternative spectrum.

3.49 We identified the 872/917 MHz bands as a possible alternative as it is currently part of our future awards programme and may share some of the characteristics of Channel 69. The bands were also identified by MNOs in response to our consultation documents on future spectrum access for PMSE, published on 20 June 2007,[48] and on the detailed design of the Digital Dividend Review band manager award, published on 31 July 2008.[49]

3.50 We noted that the 872/917 MHz bands are adjacent to spectrum used by GSM base stations operated by Vodafone and O2. Our analysis suggested there is a significant risk that wireless microphones using these bands would cause harmful interference to those base stations. This situation does not improve if the adjacent 2 x 2 MHz used by the MOD (at 870 - 872/915 - 917 MHz) is included in the analysis. With that in mind, we did not see the 872/917 MHz bands as a viable alternative to Channel 69 for PMSE.

3.51 Further, after closer examination of the 872/917 MHz bands we propose the view that PMSE would not be a viable use of this band. This consideration is based upon recent work by Ofcom which states that the 872/917 MHz bands are "adjacent to spectrum used by GSM base stations operated by Vodafone and O2. Our analysis suggests there is a significant risk that wireless microphones using these bands would cause harmful interference to those base stations. With that in mind, we do not see 872 - 876/917 - 921 MHz as a viable alternative to Channel 69 for PMSE and have not assessed the economic implications of its use"[50].

Summary

3.52 This section has set out a high level overview of our understanding of the alternative services that could be used in this band. It is not an exhaustive list and we would welcome views on other potential candidates and on the likelihood of these services being used in the band were it to be made available for use. In particular, we would like to receive information that is relevant to the assessment of the potential economic value of these services. We would also like to receive any further information on the technical characteristics of these potential uses.

3.53 We will consider the information when assessing whether a full licensing or light regulatory approach is likely to generate the highest possible benefits to UK citizens and consumers.

3.54 The answers to these questions should take account of the technical conditions, such as limits on transmission power as proposed in Section 4.

---

[47] http://www.ofcom.org.uk/consult/condocs/800mhz/800mhz.pdf.
[48] http://www.ofcom.org.uk/consult/condocs/pmse/pmse.pdf.
[49] http://www.ofcom.org.uk/consult/condocs/bandmngr/condoc.pdf.
[50] Paragraph 5.45 of 'Digital dividend – clearing the 800 MHz band'. See http://www.ofcom.org.uk/consult/condocs/800mhz/ for more information.

Question 1: Do you believe that the uses listed in this section are possible candidates of the 872/917 MHz bands?

Question 2: Are there additional applications/services (not listed above) that could make viable use of the 872/917 MHz bands that Ofcom should be aware of?

Question 3: What services do you believe should be authorised to use this band? Could you supply relevant information supporting your preference and include any economic data relating to the value of the spectrum in providing these services?

Section 4

Potential technical conditions for the 872/917 MHz bands

Introduction

4.1 This section sets out the technical conditions for the full licensing and light regulatory approaches that we consider may be necessary to protect services in the adjacent bands.

4.2 The following technical conditions and separation distances should be taken as our initial view on this subject and we invite stakeholders to respond to the consultation in a manner which will help us refine them further as necessary.

4.3 A full analysis of what conditions would be objectively justified, non discriminatory, proportionate and transparent, to the extent those requirements must be met and would fulfil Ofcom's statutory duties, will be made of any conditions Ofcom ultimately considers for any licensed use of the 872/917 MHz band.

4.4 For the full licensing approach we set out the powers that could be available in the 872/921 MHz frequency bands and for the light regulatory approach we propose separation distances that may be necessary if the proposals in the ETSI SRDoc for RFID/SRD were to be adopted.

Proposal for a full licensing approach

4.5 The main change from the 2006 Consultation relates to our expectation that we may need to protect future services (including UMTS) in the bands adjacent to the 872/917 MHz bands.

4.6 In summary the April 2006 Consultation proposed:

- The bands 875.8 - 876.0 MHz and 920.8 - 921.0 MHz were to be free of carriers;
- A power level of up to 33 dBm per mobile station was for the lower band 872 - 876 MHz;
- A power level of 32 dBm EIRP, plus 10 dBm EIRP for each additional MHz of internal guard band, for the upper band 917 - 921 MHz, up to a maximum of 56 dBm EIRP per transmission site; assuming a minimum spacing of 20m from an award band base station in the 917 - 921MHz band to a GSM victim base station at frequencies up to 915MHz. A method for averaging the power of a wide band carrier across the band was not presented; and
- Separation distances to a GSM-R equipped railway track of between 75m and 250m. This increases to 520m for GSM base stations not equipped with duplexers.

4.7 The technical conditions presented for the band 917 – 921 MHz in the April 2006 Consultation were appropriate for a single narrow band carrier and assumed a GSM victim base station at 915 MHz. Based in part on the comments received to the consultation the technical approach has now been revised as set out in Annex 6.

Due to the changes that have taken place it is not possible to relate directly the powers proposed in this consultation and the powers described in the April 2006 Consultation.

4.8 The derivation of the new technical conditions and separation distances are set out in Annex 6, these calculations build upon the transmission rights previously proposed[51, 52] for the 872/917 MHz bands.

4.9 In particular we describe our updated methodology for calculating transmitter powers and separation distances which takes account of:

- The characteristics of an offending transmitter and a victim receiver including: Adjacent Channel Selectivity (ACS) and Adjacent Channel Leakage Ratio (ACLR); and
- The average power of wide band carriers, where the EIRP varies with frequency.

4.10 For the full licensing approach the proposed power in the 917 – 921 MHz band is defined by a formulae (from 0): using this formula we can obtain example powers (from Annex 6 Table 14) for transmitters in the 917-921 MHz band:

- 19 dBm EIRP in the band 918.26 – 919.53 MHz and 27.3 dBm EIRP in the band 919.53 – 920 MHz. These powers are less than the powers considered in the April 2006 consultation. The technical and regulatory implications of higher power (up to 50dBm EIRP A6.70) operation in the 917 – 921 MHz band are discussed in paragraphs 4.25 – 4.27, 5.09 – 5.15 and A6.65 – A6.72.

4.11 Also in the case of GSM-R we show (from A6.108) that the powers proposed in 4.10 above are also sufficient for the protection of a GSM-R mobile station.

Assumptions used to create the potential transmission rights

4.12 No internal guard bands are defined explicitly. A licensee would be free to transmit in any portion of the 872/917 MHz bands, so long as such transmission complies with the specific limits on maximum in band and out of band emission levels designed to protect services in neighbouring bands.

4.13 The 872 - 876 MHz band is proposed for uplink transmission (i.e. mobile station to base station and the band 917 - 921 MHz is proposed for downlink transmission (i.e. base station to mobile station). This is consistent with the uplink/downlink use by mobile phone cellular networks.

4.14 In deriving the possible emission rights we have so far considered the impact of transmitters in the 872/917 MHz bands on adjacent band services in the following scenarios:

- From the Band 872 - 876 MHz (Mobile station transmit);
  - into MOD stations in the band 872 - 876 MHz,
  - into SRD's in the band 863 - 870 MHz,

[51] Technical Constrainsts assocated with the 917-921 MHz band, Ofcom, February 2005
[52] Award of avaible spectrum 872 - 876 MHz paired with 917-921 MHz. Ofcom consultation, 11 April 2006

- into GSM-R uplink in the Band 876 - 800 MHz.

- From the band 917 - 921 MHz (Base station Transmit);
  - into GSM900 and UMTS900 base station at frequencies up to 915 MHz,
  - into MOD stations in the band 915 - 917 MHz,
  - into GSM–R down link in the band 921 - 925 MHz.

4.15 The emission proposals for the band 917 - 921 MHz have been derived on the basis that the distance from the base station in the 917 - 921 MHz band to a cellular base station with receiver frequencies less than 915 MHz is equal to or greater than 100m.

4.16 The technical licence conditions have been calculated on the basis that the UMTS900 network and the 872/917 MHz networks would be in accordance with current ETSI and 3GPP specifications[53] with additionally an industry standard duplexer, as described in A6.62, at the UMTS900 base station as stated in Annex 6.

4.17 We have used UMTS as a proxy for future mobile broadband technologies such as LTE; we suggest that the powers and separation distances for a UMTS victim base station are broadly applicable to other mobile broadband technologies.

4.18 Note that the out of band (OOB) emissions from the 872 - 876 MHz band are proposed in terms of dBm per 30 kHz and the OOB emissions from the 917 - 921 MHz band are proposed in terms of dBc per 30 kHz.

Technical conditions for a service, under a full licensing approach, in the 872 – 876 MHz band

Limits on in-band emissions

4.19 Our proposal at this stage is that a licensee may transmit at a maximum mean EIRP per mobile station of 23 dBm (from A6.21).

Limits on out-of-band emissions

4.20 We propose that the out-of-band emissions per mobile station transmitting over the 872 - 876 MHz band should comply with the maximum permitted values given in Table 2, Table 3 and Figure 3 below (from Table 9, 10 and 11 in Annex 6).

Table 2: Proposed out-of-band emissions below 872 MHz

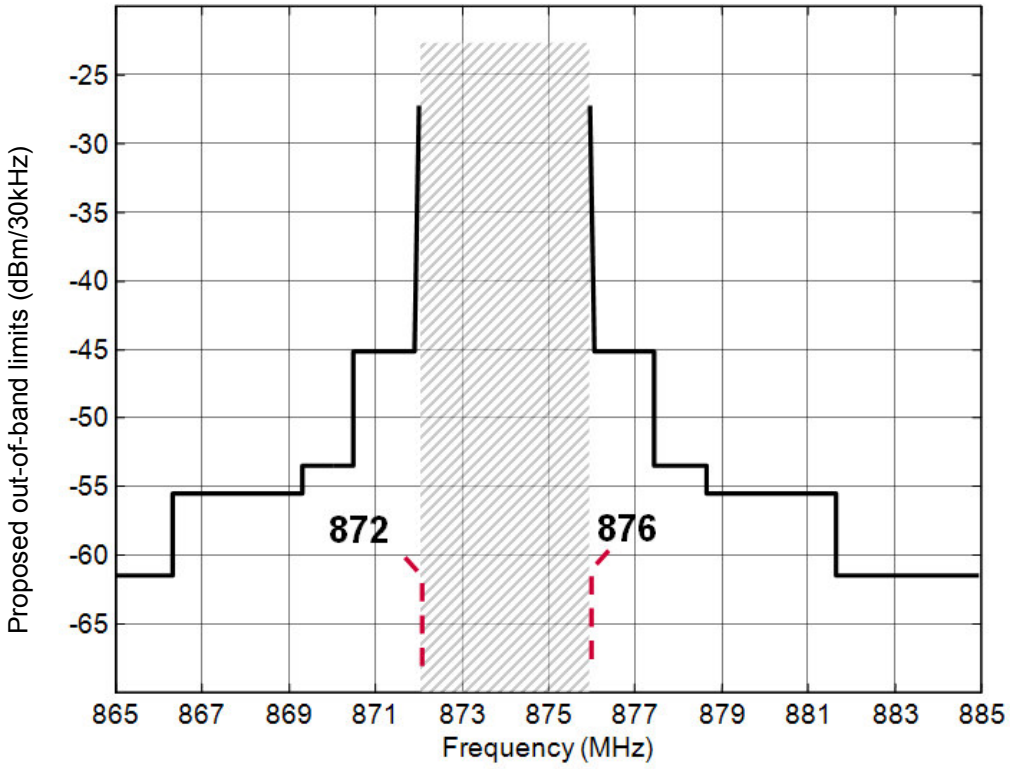
Out-of-band emissions below 872 MHz	
Frequency of measurement (MHz)	**Maximum mean EIRP (dBm / 30 kHz)**
< 866.3	–61.5
866.3 – 869.3	–55.5
869.3- 870.0	–53.5
870.0 – 870.5	–53.5
870.5 – 871.9	–45.2
872.0	–27.2

[53] For example: 3GPP TS 25.101, 3GPP TS 25.104, 3GPP 45.005 and ETSI EN 301 449

Table 3: Proposed out-of-band emissions above 876 MHz

Out-of-band emissions above 876 MHz	
Frequency of measurement (MHz)	**Maximum mean EIRP (dBm / 30 kHz)**
876.0	–27.2
876.1 – 877.5	–45.2
877.5 – 878.7	–53.5
878.7 – 881.7	–55.5
> 881.7	–61.5

Figure 3: Proposed out-of-band emissions below 872 MHz and above 876 MHz.



Lower power licensed service in the 917 – 921 MHz band

4.21 The 872/917 MHz bands licensees would be required to co-ordinate with the appropriate adjacent band operators when:

- The distance from the 917 – 921 MHz bands base station to a 900 MHz band base station is less than 100m. (from A6.62 and A6.928); and
- The distance from the 917 – 921 MHz base station to an established or announced GSM-R equipped railway line; is less than 100m; (from A6.123).

4.22 In cases where coordination with an adjacent band operator is not required then we propose the following emissions requirements.

4.23 The proposed permitted power within the band 917 – 921 MHz would be specified by formulae from 0, worked examples of how this applies are shown in Table 14 Annex 6.

$$\mathrm{EIRP}\left(\text{over the band } f_1 \text{ to } f_2\right)$$

$$= \text{-}10.\mathrm{Log}_{10}\left\{1.28\times10^{-8} + \frac{1}{(f_2 - f_1)}10^{\frac{\text{-ACSo}}{10}}\left\{\frac{10^{(916.5 - f_1)} - 10^{(916.5 - f_2)}}{2.30259}\right\}\right\} - 45 \quad dBm$$

Where ACSo is defined as the ACS derived from the receiver specification in Table 13 i.e. ACSo = 46.41dB when $f_1, f_2 < 920$ and ACSo = 58.41dB when $f_1, f_2 >= 920$.

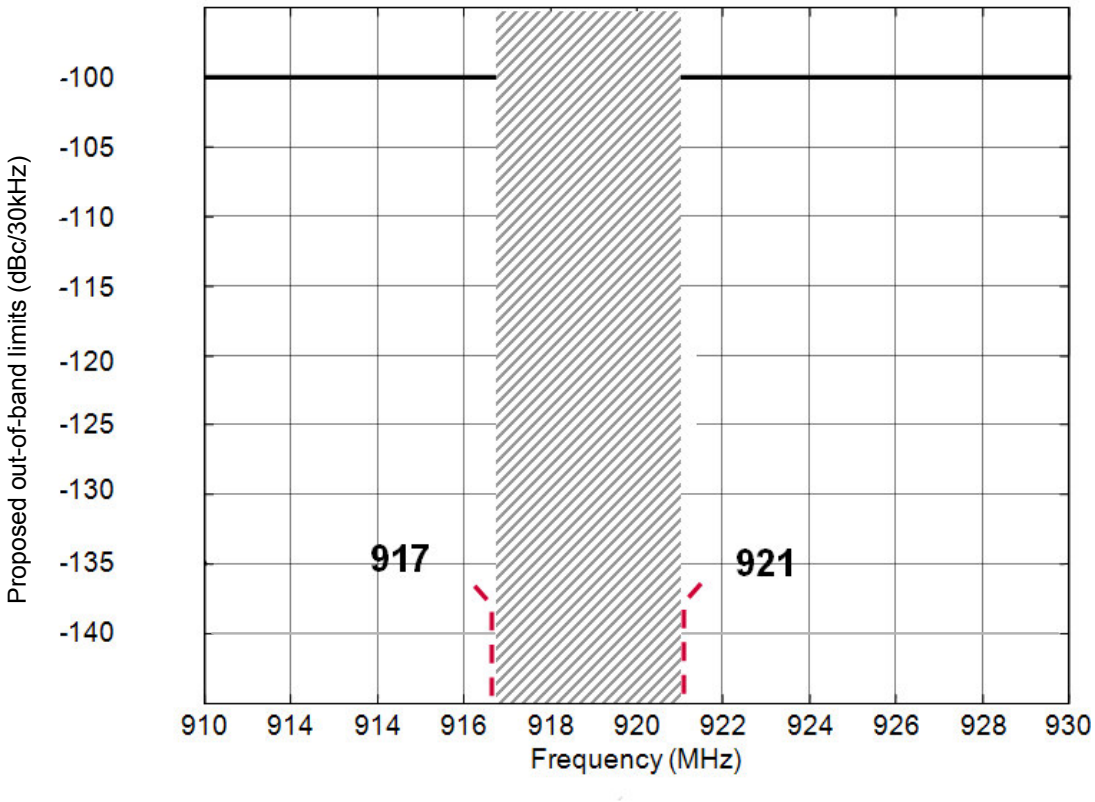
- The method for calculating the permitted power for a channel that crosses the 920 MHz border (f1<920<f2) is according to A6.57.
- In the case of multiple carriers the power of each is reduced by 10.Log10(Number_of_carriers).
- See Annex A6.63 – A6.71.

4.24 Out of band emissions in the band below 917 MHz are proposed at -100 dBc/30kHz. (from A6.100). Out of band emissions above 921 MHz are proposed at -100 dBc/30kHz, (from A6.120). Shown in Table 4 and Figure 4 below.

Table 4: Proposed out-of-band emissions below 917 MHz and above 921 MHz

Frequency of measurement (MHz)	Maximum mean EIRP (dBc / 30 kHz)
F<917	–100
Out-of-band emissions above 921 MHz	
>921 MHz	- 100

Figure 4: Proposed out-of-band emissions below 917 MHz and above 921 MHz



Higher power licensed service in the 917 – 921 MHz band

4.25 If improved filtering were employed a UMTS base station (by comparison with the filtering that would be used to meet ETSI Standards) then higher transmit powers could be possible for the 917 – 921 MHz band. The following paragraphs sets out possible technical conditions under this scenario.

4.26 Due to the higher powers the co-ordination distances will be increased ; licensees would be required to co-ordinate with the appropriate adjacent band operators when:

- The distance from the 917 – 921 MHz bands base station to a 900 MHz band base station, using GSM or UMTS900 technology, is less than 100m (from A6.31);
- The distance from the 917 – 921 MHz bands base station to a GSM900 MHz band base station, not equipped with a duplexer, is less than 500m (from A6.98);
- The distance from the 917 – 921 MHz base station to an established or announced GSM-R equipped railway line; is less than 720m (from Table 20).

4.27 In cases where coordination with an adjacent band operator is not required then we propose the following emission requirements:

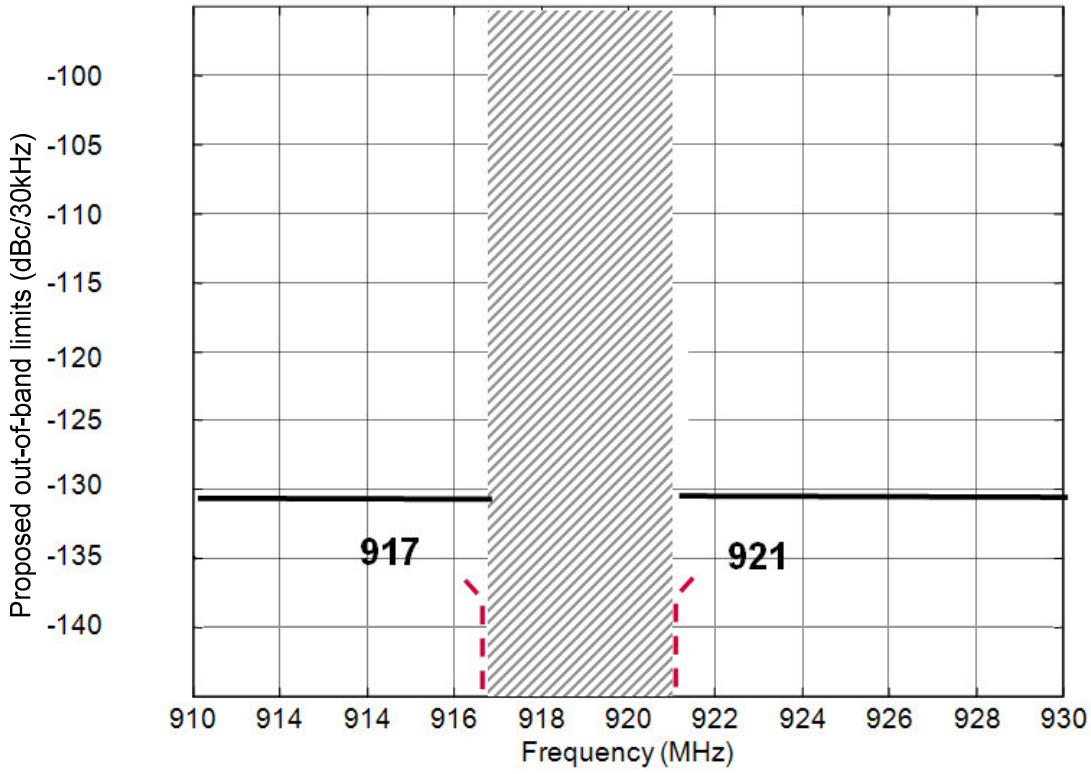
- The proposed total permitted power within the band 917 – 921 MHz would be a maximum of 50 dBm EIRP(from A6.664);

- A filter is applied in the UMTS base station receive path with attenuation 50 dB at frequencies greater than 917 MHz (from A6.68);
- Out of band emissions in the band below 917 MHz are proposed at -131dBc/30kHz (from A6.67). Out of band emissions above 921 MHz are proposed at -131 dBc/30kHz, (from A6.125). Shown in Table 5 and Figure 5 below.

Table 5: Proposed out-of-band emissions below 917 MHz and above 921 MHz

Frequency of measurement (MHz)	Maximum mean EIRP (dBc / 30 kHz)
F<917	–131
Out-of-band emissions above 921 MHz	
>921 MHz	- 131

Figure 5: Proposed out-of-band emissions below 917 MHz and above 921 MHz



Question 4: Do you agree with the methods used to assess the potential to interfere with adjacent band services in a full licensed approach?

Question 5: Do you consider that the proposed technical licence conditions would be justified and appropriate?

Technical conditions under a light regulatory approach

4.28 Two of the possible uses that have been highlighted for the 872/917 MHz bands are SRD and RFID. Both of these can potentially be used under a light regulatory approach. This possibility has become more prominent as a result of the proposals set out by the European Telecommunication Standards Institute (ETSI) in their System Reference Document TR 102 649-2 and is now under consideration in CEPT, and in light of the possible limited use of the 872/917 MHz bands if licensed (because of the technical constraints that might be placed on the bands).

4.29 This section sets out of our initial analysis of the possible technical conditions that may be required to allow RFID operation in the 917 – 921 MHz. This analysis is based on the technical conditions set out in TR 102 649-2 which Ofcom understands to be initial proposals. The analysis should be taken as our emerging thinking on this subject and we invite stakeholders to respond to the consultation to help us develop our final technical conditions that will be used if this band is used for RFID / SRD applications.

4.30 For the band 872 – 876 MHz we propose that devices with performance equivalent to the current GSM mobile station[54] will give sufficient protection to adjacent band services.

4.31 We understand that there are also proposals from ETSI TC ERM 34 and that further work will be carried out in CEPT on the licence exempt sharing issues. Consequently, the technical conditions put forward in this section and Annex 6 represent our emerging thinking about the sort of conditions that may be required. We seek comments on them on that basis**.**

4.32 Further technical work and an analysis of what conditions, if any, would be objectively justified, not unduly discriminatory, proportionate and transparent, to the extent those requirements must be met, and would fulfil Ofcom's statutory duties, will be carried out in relation to any conditions Ofcom ultimately proposes and consults on for any light regulatory use of the 872/917 MHz band.

4.33 Annex 6 sets out the technical analysis supporting the following proposals and addresses the potential choices that a user of the 872/917 MHz bands would need to consider between occupied bandwidth, power and separation distances from certain base stations.

4.34 For a light regulatory approach we propose that the technical conditions would be developed to protect base stations with industry standard filtering rather then the improved filters discussed in 5.11 to 5.15. This is due to the fragmented nature of deployment that could be expected under a light regulatory approach and the difficulty of imposing the costs of the improved filters on such fragmented users (if it is decided that 872/917 MHz band users should bear the costs).

Technical analysis

4.35 The same assumptions have been used as set out in 4.12, 4.14, 4.16 and 4.17.

4.36 A6.129 to A6.153 show that devices operating in the band 917 - 921 MHz have the potential to interfere with base stations in the band 910 - 915 MHz and GSM-R mobile stations in the band 921 - 925 MHz.

[54] 3GPP TS 45.005

4.37 One way of quantifying these effects is to derive the separation distances beyond which the potential for interference drops to an acceptable level. Our initial assessment is based on a calculation of the separation distance required between a group of RFID readers and a victim base station, such that the interference received from the RFID readers is less than the proposed interference limits given in Annex 6, Table 12.

4.38 The following tables summarise our initial assessment of the separation distances. These results may be used as a basis for further discussion and to inform our input to ETSI and CEPT.

Table 6: Possible separation distance from RFID readers in the 917 - 921MHz band to UMTS900 base station.

Environment	Approximate minimum separation distance (m)
Urban	170
Suburban	330

Table 7: Possible separation distance from RFID readers in the 917 - 921MHz band to GSM base station.

Environment	Approximate minimum separation distance (m)
Urban	190
Suburban	370

Table 8: Possible separation distance from RFID readers in the 917 - 921MHz band to GSM-R mobile station (i.e. related to use on/around the train track).

Environment	Approximate minimum separation distance (m)
Urban	110
Suburban	220

Question 6: Do you agree with the methods used to assess the likelihood of services interfering with adjacent band services under the light regulatory approach?

Section 5

Approaches to authorisation

Introduction

5.1 In Section 2 we outlined the reasons why we believe that there are likely to be two distinct approaches available to Ofcom for the authorisation of the 872/917 MHz bands:

- A full licensing approach: under which a limited number of licences are awarded e.g. a national wide area licence(s) suitable for mobile broadband type use awarded via an auction;
- A light regulatory approach: in which individual transmitters are authorised without limitation on their numbers, e.g. suitable for SRD / RFID use (either under a licence exempt regime, or under a light licensing regime).

5.2 As we note above, we believe that it is likely that the full licensing and light regulatory approaches will be mutually exclusive (e.g. if the band were awarded under a full licensing approach for mobile broadband use it is very unlikely that we could also authorise SRD under a light regulatory approach without either, there being unacceptable interference between the two uses, or the technical conditions needed to protect one use from the other being so restrictive as to make that use un-viable).[55]

5.3 As set out in this consultation both approaches have benefits which are unique to the services for which they may be suitable and, as such, we are currently not in a position to make a judgement on the most appropriate authorisation route. It would therefore be beneficial if stakeholders and consumers could inform Ofcom of their preferred authorisation option for the 872/917 MHz bands and provide any supporting evidence.

5.4 The choice of authorisation approach will, of course, be dependent on the type of applications for which we believe the band is most suitable. Our decision will be based in part on the responses we receive to this consultation and on factors including, but not limited to:

- Economic evidence;
- Reversibility of any decision; and
- Ease and cost of implementation.

5.5 Choosing the authorisation approach to the spectrum will involve an assessment of the costs and benefits which would flow from the relevant potential uses. Ofcom notes this will generally inform rather than determine our decision. Fulfilling our statutory duties will often mean taking account of issues that would fall outside a narrow consideration of costs and benefits. We also note that, it is often difficult to quantify all the costs and benefits, in which case, it may be hard to identify which option has the highest net benefit and choose an option solely on that basis (e.g. due

[55] Although we will consider further whether they are not so exclusive

to uncertainty over the value of potential uses). Where such factors exist, a qualitative rather than a quantitative approach may more appropriate.[56]

5.6 Accordingly, one determinant of our decision will be an assessment of the potential value for citizens and consumers that could be created over time by the applications that would be enabled under each authorisation approach (full licensing or light regulatory approach), recognising that these approaches are likely to be mutually exclusive. Put another way, we will need to make judgements about whether the scale of potential benefits for citizens and consumers that might be generated by the types of applications requiring a full licensing approach (such as mobile broadband, Digital PMR, GSM-R etc) are likely to be greater than, or less than, the scale of potential benefits for citizens and consumers that might be generated by the types of applications that would be enabled by a light licensing regime (such as SRDs, RFIDs etc). We consider that if the lower power limit were to be adopted under the full licensing approach (see below) then this would reduce the economic value that could be created by the applications that would be enabled under this approach. This could make the full licensing approach less advantageous by comparison with the light regulatory regime.

5.7 A comparative assessment of the potential benefits that could be enabled under each authorisation approach will be subject to considerable uncertainty and will require a number of judgements to be made. Feedback from stakeholders in response to this consultation supported by analysis and evidence, will play an important role in supporting the assessment that we undertake. (This is a quite different situation to one where all the plausible candidate uses of a band would require a full licensing approach and the question of which candidate use is likely to create greatest benefits does not require regulatory judgements to be made about competing values in use; instead, the spectrum can be awarded via auction with the bidder(s) that value it most ultimately acquiring the spectrum).

5.8 The rest of this section now considers a number of specific issues that we will need to consider and make decisions upon in due course, depending on which of these two approaches (full licensing approach or light regulatory approach) we decide to pursue.

Authorisation under a full licensing approach

5.9 Under the full licensing approach we would need to make a number of decisions relating to:

- The choice of power levels specified in the technical conditions;
- The method of spectrum award;
- Spectrum packaging.

Choice of lower or higher power technical conditions

5.10 As set out in Section 4 and Annex 6 there are two possible sets of technical conditions that could be considered under the full licensing approach: a lower power set and a higher power set. The choice of which set of technical conditions to adopt would depend on which would be likely to generate the higher net value, taking account of:

[56] http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf, (paragraph 5.25)

- The additional value in use that might be created by permitting higher power uses in the 917 – 921 MHz band (over and above the value that might be created by permitting lower power uses in this band): as against

- The additional cost of filtering on UMTS900 base stations (or the cost of other coordination / mitigation measures) that would be required in order to enable higher power uses of 917 – 921 MHz band to be authorised, together with a measure of the cost associated with any reduction in UMTS900 base station performance resulting from the filtering (and also the cost of meeting reduced OOB emissions in the 917 – 921 MHz band, if relevant).

5.11 As above, our assessment of this choice (which is, of course, an input into the assessment of whether to opt for a full licensing approach or a light regulation approach) will be informed by information provided by stakeholders in their responses to this consultation.

5.12 We have made a preliminary estimate of the cost impact on a UMTS900 network. For this we have assumed a roll out of approximately 4,500 UMTS900 sites (this is consistent with the medium rollout scenario from our Mobile Liberalisation consultation[57]).

5.13 An indicative cost, based on our initial investigation, for the improved filter in the UMTS900 base station receive path would be approximately £400 each for 1000 units. If we assume that each site requires one filter per sector then the total additional cost could be in the approximate region of £400×3×4500 = £5.4 M.

5.14 However, this estimate should be viewed cautiously:

- The costs will vary depending on whether the filters are specified and fitted at the manufacturing stage or are added later as a retro fit, in which case they may have to be fitted outside of the equipment cabinet;

- The high specification filters may impact the performance of the base station and these effects would need to be taken into account. An example would be an increased insertion loss which could potentially lead to a reduction in the base station coverage area;

- Further work may show that the UMTS ACS is better than the values derived from the ETSI specification; filters would only be required in areas where it is anticipated that a licensed service in the 872/917 MHz band will have the potential to interfere with UMTS900;

- The new 872/917 MHz band Licensee could make bilateral arrangements with the adjacent band operators based on physical configurations with agreed antenna to antenna coupling.

5.15 We have not estimated the cost of the reduced OOB emissions from a transmitter in the band 917 - 921 MHz as we suggest that the OOB emissions are more manageable than ACS and therefore can be obtained without excessive cost to the 872/917 MHz band operator. We note that, in any event, this would be for a potential 872/917 MHz operator to determine when considering using this band.

[57] Application of spectrum liberalisation and trading to the mobile sector – A further consultation – Annex 7, paragraph A7.50

5.16 If a high power service were to be deployed in the 917 – 921 MHz band, Stakeholders may wish to consider to whom, and using what mechanism, the costs for mitigation (e.g. filtering to enable co-existence and protect adjacent services) should be fall.

Question 7: We would like stakeholder views on the cost and performance impact of the UMTS900 filters described above.

Question 8: Are there are any other methods that would give the same protection as the filters? What costs and performance impacts would these have?

Question 9: What are your views on the need for and justification of such mitigation measures and how their cost should be borne?

Spectrum award

5.17 Under a full licensing approach there are two possible authorisation mechanisms that are most likely to be compatible with our statutory duties: an auction or comparative selection (also known as a "beauty contest"). Of these, we believe that an auction is likely to be the most suitable approach. The UK Government stated its commitment to auctions as the primary assignment mechanism for spectrum awards, where possible, in its response[58] to the Cave Report[59] and Ofcom endorses this commitment.

5.18 Whilst these two processes are different, (auctions allow the market to reveal the relative value and use of the spectrum, whereas comparative selection relies on the Regulator making this decision), they both result in a limited number of licences being granted. Ofcom believes that the most appropriate way to further the interests of citizens and consumers is not to unduly restrict the range of applications and technologies that are allowed to use the spectrum, but instead allow the market (rather than the regulator), to decide the best use.

5.19 Under a full licensing / auction approach there are several steps that would need to be addressed before any licence(s) could be awarded. An auction process would need to be designed, consulted on and undertaken. In parallel with this it would be necessary to develop and make Auction Regulations, and it would likely be necessary to develop and make Spectrum Trading Regulations, Register Regulations and a Limitation Order. All these regulatory requirements and documents stipulate the rules and prescribe how the auction process is run, the number of licences that can be awarded, how they must be registered and may be traded.

5.20 Ofcom would also need to consult on and publish an Interface Requirement[60] to set the essential basic technical parameters for the services to comply with.

[58] DTI, RA and HM Treasury: *Government Response to the Review of Radio Spectrum Management*, October 2004, http://www.spectrumaudit.org.uk/pdf/governmentresponse.pdf
[59] Cave, Martin: Review of Radio Spectrum Management, March 2002 – http://www.spectrumaudit.org.uk/pdf/20051118%20Final%20Formatted%20v9.pdf
[60] http://www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/

Packaging

5.21 If, following this consultation, we make a decision to follow a full licensing / auction approach we will then hold a further consultation on the auction process and award design. However, the packaging of spectrum will be a key design feature and it is useful to obtain initial stakeholder feedback on packaging at this stage.

5.22 There are two basic considerations needed for the package design for any auction of the 872/917 MHz bands; these relate to the case for splitting the award either by frequency or geographically:

- Frequency split: bearing in mind the applications listed in Section 3 our current view is that there would be no benefit from splitting this block and, therefore, that a single 2 x 4MHz lot would be likely to be appropriate;.

- Geographical split: we are aware of some interest in splitting the award into separate Great Britain (GB) and Northern Ireland (NI) lots as we note that this band has already been auctioned in Ireland. However, other geographic splits are likely to create complicated boundary conditions that could lead to reduced value and we are not aware of interest in such splits. As a consequence we believe that, other than a possible GB/NI split, geographic splitting of lots is likely to be undesirable.

Question 10: Stakeholders views are sought on whether the spectrum should be awarded as a single lot by frequency, or whether it should be split in to smaller frequency lots.

Question 11: We would like stakeholder's views on whether the packaging should be split GB/NI or if we should proceed with UK wide packages.

Authorisation under a light regulatory approach

5.23 A light regulatory approach could be introduced in two ways, a light licensing regime or a licence exempt regime.

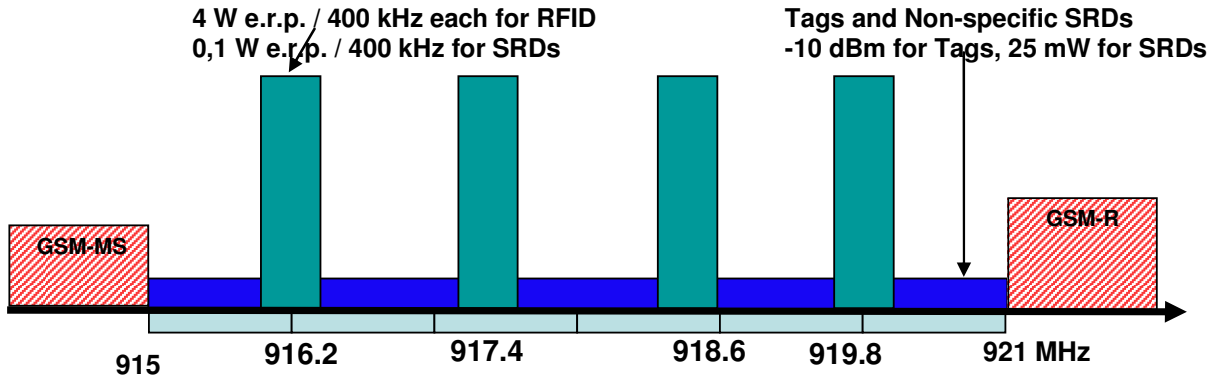
5.24 The adoption of either regime would be based on any appropriate technical conditions for protecting adjacent users. If the 872/917 MHz service can coexist with adjacent services without causing undue interference then licence exemption would be appropriate. If our analysis shows that there is a potential for interference, but this could be mitigated (e.g. with the use of separation distances or some other technique) then light licensing of the service might be need for reasons outline below.

5.25 In Section 3 we discuss the possible interest in the use of RFID/SRD in the 872/917 MHz bands, and it is suggested in the ETSI SRDoc that the band could be split as shown below:

- SRD use in the 872 - 876 MHz band;

- RFID use in the 917 – 921 MHz band, (note that the ETSI proposal has a fourth channel, 916.4 MHz, that is outside the frequency range covered in this consultation (it is in the MOD spectrum, 915 – 917 MHz); and

- SRD use in the band 917 – 921 MHz with powers of 0.1 W e.r.p. being proposed in the RFID channels and with a max power of 25mW e.r.p outside the RFID channels as shown below:



(Source Figure 4 TR 102 649-2 V1.1.1)

5.26 Using the proposals in the ETSI SRDoc as a basis, our current technical analysis in Section 4 and Annex 6 shows that in order to use RFID a significant separation distance would be required to protect adjacent users, GSM, UMTS and GSM-R (in the order of 190 - 430 m). This is likely to require a light licensing approach.

5.27 We believe that licence exemption would not be appropriate for RFID use if a separation distance is required as it would not be possible to ensure co-ordination distances are met. In a licence exempt regime it would be harder to trace interference and operators would be unaware of the existing locations of RFID installations when deploying new base stations.

5.28 To date we have not analysed the impact of SRD use in the band but it is reasonable to assume that if they fit into the technical conditions set out for mobile hand sets then this would be sufficient on its own to manage interference.

5.29 Therefore SRDs in both the 872/917 MHz bands could, in principle, be authorised via the licence exempt route.

Light licensing

5.30 Under a light licensing regime users of a band are awarded non-exclusive licences which are typically available to all, and are either free or only have a nominal fee attached to them. There may be further obligations associated with the provision of a licence such as the need to register the location of any transmitters and, possibly, to co-ordinate their deployment with users in adjacent bands or other registered users in the same band.

5.31 Before licences could be issued under a light licensing regime Ofcom would first need to consult on its proposals, technical analysis and proposed fee rates.

5.32 If our assumptions about the characteristics of RFID are confirmed by responses to this consultation and / or the current work being carried out by CEPT/ETSI then it is likely that a light licensing approach could be adopted.

5.33 It should be noted that the UK could authorise RFID use in the band before the CEPT/ETSI work is complete. Indeed there is an argument that there would be

economic value to the UK in going down this route whether or not the rest of Europe does so. This is because the 917 – 921 MHz band aligns with part of the global RFID band used in the rest of the world, and the performance of the majority of RFID tags are optimised for this band rather then the current European band of 863 – 870 MHz.

5.34 In the discussion of the full licensing approach above, it was noted that the cost of protecting adjacent services requires further detailed consideration. For a light licensing regime, our preliminary proposal is that the technical conditions would be developed to protect base stations in adjacent bands on the assumption that they deploy standard filtering rather then the improved filters discussed in 5.11 to 5.15.

5.35 Due to the potential for interference between RFID transmitters and adjacent services at distances closer than the separation distances we have calculated, we anticipate that the location of all RFID will need to be registered on a database.

5.36 Exactly how the database and process would work will be discussed in more detail in the next consultation if a light licensing approach is chosen. At a basic level, a database would enable us to check whether any mandatory separation distances are being respected and would enable licensees in adjacent bands to check the location of transmitters in the vicinity of their base sites to help track down sources of interference.

5.37 The licences would detail the general terms and conditions, and contain a licence schedule or schedules that would list the technical parameters and frequencies of the service or services (a licence may have more than one). Ofcom would also need to consult on and publish an Interface Requirement for these licences to set the essential basic technical parameters for the services to comply with.

5.38 By requiring the registration of transmitter locations, and possibly their technical characteristics, light licensing provides an efficient means for the protection of incumbent services in adjacent bands from interference due to new services.

5.39 In the UK, light-licensing databases are at present established and maintained by Ofcom, with a nominal annual fee charged. The licences are of an indefinite duration, but subject to revocation following a reasonable notice period (typically five years).

5.40 For a light regulatory approach, Ofcom's initial view is that, because of the fragmented nature of deployment this approach might encourage (i.e. the potential for multiple licensees to be distributed more or less randomly across the country), it would be impractical for adjacent operators to co-ordinate locally on all RFID installations. But for the deployment of new base stations, by adjacent operators, it may be necessary to agree locally on a case by case basis.

5.41 Light Licensing is explained in more detail in Section 5 of the Licence Exemption Framework Review[61] .Examples of this type of licensing scheme that have been implemented in Ofcom are 5.8 GHz Fixed Wireless Access Licence and 71 - 76 GHz and 81 - 86 GHz Self Coordinated Links.

Question 12: Would it be practical for RFID users and adjacent operators (e.g. GSM, UMTS, GSM-R) to co-ordinate locally on a case by case basis? The answers to this will help Ofcom develop its views on whether a database would be required.

[61] http://www.ofcom.org.uk/consult/condocs/lefr/lefr_statement/

Question 13: Do you agree with Ofcom's preliminary proposal that the separation distances suggest a light licensing regime if SRD/RFID use in this band were to be supported? If not, how should the interference into adjacent bands be managed?

Licence exemption

5.42 In deciding whether spectrum use should be made exempt from licensing it is important to note that Ofcom is subject to certain legal obligations under the Communications Act 2003, Wireless Telegraphy Act 2006 and EU Authorisation Directive (2002/20/EC).

5.43 There are two approaches to spectrum used by licence-exempt devices:

- The first is application-specific, where frequencies are reserved for exclusive licence-exempt use by a single or a small number of defined applications (e.g. spectrum used by DECT cordless phones);
- The second is spectrum commons[62], where only the technical conditions are defined (e.g. in-band and out-of-band power limits) but where any application may be used.

5.44 Radio equipment is made licence exempt by Regulations made under the WT Act using a Statutory Instrument (SI). In general, Ofcom must exempt radio stations, equipment or apparatus where we are satisfied that their use is not likely to involve any undue interference to other legitimate use of radio spectrum or is contrary to an international obligation.

5.45 If licence exemption is considered Ofcom would need to consult on its proposals and technical analysis demonstrating that it is possible for the exempt services to co-exist together and with services in adjacent bands. This consultation would list the draft Statutory Instrument known as an "Exemption Order" that would need to be published to exempt the desired radio equipment from the need from licensing. Again an Interface Requirement would also be required to detail the basic technical criteria necessary for the radio equipment to comply with.

5.46 Following publication of the Exemption Order (and necessary supporting documents; Interface Requirements etc) stakeholders and consumers could legally use the exempt radio equipment without the need to apply for a licence or seeking coordination.

5.47 Ofcom will not be able to maintain information about the location and use of licence-exempt apparatus/equipment. So, whilst its licence exempt use would be unlikely to be permitted where it will cause undue interference, and it must in any event comply with any applicable equipment regulations (as to its potential for interference and electromagnetic compatibility, for example), users of such equipment should be aware that there may be a very dense deployment of exempt equipment at certain locations and the ability of such equipment to withstand interference will to a large extent depend on its design, quality and robustness. Ofcom's ability to investigate or manage any interference to, or between, items of exempt apparatus/equipment would be limited.

[62] http://www.ofcom.org.uk/consult/condocs/scc/statement/

Combining light licensing and licence exempt use in the 872/917 MHz bands

5.48 It is possible that a light regulatory approach could be implemented by treating the bands 872 – 876 MHz and 917 – 921 MHz separately or allowing a combination of light licence and licence exempt in the same band. There may also be licence exempt uses that could sit alongside fully licensed applications.

5.49 This issue would need to be reviewed further in light of responses to this consultation.

Reversibility of any Ofcom decision

5.50 Given the uncertainty surrounding the possibility of a full licensing approach or light regulatory approach in the 872/917 MHz band, we consider that it is important to take into account the reversibility of any Ofcom decision.

5.51 Were we to go for a full licensing approach in the 872/917 MHz band it would be possible (taking account of constraints on spectrum management such as minimum licence terms) to reverse the decision if the market evolved in a different direction. For example, if strong evidence emerged on the value of licence exempt use, the spectrum could be made licence exempt at the end of the minimum licence period.

5.52 However, were we to licence exempt the 872/917 MHz band it could be significantly more difficult to reverse this decision if the market evolves in a different direction. This is because making this spectrum licence exempt could result in a large and diverse customer base whose ownership and location is unknown, and where use of the spectrum is not recorded, meaning that the task of clearing existing use (in order to change the designated use of the spectrum) would take time and be difficult to do.

5.53 A light licensing regime would likely sit between full licensing and exemption in terms of reversibility. This type of authorisation regime would allow us to track where transmitters are installed and to issue revocation notices. However, due to the potentially large number of users, reversing such a regime and moving to a full licensing regime could still be more involved than in the case of a full licence approach in which the spectrum has been awarded to one (or at most a few) licensees via an auction. However moving to a licence exempt regime from a light licence regime, would be relatively straightforward.

Summary

5.54 This section has discussed the alternative approaches to authorisation that we could adopt: a full licensing approach and a light regulatory approach (of which there are two possible flavours, light licensing or licence exemption). A key distinction between these approaches is that in the full licensing approach the spectrum would be awarded via auction to a limited number of licensees whereas, under the light regulatory approach, there would be no limit on the number of parties that would be able to use the spectrum.

5.55 The choice between these two main approaches will be informed by an assessment taking account of a range of relevant factors. While the economic benefits (net of costs) for each option will form part of the assessment, not all benefits or costs may be readily quantifiable. Moreover, factors such as uncertainty and reversibility of the decision will also need to be considered. Above all, our decision will need to fit with our range of statutory duties and any international obligations.

5.56 Depending on the choice of main authorisation approach there will be number of subsidiary issues that we will then need to address (such as the choice of spectrum packaging for an auction under the full licensing approach).

5.57 We are particularly interested in hearing from stakeholders that see themselves as potential users of the bands in order to inform the above assessments. We would find it particularly helpful for these responses to be accompanied by information and evidence relating to the nature of potential use and to the factors that could drive the delivery of benefits to citizens and consumers through this use.

Section 6

Next steps

6.1 We are seeking responses to this consultation by 3 November 2009. We will then undertake further analysis of the potential benefits of the different authorisation options, drawing on the responses to this consultation. We would welcome meetings with interested parties during and after this consultation period. This may enable us to make a decision on the main choice of authorisation approach (full licensing approach or light regulatory and, in the latter case, the balance between light licensing and licence exemption) in the first half of 2010. This decision will reflect, in the main, our assessment of which types of application might generate greatest net benefits for citizens and consumers in future.

6.2 At the same time as this Statement, or shortly thereafter, we would expect to publish a further consultation setting out more detailed proposals for implementing the chosen authorisation approach. This may include further consultation on the technical conditions.

6.3 Depending on the approach chosen, this could lead to the authorisation of this spectrum later in 2010.

6.4 Through this period we will take into account the ongoing CEPT work on these bands and the potential impact on Ofcom's proposals and possible timetable should a light regulatory approach be chosen as the preferred option. However, we do not think it would be necessary for Ofcom to postpone making any decisions until CEPT has concluded its studies (although there may be scenarios where this could be desirable).It should be noted that CEPT Decisions and Recommendations are not mandatory and there may be no over-riding reason for all of Europe to adopt the same approach to this band.

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 3 November 2009**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://www.ofcom.org.uk/consult/condocs/872_876_mhz/howtorespond/form, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email mark.austin@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Mark Austin
03:99
Mobile Services Spectrum Team
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 483 4303

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Mark Austin or Richard Young on 020 7981 3000.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether

all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Following the end of the consultation period, Ofcom intends to publish a statement in Autumn 2009.

A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

Vicki Nash
Ofcom
Sutherland House
149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title: Consultation on the way forward for the future use of the band 872 - 876 MHz paired with 917 - 921 MHz

To (Ofcom contact): Mark Austin

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing	☐	Name/contact details/job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name Signed (if hard copy)

Annex 4

Consultation questions

A4.1 Question 1: Do you believe that the uses listed in this section (Section 3) are possible candidates of the 872/917 MHz bands?

A4.2 Question 2: Are there additional applications/services (not listed above (from Section 3)) that could make viable use of the 872/917 MHz bands that Ofcom should be aware of?

A4.3 Question 3: What services do you believe should be authorised to use this band? Could you supply relevant information supporting your preference and include any economic data relating to the value of the spectrum in providing these services?

A4.4 Question 4: Do you agree with the methods used to assess the potential to interfere with adjacent band services in a full licensed approach?

A4.5 Question 5: Do you consider that the proposed technical licence conditions would be justified and appropriate.

A4.6 Question 6: Do you agree with the methods used to assess the likelihood of services interfering with adjacent band services under the light regulatory approach?

A4.7 Question 7: We would like stakeholder views on the cost and performance impact of the UMTS900 filters described above.

A4.8 Question 8: Are there are any other methods that would give the same protection as the filters? What costs and performance impacts would these have?

A4.9 Question 9: What are your views on the need for and justification of such mitigation measures and how their cost should be borne?

A4.10 Question 10: Stakeholders views are sought on whether the spectrum should be awarded as a single lot by frequency, or whether it should be split in to smaller frequency lots.

A4.11 Question 11: We would like stakeholder's views on whether the packaging should be split GB/NI or if we should proceed with UK wide packages.

A4.12 Question 12: Would it be practical for RFID users and adjacent operators (e.g. GSM, UMTS, GSM-R) to co-ordinate locally on a case by case basis? The answers to this will help Ofcom develop its views on whether a database would be required.

A4.13 Question 13: Do you agree with Ofcom's preliminary proposal that the separation distances suggest a light licensing regime if SRD/RFID use in this band were to be supported? If not, how should the interference into adjacent bands be managed?

Annex 5

April 2006 consultation and responses

Background

A5.1 The April 2006 Consultation proposed that the 872 - 876MHz paired with 917 - 921MHz band should be licensed via an auction. The consultation outlined the key issues and asked the following question:

- "Do stakeholders agree with these proposals for the award of this band or have any other comments on the contents of this document?"

A5.2 Our proposal to use an auction as the method for assignment, and our other proposals relating to the details of the auction design, were derived from the objectives for the award, and in particular the aim of securing optimal use of the spectrum. Based on the available evidence and spectrum usage in 2006 we consider that the proposals it made were fully in line with our statutory duties.

A5.3 We proposed that the level of the reserve price should be set at £50,000, which would be the minimum for any valid bid as our primary objective in the auction was to promote the optimal use of the spectrum. We considered that the main function of the reserve price in this award was to deter frivolous bidders and it should be set at the minimum level necessary to do this without deterring genuine bidders.

A5.4 We received twelve responses (nine public and three confidential (one part confidential)) to the April 2006 Consultation from a range of interested parties. These included responses from the aeronautical industry, telecommunications industry, Mobile Network Operators, Government, RFID industry, rail industry and film industry.

A5.5 The full text of the non-confidential responses can be found at: http://www.ofcom.org.uk/consult/condocs/872 - 876/responses/

A5.6 We considered the options of licensing, exemption and not awarding the spectrum at all. In the consultation we proposed that the option to award a single licence by auction made optimal use of the spectrum, promoted competition and best fulfilled our other duties on the basis that:

- a high number of users of the two blocks of 4 MHz would require particularly strict co-ordination of their potentially varied uses and technologies, thereby imposing constraints on each user that could significantly limit the use of the Spectrum Bands in certain areas;

- we were not aware of any demand for access to the 872/917 MHz bands under a large number of, or indeed several, distinct licences (for each less than 2x4 MHz) or under concurrent licences (with equal access to the Spectrum Bands);

- we also proposed that as the licence would be tradable there would be scope for the licensee and the market to change this situation as the number of licensees in the 872/917 MHz bands could therefore be increased through concurrent or partial trades;

- as demand for the spectrum was uncertain and, to some extent, was unclear as to what technologies and services might wish to use this spectrum there was no obvious basis on which to package the available spectrum. That the spectrum was relatively limited and splitting the spectrum into smaller packages would limit the possibilities for its use, particularly as tight emission rights would be needed to prevent interference between packages, this would run counter to the efficient use of the spectrum and pointed to offering the 872/917 MHz bands as a single package;

- (related to the point above) Given the uncertainty over future use of the band there was no basis or justification for offering a number of licences covering pre-determined geographical areas;

- geographical partitioning was considered likely to inhibit efficient use of the spectrum, compared to a licence for the UK as a whole, because of the need to manage the risk of interference between the various geographical zones at the boundaries;

- other assignment mechanisms were unlikely to be as efficient in promoting optimal use of the spectrum for this award if demand exceeded supply;

- an auction was likely to be the preferred mechanism for assigning unused or under-used spectrum as an auction was likely to be the most open, transparent and non-discriminatory way of releasing spectrum, using clear and simple criteria to identify eventual licensees among a number of candidates;

- the notice given to stakeholders on plans for the award with publication of the SFR:IP in January 2005 should allow them a reasonable period for exploring potential uses and proposed, subject to the outcome of the consultation, that the auction take place in early 2007;

- a single-round, sealed-bid, second-price auction should be used as this design is simple, quick and low cost to administer and participate in;

- the risks of an inefficient outcome as a result of using a single-round sealed-bid process were considered to be low in the circumstances of this particular award; and

- The risk of collusion was also considered to be low, as opportunities would be limited in a single-round sealed-bid process for a single licence.

Overview of the key proposals from the April Consultation

A5.7 The key elements of the proposed spectrum packaging and licensees' rights and obligations for the spectrum to be auctioned were as follows:

- One UK licence would be offered;

- The licence would have an indefinite term with an initial period of fifteen years (during which time Ofcom's powers to revoke will be limited);

- The licence would be tradable;

- The licence would be technology and application neutral; and

- The licence would contain transmission rights and technical provisions designed to protect adjacent band users from harmful interference;

A5.8 The key elements of the proposed award process were as follows:

- The auction would take the form of a single round sealed bid auction – each bidder will be able to submit one bid;
- The winning bidder would be the one that submits the highest bid;
- The auction would be based on a second price rule: the winning bidder would pay the price set by the next highest bid, or the minimum price if there was no other valid bid; and
- The minimum price for the licence would be £50,000.

Objectives of the April 2006 consultation

A5.9 The main objective of the April 2006 consultation was to further the interests of citizens and consumers by promoting the optimal use of the spectrum. This aim was central to the award of the frequency bands 872 - 876 MHz and 917 - 921 MHz. In preparing its proposals to secure this objective, we considered and had regard, in particular, to the availability of and demand for the spectrum and to the desirability of promoting:

- the efficient management and use of the spectrum;
- the economic and other benefits that may arise from use of the spectrum;
- the development of innovative services; and
- competition in the provision of electronic communications services.

A5.10 The earlier SFR identified that in many circumstances the use of auctions is likely to be the most appropriate means of assigning spectrum that is not currently assigned where demand for the spectrum is likely to exceed supply. It also sets out the general view that wireless telegraphy licences for award should, so far as possible, include rights that are technology and usage neutral.

A5.11 On the basis of the above we proposed that a single round sealed bid auction in early 2007 for the award of an indefinite (minimum 15 years), tradable, technically defined, single national wireless telegraphy licence was considered the optimal choice and most spectrally efficient.

A5.12 In reaching this proposal we also considered various other award processes (licence exemption / no award), award mechanisms (first come first served processes / comparative selection) and auction options (multi-round, open, ascending bid auctions / Anglo-Dutch hybrid). It was felt these options did not best fulfil all Ofcom's duties for the following reasons:

Licence exemption

- Based on our technical analysis we stated that we believed there would be significant risks of interference between users of the 872/917 MHz bands, and between these users and adjacent users, if use were exempt from licensing;

- the number of unlicensed users could become very high and, even with low power limits, their systems would be unlikely to coexist without harmful interference if their locations could not co-ordinated in some precise way;

- Our assessment was that the available mitigation techniques would not be sufficient to appropriately reduce the risk of in-band interference;

- There was no evidence of demand for licence-exempt use of the 872/917 MHz bands at that time (based on the market study Ofcom had commissioned and responses to the SFR:IP). By contrast, Ofcom had found evidence of interest for the deployment of wide-area services which would typically require licensed access to the Spectrum Bands in the interests of efficient use.

- We did however consider that mobile stations transmitting in the band 872 - 876 MHz could be exempt from licensing and that any exemption would likely be subject to similar emission conditions as the proposed licence.

No Award

- The option of not awarding the spectrum was not considered to be a viable option as Ofcom felt that through releasing available spectrum into the market it was likely to further the interests of citizens and consumers. It was felt that an award would offer opportunities for additional capacity for services, additional innovation and competition. We considered that so long as there was any reasonable prospect of the spectrum coming into use, with benefits greater than the administrative costs of release, it would not be in the interests of citizens and consumers to leave the spectrum unavailable.

Other award mechanisms considered

A5.13 We considered that other assignment mechanisms were unlikely to be as efficient in promoting optimal use of the spectrum for this award if demand exceeded supply.

A5.14 The alternative assignment mechanisms considered were a first come first served processes, where licences are assigned to applicants in the order of their application, and a comparative selection process, where licences are assigned to the applicants that, in the regulator's judgement, best satisfy the selection criteria that it has set.

A5.15 We believed that a first come first served process would not be appropriate where demand for spectrum is likely to exceed supply, as the first applicant may not be the person who would make the most efficient use of the spectrum.

A5.16 A comparative selection process would involve us defining selection criteria and assessing candidates' submissions against these. We felt this carried the risk of subjective judgements being made and of the spectrum not being awarded to the bidder best able to use it to maximum economic advantage.

Other award designs considered

A5.17 Two other award designs were considered in the April 2006 consultation, namely:

- Multi-round, open, ascending bid auctions; and

- Anglo-Dutch hybrid.

A5.18 We considered the suitability of these alternative auction formats by taking account of the following factors:

- simplicity, speed and costs of administration and participation;
- incentives for participation;
- efficiency of outcome; and
- opportunities for collusion.

A5.19 Another key aspect we considered was how the final price paid should be determined in a single-round sealed-bid auction. For an auction with a single lot, it was considered there were two main alternative pricing rules:

- a first-price auction where the winner pays the amount that they bid;
- a second-price auction where the winner pays the amount of the next highest bid (i.e. the highest losing bid) or the reserve price if there is no other valid bid.

A5.20 It was believed that the choice of pricing rule would have a significant implication for the outcome of the auction because of its influence on the behaviour of bidders in the auction

A5.21 In our deliberations we considered both the pros and cons of both first-price and second-price single-round, sealed-bid auctions.

A5.22 Given the increasing complexity of running a multi-round, open, ascending bid auction or Anglo-Dutch hybrid auction it was considered these would be more time consuming and costly, with an increased chance of collusion, than a sealed bid process. It was considered that with the uncertainty over spectrum demand and the differences in cost and complexity to bidders may deter them from participating in the auction.

Summary of the responses to the April Consultation

A5.23 Of the twelve responses received four agreed with and supported the proposals and our approach to the award of the spectrum as defined in the April Consultation.

A5.24 Several of the responses contained critiques of technical issues and some contained substantial points.

A5.25 The following list highlights the main themes, questions and concerns arising from the responses to the April Consultation. These can be broken down into fifteen distinct areas:

1. Reserving the spectrum for a particular use or user

A5.26 There were three responses on this particular issue:

- Network Rail and the Department for Transport raised issues of MOD/GSM-R co-existence and that the spectrum should be identified for potential MOD exclusive use to resolve GSM-R coexistence issues. They considered that if not, this could breach EU legal requirements; and

- The RFID Retail Expert Group felt that we should consider reserving the spectrum for RFID use with an undertaking to thoroughly analyse the costs and benefits of doing so.

2. Potential uses for the spectrum

A5.27 There were five responses that specifically addressed this issue:

- BAA felt that we should consider the possibility of allowing a PMR band manager to administer this spectrum and encourage band managers to bid for the spectrum;

- Richmond Film Services requested if both legs of the band could be used for low power (40mW) radio microphones as no base stations would be needed;

- One confidential response thought that 3G use should not be permitted in the band;

- Qualcomm stated that the spectrum could potentially be used for wide area mobile technologies such as CDMA2000 and FLASH-OFDM; and

- Zapp Holdings believed demand for the spectrum would be low because of the discrimination it claimed we were exercising against new entrants in order to protect incumbent licensees.

3. Existing rights of licensees

A5.28 O2 considered that it was inappropriate for us to assess the likelihood of harmful interference being caused based on our understanding of historical deployment of particular configurations and specifications of radio equipment that form no part of incumbents' licence requirements. The award should allow incumbent licensees in neighbouring bands to exercise their full rights to deploy any radio equipment that meets the relevant licence conditions, anywhere within the geographically licensed area, and with full protection from harmful interference caused by equipment that is proposed to be licensed in the Spectrum Bands.

4. Award packaging (1 national licence)

A5.29 Five responses addressed this issue:

- Both Qualcomm and one confidential response supported the proposal for 1 national licence. The confidential response would have preferred several smaller licences be offered, but qualified its support based on the constraints required to protect adjacent users;

- Arqiva supported the award of a single national licence, but if it was decided the award should be divided into smaller lots, applicants should be allowed to bid for the whole band in addition to any other bids for specific lots;

- BAA believed that instead of the proposed one national licence we should offer several licences to promote competition , innovation and the provision of PMR services (as in 412 - 414 MHz / 422 - 424MHz award); and

- Zapp Holdings felt the April 2006 Consultation was discriminatory and breached some of our basic principles; would not lead to efficient use of the spectrum or promote competition and innovation and was not technology neutral.

5. Auction Format

A5.30 One confidential response addressed this point and expressed the view that it was concerned about the single round, sealed bid auction format we had proposed and that it would prefer a multi round ascending auction. This would promote competition and be more efficient. They emphasised that a sealed bid auction unnecessarily introduces risk which can act as a deterrent to inventors.

6. Timing of the award

A5.31 There were four responses on this point that all agreed the award should be delayed:

- Both Network Rail and the Department for Transport felt the auction should be delayed until the GSM-R issues had been addressed fully and Ofcom had taken account of the ongoing European progress toward securing more spectrum for GSM-R;

- The RFID Retail Expert Group felt that the award should be delayed until the case for unlicensed RFID use had been investigated; and

- One confidential response felt that we needed to wait until the 2G mobile liberalisation and spectrum usage rights issues have been resolved and a reasonable level of 3G investment payback has been realised.

7. Technical condition

A5.32 There were five responses that raised technical points:

- One confidential response thought it would beneficial for capacity and network planning if the internal guard bands could be used for roll off and requested clarification on whether the internal guard bands could be used for roll off for low power wide band technologies. Clarification was sought on whether +1MHz of guard band would be needed at 917 - 921 MHz (for each extra dBm) in addition to the 0.2 MHz free of carrier at the top end and whether roll-off from carriers would be permitted within the additional guard band;

- One confidential response was concerned about the reliance on ECC studies and lack of supporting evidence and that we should consider the approaches taken in other European Member States and define a more relaxed set of technical conditions;

- Network Rail asked as the MOD do not fall under our jurisdiction whether they would need to seek approval for a change of use of the adjacent spectrum and what protection would be offered from MOD usage of equipment with a wide spectral footprint close to the band edge;

- O2 felt we had not clearly stated its assumptions about the filter characteristics for GSM base stations already fitted with duplex filters; and

- Qualcomm expressed a wish to explore the possibility for two FDD carriers of 1.25MHz, considered that guard bands were not required and that consideration should be given to providing adjacent service protection via varying power limits.

8. Technical conditions - power levels / interference

A5.33 There were six responses on this issue:

- One confidential response felt that coupling the maximum transmit power to the occupied system bandwidth would de-value the spectrum and is not required for co-existence. They also felt that the noise limited scenario is not relevant and that the interference limited results of ECC Report 41 should be used as a basis for validating the co-existence of PAMR and GSM-R as has been done in other European countries;

- Network Rail argued that efficient use of the bands under licence exempt or technology neutral licensing could result in significant worsening of conditions for spectral neighbours through the noise floor rising due to a large number of users;

- O2 did not believe that the approach taken in the April 2006 Consultation was consistent with the 1785 – 1805 MHz Northern Ireland award. O2 considered the limit of maximum radiated power proposed in 1785 – 1805 MHz Northern Ireland award to be an appropriate way of ensuring that potentially affected services are protected from interference. It argued that the methodology in the April 2006 Consultation was inappropriate as it places an inequitable burden on the nearest adjacent GSM user of the band and that we had not presented any evidence for our proposal;

- Qualcomm expressed a wish to explore further the reasons for the power limits and the impact these would have on systems that could potentially be deployed in the spectrum;

- One confidential response agreed with the proposal to have different EIRP limits depending on the distance from the band edge that the transmission occurs. Clarification was also requested on whether an internal guard band is necessary or could a lower EIRP limit be used to closer to the band edge; and the reference bandwidth for the out of block emission mask which is not specified above 876MHz or 921MHz; and

- Zapp Holdings believed that we had taken a biased position in favour of O2 and that the 56 dBm power level should be applied across the whole 917 - 921 MHz band.

9. Technical conditions - separation distances

A5.34 There were three responses on this issue:

- Network Rail expressed concern:

    - on how the revised separation distances had been reached and felt we should provide justification as to how these have been reached as it was not clear how they were derived from ECC Report 38 and whether the figures derived for CDMA-PAMR were applicable to our spectrum neutrality approach;

  - that to reduce the risk of interference from adjacent fixed transmitters and ensure a minimum coupling loss, similar protection distances as identified in ECC Report 38 should be applied to the protection requirements for mobile users transmitting in the 872 - 876MHz band in the vicinity of GSM-R base stations. It was argued that licence exemption of mobile transmitters in the 872 - 876 MHz band would render minimum separation distances from GSM-R base stations both unmanageable and unenforceable;

- One confidential response questioned whether the separation distances between base stations and GSM-R systems were realistic and queried whether the separation distances from GSM-R is necessary as there are no separation requirements or guard bands between GSM operators. They also requested that further information on the number of MOD sites and the likely co-ordination / separation distances required is necessary; and

- Zapp Holdings argued that separation distance should be reduced to 20m for the new entrant, but under conditions that the new entrant should not produce harmful interference to O2, and that O2 should protect themselves against unwanted signals transmitted in the adjacent band.

10. Technical conditions - GSM duplexers / duplex direction

A5.35 There were five responses in respect on this issue:

- One confidential response queried our duplex direction proposal and argued this contradicted our position that the licence would be technology neutral as it assumed FDD technology would be employed. It was asked whether we would consider allowing the use of TDD transmitters and mobiles that meet the power requirements and not requiring a duplex arrangement be allowed in both the upper and lower bands;

- One confidential response believed that the majority of GSM base stations currently deployed already use duplexers and this would be particularly true for base stations in this spectrum as all equipment deployed in this band should be new equipment with duplexers. It was therefore argued that no special provision should be made for GSM base stations without duplexers as these should not be in use in the critical GSM channels from a co-existence perspective;

- O2 felt we had not clearly stated our assumptions about the filter characteristics in those GSM base stations that are already fitted with duplex filters and questioned the way in which use and performance of input filtering was determined. O2 argued that the existence of duplexers on GSM base stations and the locations of base stations should not form an input to our proposals, otherwise the terms would not be equitable between GSM operators;

- Qualcomm agreed that we should employ FDD to protect adjacent services. This would also tie in with European band plans; and

- One confidential response stated it would welcome further information on the number of O2 sites that would require a separation distance or additional filtering and an indication of the cost of the additional filtering to protect O2 sites.

11. Technical conditions – relaxation of constraints through negotiation with adjacent users

A5.36 One confidential response felt that due to the linkage of the technical licence conditions to O2 that it was inappropriate to define the licence terms this way as this would gives O2 control over the value of the spectrum post auction and award. It would be fairer to define scenarios whereby the technical licence terms can be relaxed and agreed with O2 pre auction and award.

12. Information on adjacent / neighbouring users

A5.37 There were two responses on this issue:

- One confidential response requested further details on the likely cross border constraints that could be imposed if an operator deployed a wideband CDMA system in the band particularly if narrow band systems were to be deployed in neighbouring countries. It was felt that cross border co-ordination could impose a significant constraint on network deployment, especially in South East England and Northern Ireland; and

- Network Rail felt that any requirement to participate in interference analysis and resolution would be an infringement of Network Rail's "quiet enjoyment of their spectrum allocation". Network Rail argued that the new incumbent may be expected to observe procedures with respect of some transmitters to accord with European agreements, but had not put in place any limitations on the impact on the noise floor in adjacent spectrum to protect the spectrum rights of Network Rail.

13. Linkages to 2G mobile liberalisation

A5.38 Two responses addressed this issue:

- Zapp Holdings stressed that it was imperative in connection with the refarming of the 900 MHz band for UMTS900 that normal requirements for the protection of receivers against power from transmitters in adjacent bands were reinstated; and

- One confidential response urged us, given the close proximity of the spectrum to GSM 900MHz and in relation to the discussions on liberalisation, to ensure that the spectrum award does not create further competition issues.

14. Linkages to spectrum usage rights (SURs)

A5.39 Two responses looked at this issue:

- One confidential response was very concerned that we were proposing to auction this spectrum whilst critical aspects of the policy regime that would apply to the new licensees remained uncertain, citing the need to ensure that the property rights in spectrum are adequately defined prior to any auction. This response considered the proposed licence to be legally unclear and expressed a preference for a certain, defined legal title to spectrum and cautioned that disputes around interference and the question of liability relating to interference would remain unclear; and

- O2 agreed that the most appropriate definition of spectrum usage rights was one that does not need to assume the location or nature of deployments in

neighbouring bands to enable a licensee to meet its licence conditions. It expressed a view that neighbouring licensees, unless otherwise directed through specific licence conditions, should be free to deploy equipment in whatever configuration they choose, providing that all radio equipment meets its licence conditions, therefore, assumptions about deployments in neighbouring bands should not feature in Ofcom's technology and usage neutral spectrum awards programme.

15. Account of previous Ofcom consultation responses and Economic consultants report

A5.40 One confidential response noted that its views on our wider policy approach, as set out in previous responses, were relevant to the proposals to award a licence for these spectrum bands. In particular it noted the relationship between this award and the 3G Auction in 2000 and disagreed with us in not applying a restriction on 3G use in the use of spectrum bands.

A5.41 Network Rail expressed concerns about the accuracy of the DotEcon, Analysys and Mason Communications report in respect to its claims on GSM-R spectrum usage and requested the document be withdrawn from the public domain. They also felt their previous response to the SFR:IP requesting Ofcom delay the proposed auction until co-existence issues with MOD had been resolved had not been represented.

A5.42 Zapp Holdings stated that there were many places in the April 2006 Consultation where they would (and in some cases had already done so in the past) argue that the technical constraints being imposed are excessive and are not justified on fair and reasonable grounds.

Comments received post April Consultation

A5.43 Following on from the April 2006 Consultation we have continued to engage with all concerned parties who have expressed an interest or concern in regards to the award of the Spectrum Bands; with European Regulators on the deployment of the 872/917 MHz bands and continue to actively take part in the relevant European fora looking at the possible future uses for these bands. The following list details the main issues that have been raised with Ofcom in regard to this spectrum:

- We were asked if it would be possible to explore the possibility of increasing the in-band power per carrier by proposing a relaxation to the protection limits offered to the existing GSM and GSM-R incumbents. This issue has now been addressed in the technical analysis in Annex 6 of this document;

- Queries were raised on the analysis in the April 2006 Consultation on the basis that receiver filter attenuations were not available to all base stations. Annex 6 now provides examples of different in- band powers according to varying degrees of protection offered by combined transmit and receive filter attenuation, and the analysis in Section 5 poses questions about the achievable protection limits;

- Queries were raised on whether it would be possible to explore the possibility of using a standard 3G technology (3.84MHz nominal channel bandwidth) to provide live video and data feeds to the police whilst in the field. The detailed analysis in Annex 6, which relates carrier bandwidth to proposed transmission power, indicates that such wide band technologies would be difficult to implement within the award spectrum. Questions were asked about the possibility of allowing TD-CDMA systems to operate in the spectrum bands. TD-CDMA uses

time division duplexing allowing the up-link and downlink to share the same spectrum block. The current thinking relates to this possible Award has been developed based on the assumption that frequency division duplexing would used i.e. the uplink is in the 872 – 876 MHz block and the downlink is in the 917 – 921 MHz block. The use of a TD-CDMA technology would result in the possibility of base station to base station interference in the upper band, and in the lower band the base station would be limited to the mobile power. However if the TD-CDMA equipment could operate within the proposed restrictions set out for this Award then it would be possible to use this band for TD-CDMA as the band would be awarded on a technically neutral basis.

- We were asked if it would be possible to roll out a network using the FDD OFDM technology using a carrier bandwidth of 1.27MHz (as has been done in other European countries); The analysis in Annex 6 demonstrates that a carrier bandwidth of 1.27 MHz is feasible as long as the technology is capable of meeting the proposed transmission mask characteristics.

- We were asked if it would be possible to split the award and offer two licences, one for Great Britain and one for Northern Ireland. This was based on the understanding that the situation in Northern Ireland (and co-ordination with Ireland) may enable more favourable licensing conditions because of different densities of incumbent adjacent users and as Digiweb has already established a network in Ireland in this band.

- We note all the concerns raised above and where these are not directly addressed in this document we will carry the issues forward into further work in this matter as appropriate.

Ofcom position following April 2006 consultation

A5.44 Speaking broadly, we consider that, in view of the time that has passed since the 2006 consultation, it cannot simply resume that consultation by taking its original proposals, considering and responding to the April 2006 Consultation responses and making decisions confirming or amending the 2006 proposals.

A5.45 Instead, we consider it appropriate to re-consider the assignment of the 872/917 MHz bands, considering the responses to the April 2006 Consultation (in particular regarding the protection of adjacent band services and constraints on the 872/917 MHz bands), developments since 2006 and the present circumstances. To the extent that stakeholders consider that their 2006 responses remain valid and require further consideration by Ofcom, they are invited to say so.

A5.46 The issues raised on mobile liberalisation and Spectrum Usage Rights (SURs) in the April 2006 consultation are being addressed separately by us.

A5.47 Our current views on mobile liberalisation can be found at: http://www.ofcom.org.uk/consult/condocs/spectrumlib/

A5.48 Our current position on SURs can be found at:

- http://www.ofcom.org.uk/consult/condocs/surs/

- http://www.ofcom.org.uk/radiocomms/isu/sursguide/sursguide.pdf

- http://www.ofcom.org.uk/about/accoun/simpl08/simpl08.pdf

Overview of the responses to the April 2006 consultation

Organisation	Comment
Arqiva	Generally agree with spectrum packaging proposals. Ask that if Ofcom should subsequently decide to subdivide spectrum into smaller lots then award process should allow bidder to obtain all lots. Concerned about potential impact of interference restrictions on viability of a national service.
Confidential response	Generally agrees with the proposals for a single national licence. Technical queries about guard band and whether it could be used for roll off. Feel that the duplex direction imposed is not technology neutral as it appears to assume a FDD technology.
BAA	Strongly support the release of spectrum, particularly if it can be used for on-site digital PMR based services. Concerned that only one licence is offered and this would not encourage competition and innovation. Suggest approach taken for 412-414 MHz/422-424 MHz award of increasing the number of licences. Believe that band managers should be encouraged to bid for the spectrum.
Department for Transport	Concerned that if this spectrum is sold commercially then it may close off the only workable solution to the current conflicting priorities between MOD and Network Rail over the 876-880 MHz and the complimentary 921-925 MHz spectrum. This would have implications for the public purse and may lead to HM Government being infracted and fined by the European Court. They understand that Ofcom is commissioning research on the co-existence of MOD and Network Rail in the same spectrum however the first phase is not due for completion until the end of August 2006.
Confidential response	Urges Ofcom to define a more relaxed set of technical licence terms as this would expand the uses of the spectrum, reinforce business cases and increase the value of the spectrum. Advises that T-Mobile are, deploying UMTS FDD TD-CDMA equipment in this spectrum in the Czech Republic and that the situation is in most respects identical to that of the UK..
Confidential Response	3G use should be prevented and it should be ensured that the award does not create competitive issues for 900 MHz spectrum.
Network Rail	Suggest that any auction be postponed as Ofcom has yet to satisfy obligations in respect of adjacent GSM-R spectrum. Issues of MOD/GSM-R co-existence need to be first resolved. Do not believe that their previous response to the SFR:IP has been taken into account. Various technical comments. Believe that DotEcon/Analysys Mason report was factually

	incorrect and should be withdrawn from the public domain.
O2	Do not believe that this is an equitable approach compared to other recent Ofcom proposals. O2 do not think that the technical approach for protection is consistent with that taken for the 1785-1805 MHz NI process. Assumptions about deployments in neighbouring bands should not feature in Ofcom's technology and usage neutral spectrum awards programme. Believe that it is inappropriate for Ofcom to assess the likelihood of harmful interference based on an understanding of historical deployment of configurations and specifications that do not form part of the incumbents licence requirements.
Qualcomm	Support proposal on spectrum packaging. Would like to explore the option for 2x1.25 FDD wide area carriers. They propose that the guard band from the 2x4 MHz is not needed adjacent service protection could be provided by varying power level limits. They would like to explore technical issues further with Ofcom.
RFID Retail Expert Group	Auction should be postponed until Ofcom has had the opportunity to fully investigate the economic, technical and competitive benefits of dedicating this spectrum to RFID users. Advise that this band is close to the frequency that tags and readers currently use so migration might not present too many difficulties.
Richmond Film Services	Agree with Ofcom proposals. Ask whether radio microphones would be permitted since no base stations would be used.
Confidential response	Agrees that in this case a single national licence is the most suitable option. Would prefer a multi round ascending auction to a second price sealed bid auction. Concerns regarding undue discrimination and new licensees being able to establish 3G type systems. Also concern that critical aspects of policy regime that will apply to new licensees remain uncertain. Technical issues regarding necessity of guard band, out of band emissions and constraints due to GSM-R, O2 and MOD.
Zapp Holdings (formerly Inquam)	Believe that Ofcom has taken heavily biased position in favour of O2. Technical constraints are excessive. Discrimination against new entrant to the band. Believe potential business users will find it practically impossible to construct a business case. Ofcom should allow full 56 dBm power level across whole 917 - 921 MHz and reduce separation distance to 20 m under conditions that new entrant should not produce harmful interference to O2, and that O2 should protect themselves against harmful wanted signals transmitted in the adjacent band.

Annex 6

Detailed technical analysis: Assessment of possible transmission rights for the 872/917 MHz bands

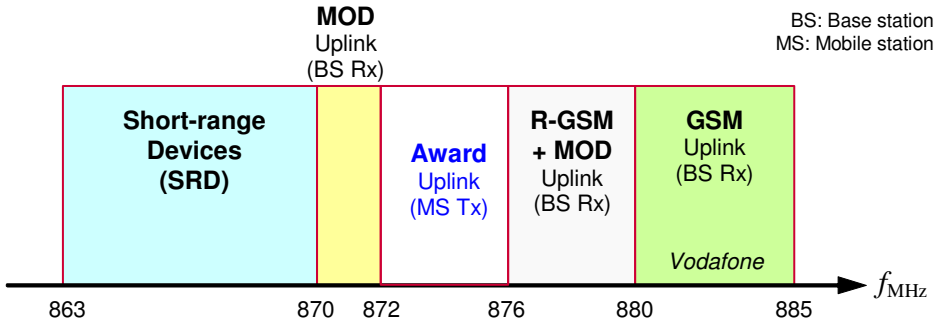
A6.1 In this Annex we consider in band and out of band emission proposals for a service in the 872/917 MHz bands, based on an evaluation of the potential impact of such emissions to degrade existing radio services occupying the neighbouring bands.

A6.2 We reiterate that we put the technical analysis forward as emerging thinking, advanced on the proposed basis it is necessary to protect the adjacent bands. We put forward technical constraints that are indicative of the sort of constraints we propose may be necessary and we seek comments on them on that basis.

Proposal for a full licensed approach in the band 872 - 876 MHz

A6.3 Figure 6 below shows the current use of frequencies adjacent to the 872 - 876 MHz uplink portion of the 872/917 MHz bands:

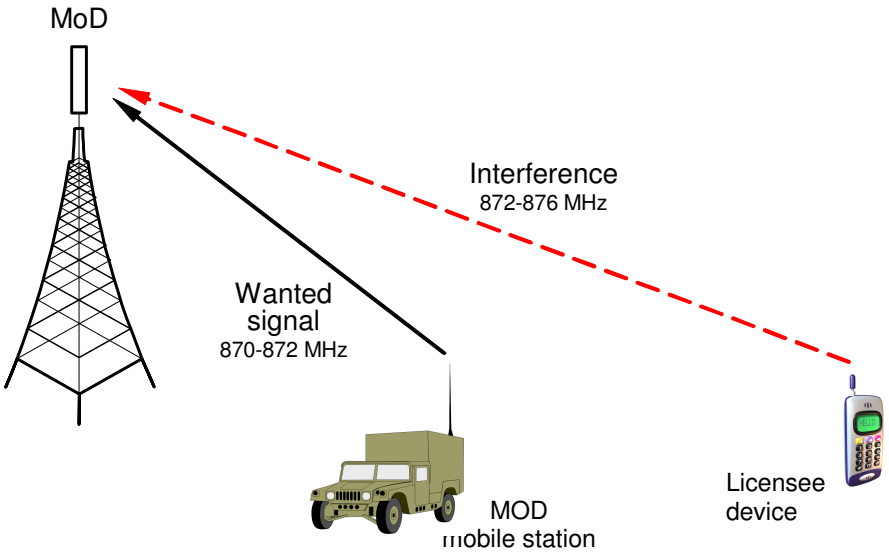
Figure 6: Services in bands adjacent to the 872 - 976 MHz band.



Co-existence with the MOD in the 870 - 872 MHz band

A6.4 The 870 - 872 MHz band is used for uplink communications by the MOD Figure 7 illustrates the interference scenario involving a licensee device transmitting in the 872 - 876 MHz band, and a MOD base station receiver.

Figure 7: Interference scenario relating to the 870-872 MHz band.



A6.5 An estimate of compatibility may be gained by considering MOD base station characteristics as being similar than that of GSM base station receivers. In this interference scenario one might expect the typical distances between devices transmitting in the 872 - 876 MHz band and MOD base station receivers to be similar to the distances between the GSM mobile station and adjacent GSM base station receivers.

A6.6 This suggests that sufficient levels of protection would be afforded to MOD base station receivers if limits were specified for emissions from the 872 - 876 MHz band falling into the 870 - 872 MHz MOD band based on emissions in the GSM up link band.

A6.7 Based on the above argument, for the uplink portion of the band, it is proposed that the limits for the licensee's out of band emissions into the 870 - 872 MHz band could be set to follow the GSM mobile station emission mask[63] (for an EIRP of 23 dBm centred at 872.3 MHz).

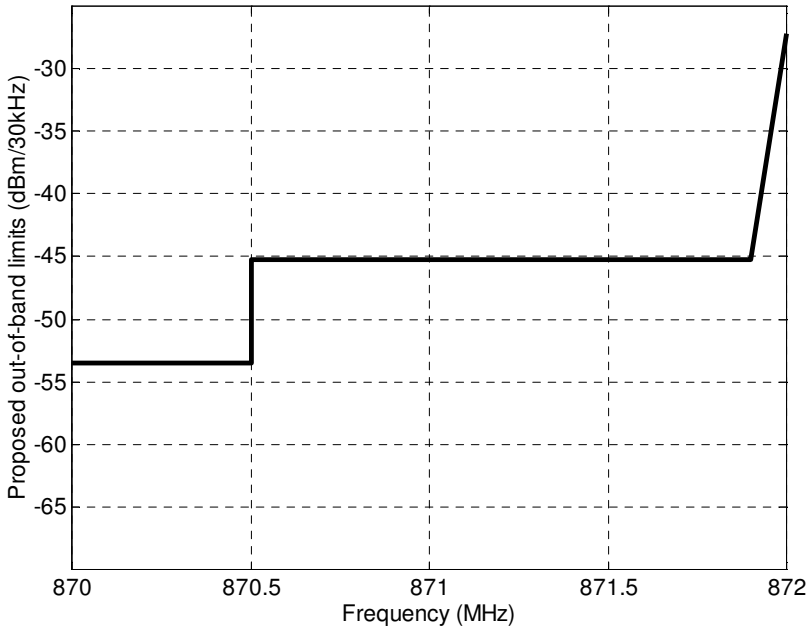
A6.8 The proposed limits are illustrated in Table 9 and Figure 8 below.

Table 9: Proposed limits on licensee device out-of-band emissions into the 870 – 872 MHz band.

Frequency of measurement (MHz)	Maximum mean out of band EIRP per device (dBm / 30 kHz)
870.0 – 870.5	–53.5
870.5 – 871.9	–45.2
872.0	–27.2

[63] ETSI TS 145 005

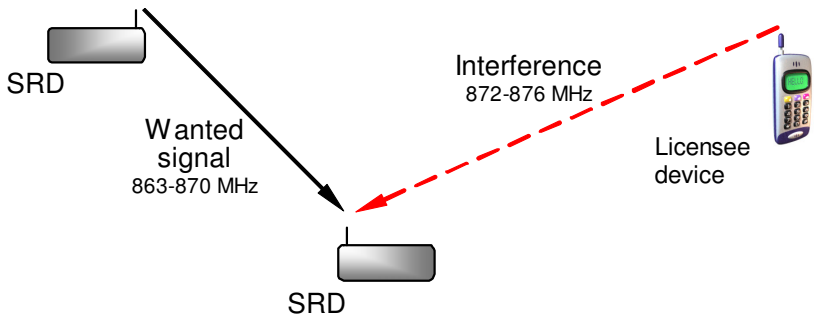
Figure 8: Proposed limits on licensee device out-of-band emissions into the 870 - 872 MHz band.



Co-existence with SRD in the 863 - 870 MHz band

A6.9 The 863 - 870 MHz band is used by a variety of licence exempt short range devices (SRD), used for applications such as Radio Frequency Identification (RFID), wireless alarms, and radio microphones. Figure 9 illustrates the interference scenario involving a licensee device transmitting in the 863 - 870 MHz band and a SRD receiver.

Figure 9: Interference scenario relating to the 863 - 870 MHz band.



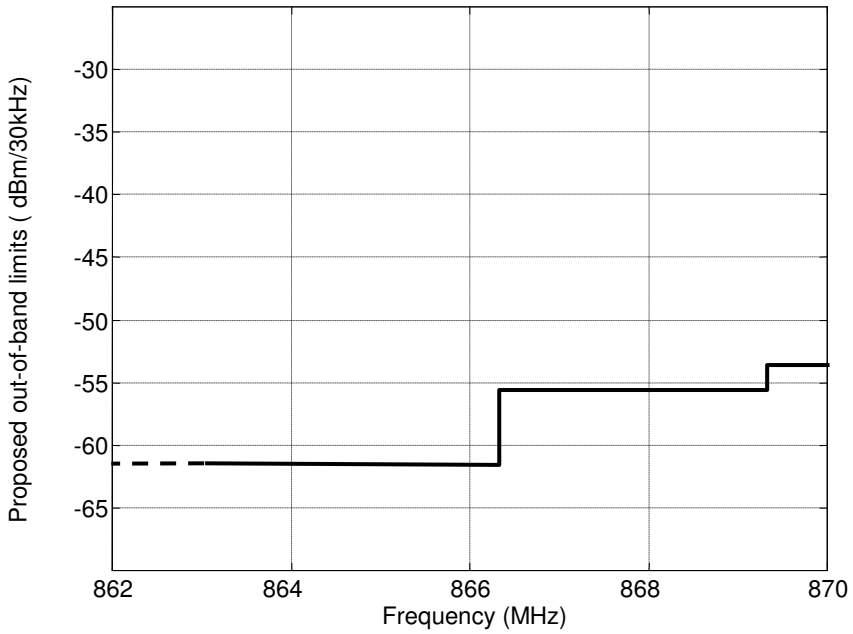
A6.10 In line with the approach adopted in A6.7, it is proposed that the limits for the licensee's out-of-band emissions into the 863 - 870 MHz band could be set to follow the GSM mobile station emission mask (based on an EIRP of 23 dBm centred at 872.3 MHz)..

A6.11 The proposed limits are illustrated in Table 10 and Figure 10

Table 10: Proposed limits on licensee device out-of-band emissions into the 863 - 870 MHz band.

Frequency of measurement (MHz)	Maximum mean out of band EIRP per device (dBm / 30 kHz)
863.0 – 866.3	–61.5
866.3 – 869.3	–55.5
869.3 – 870.0	–53.5

Figure 10: Proposed limits on licensee device out of band emissions into the 863 - 870 MHz band.



A6.12 It should be noted that SRD use the 863 - 870 MHz band on a non-protected non-interference basis and radiate at power levels of up to 2W EIRP. Given the potential higher wanted signal power of SRD one may therefore conclude that their operation would not be materially affected by licensee devices occupying frequencies at least 2 MHz away from the wanted SRD carrier and radiating at power levels of up to 23 dBm. This understanding is supported by a brief look at the specific case of RFID as an example of the type of SRD which operate in the band 865 - 868 MHz.

Blocking

A6.13 In order to provide sufficient protection to the RFID receiver, the path loss, L_{PL}, from the licensee device should satisfy the following condition:

$$P_{0(\mathrm{dBm})} - L_{\mathrm{PL(dB)}} + G_{\mathrm{A(dB)}} - L_{\mathrm{C(dB)}} - L_{\mathrm{F(dB)}} \leq \gamma_{\mathrm{B(dBm)}}$$

where L_{F} is the receive filter attenuation, G_{A} and L_{C} are the receiver antenna gain and feeder loss respectively, P_0 is the licensee EIRP, and γ_{B} is the maximum

permitted blocker power at the receiver. According to EN 302 208-1[64], the blocking level for a 3 dB desensitization of an RFID receiver is –35 dBm.

Then for L_F = 20 dB (based on a conservative estimate of a RFID receiver filter roll off of 5 dB per MHz from 868 to 872 MHz), $G_A - L_C$ = 6 dBi, P_0 = 23 dBm, and γ_B = –35 dBm we have:

$$L_{PL} \geq 44 \text{ dB}$$

A6.14 In other words, a path loss of at least 44 dB is required for a licensee device with an EIRP of 23 dBm not to cause blocking of an RFID interrogator receiver. This path loss corresponds to a minimum required transmitter receiver separation of around 4.4 m (free-space model[65]) or 2.5 m on the same building floor (ITU-R P.1238-3 indoor office model[66]). In practice, additional attenuation from walls, floors, and other obstructions (especially in indoor environments) will reduce the potential for interference, implying that blocking by licensee devices is unlikely.

Listen before talk

A6.15 Some RFID interrogators in the 865 - 868 MHz band operate on a listen-before-talk (LBT) basis. In other words, prior to each transmission, a RFID interrogator switches to a listen mode and monitors the radio channel for a certain period. Any signal detected by the receiver in excess of a specified threshold level would indicate that some other device already occupies the channel. In such a situation the interrogator does not transmit but monitors other channels within the band until it detects one in which the received signals are below the threshold level. In this way there is some resilience to external interference. Alternatively, the interrogator may remain listening to the same channel until it is clear.

A6.16 Clearly, in the presence of impolite (i.e. high power and continuous) interferers an interrogator may remain in listen mode indefinitely and never get the opportunity to transmit. Therefore there may be a limit to the RFID resilience to interference. The latest revision of the RFID Standard[67] replaces LBT with synchronised operation and so these newer installations are more resilient to interference.

[64] ETSI EN 302 208-1, V1.1.1 (2004-09), "Electromagnetic compatibility and radio spectrum matters ERM); Radio frequency identification equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W; Part 1: Technical requirements and methods of measurement".
[65] L_{PL} = –147.56 + 20log(f) + 20log(d) dB, where f = 868 x10^6 Hz and d is distance in metres.
[66] Recommendation ITU-R P.1238-3 "Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 900 MHz to 100 GHz". Here L_{PL} = –147.56 + 20log(f) + N log(d) + L(n) dB, where (for the 900 MHz band) f = frequency in MHz, d = distance in m (and where d >1), N = 33 in an office environment, and L(n) is attenuation due to n floors, with L(0) = 0, L(1) = 9, L(2) = 19, L(3) = 24.
[67] ETSI EN 302 208 (V1.1.2) (all parts) Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W.

A6.17 In order for the emissions by a licensee device not to impact the LBT mechanism of an RFID interrogator, the path loss, L_{PL}, from the licensee should satisfy the following condition:

$$\mathrm{EIRP}_{\mathrm{OOB\,(dBm/30kHz)}} - L_{\mathrm{PL\,(dB)}} \leq \gamma_{\mathrm{Th\,(dBm/30kHz)}}$$

where $\mathrm{EIRP}_{\mathrm{OOB}}$ is the out of band power radiated by the licensee device and is co-channel with the receiver, and γ_{Th} is the LBT threshold. According to EN 302 208-1, the LBT threshold levels are defined (at the antenna of the interrogator) as –83, –90, or –96 dBm/ 200 kHz depending on the interrogator's EIRP. Considering the most sensitive level of γ_{Th} = –96 dBm/200 kHz (–104.2 dBm/30 kHz), and assuming a maximum licensee out-of-band EIRP of –55.5 dBm/30 kHz (see Figure A2.8 of ref [67]), we have:

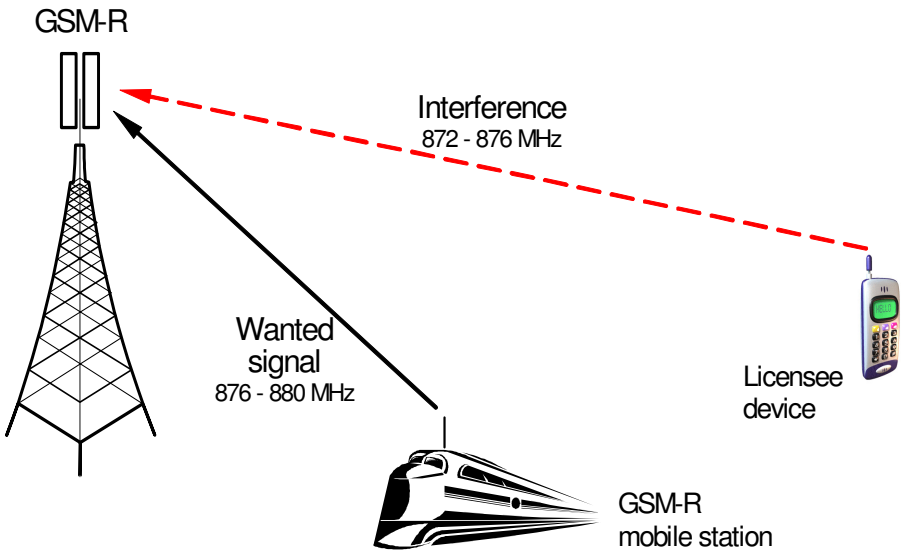
$L\mathrm{pl} <= 49$ dB

A6.18 In other words, an estimated path loss of greater than 49 dB is required for a licensee device with an EIRP of 23 dBm not to affect the LBT mechanism of an RFID interrogator. This corresponds to an estimated minimum separation of 8 m (free space) or 3.5 m (ITU-R P.1238-3 indoor office model). Once again, the existence of walls, floors, and other obstructions (especially in indoor environments) implies that harmful interference to SRD by licensee devices operating in the 872 - 876 MHz band is unlikely.

Co-existence with GSM-R in the 876-880 MHz band

A6.19 The 876 - 880 MHz band is currently used in the UK for uplink communications by railway radio communication systems via the GSM-R standard. Figure 11 illustrates the interference scenario involving a licensee transmitting in the 872 - 876 MHz band and a GSM-R base station.

Figure 11: Interference scenario relating to the 876 - 880 MHz band.



A6.20 Note that the above Mobile Station to Base Station (MS to BS) interference is quite typical of uplink interference caused by all cellular mobile networks operating in

adjacent bands. For example, interference into the 876 - 880 MHz band from the 880 - 885 MHz band licensed to Vodafone may equally be characterised by Figure 12 with the licensee device replaced by a Vodafone mobile station. The technical specifications for standards such as GSM are designed to allow the radio networks to adequately operate under such an interference environment.

A6.21 Based on similar arguments, it is proposed that the maximum EIRP for a licensee device transmitting in the 872 - 876 MHz band could be set to 23 dBm. This limit is considerably lower than the nominal maximum radiated power of 33 dBm for the Class-4 GSM900 mobile stations commonly deployed in the 880 - 915 MHz band. Consequently, it might be expected that interference generated by the licensee devices toward the GSM-R network would similarly be considerably lower than that generated by GSM 900 handsets in operation today.

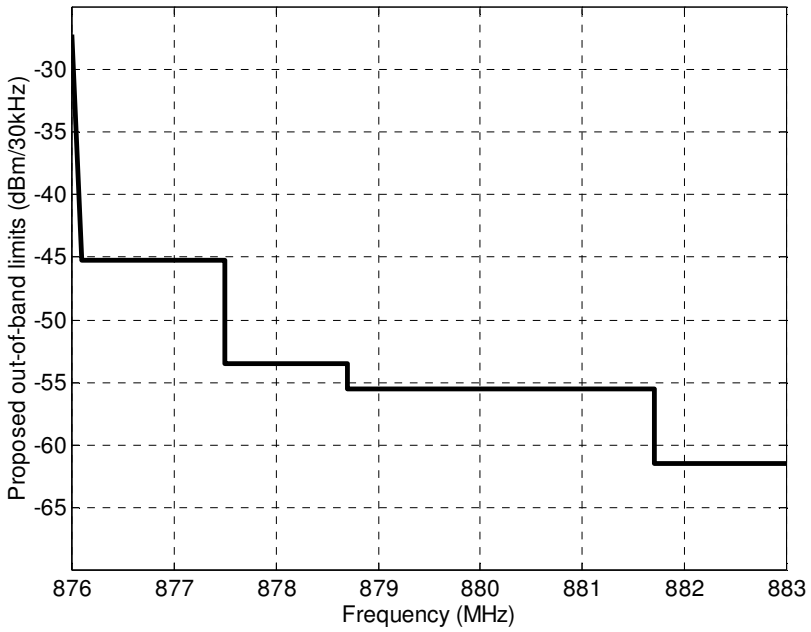
A6.22 It is proposed that the limits for the licensee's out-of-band emissions into frequencies above 876 MHz could be set to follow the GSM mobile station emission mask (for an EIRP of 23 dBm centred at 875.7 MHz).

A6.23 The proposed limits are illustrated in Table 11 and Figure 12.

Table 11: Proposed limits on licensee device out of band emissions into frequencies above 876 MHz.

Frequency of measurement (MHz)	Maximum mean out of band EIRP per device (dBm / 30 kHz)
876	–27.2
876.0 – 876.1	linear interpolation
876.1 – 877.5	–45.2
877.5 – 878.7	–53.5
878.7 – 881.7	–55.5
> 881.7	–61.5

Figure 12: Proposed limits on licensee device out of band emissions into frequencies above 876 MHz.



Proposals for the 872 - 876 MHz band

A6.24 Proposed uplink transmission rights were derived for co-existence with GSM-R networks, MOD services, and SRD operating in the neighbourhood of the 872 - 876 MHz band. Specifically:

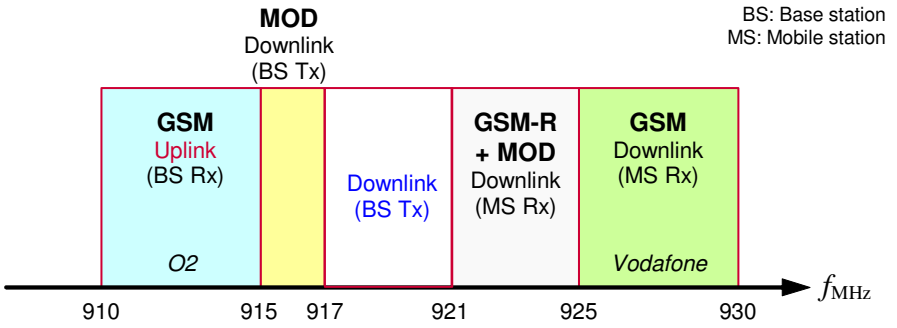
- Limits on licensee in-band emission levels within the 872 - 876 MHz band were defined;
- Limits on licensee out-of-band emission from the 872 - 876 MHz band into the neighbouring frequency bands were computed; and
- These limits are based on the current specification for GSM mobile stations.

Proposal for a full licensed approach in the 917 – 921 MHz band

A6.25 In this section we derive proposed in-band and out-of-band emission limits for the 917 - 921 MHz band, based on an evaluation of the potential impact of such emissions on existing radio services occupying the neighbouring bands. In developing the proposed transmission rights we take account of the victim receiver characteristics, as we understand them to be.

A6.26 Figure 13 depicts the current use of frequencies adjacent to the 917 - 921 MHz downlink portion of the band.

Figure 13: Services in frequency bands adjacent to 917 - 921 MHz



A6.27 The interference scenarios that we considered are transmissions from an 872/917 MHz band base station into the following receivers; a UMTS900 base stations, GSM base stations, MOD networks and GSM-R mobiles.

Internal guard bands

A6.28 No internal guard bands are defined explicitly. A licensee would be free to radiate in any portion of the 917 - 921 MHz band, so long as the emissions comply with the in band and out of band limits derived to protect services in neighbouring bands.

Duplex direction

A6.29 Under the full licensing approach, the 872 - 876 MHz band would be assigned for uplink transmission (i.e. mobile station transmit, base station receive) and the 917 - 921 MHz band would be assigned for downlink transmission (i.e. base station transmit, mobile station receive). This proposed channelling arrangement is consistent with the use of adjacent bands by mobile phone cellular networks.

Co-existence with base stations receivers in the band up to 915 MHz

Receiver assumptions

A6.30 A base station victim receiver is assumed to use either GSM900 or UMTS900 technology.

Co-ordination

A6.31 We have assumed a coordination distance of 100m. That is, the transmission specification is proposed so that 872/917 MHz band licensees are able to deploy base stations at distances of greater 100m from 900 MHz mobile network base stations, without the need for detailed co-ordination with the operator of the 900 MHz band base station, subject to the limitations described later in this section.

A6.32 Co-ordination with the operator of a 900 MHz band base station is likely to be required if the distance from a licence base station to a 900 MHz band base station is less than 100m.

The proposed methodology to calculate permitted EIRP

A6.33 A permitted EIRP per unit bandwidth can be readily derived from:

$$\gamma = \text{EIRP} - \text{ACIR} - L_{pl} + G_a$$

where γ is the target interference power per unit bandwidth. ACIR is the adjacent channel interference ratio, L_{pl} is the path loss and G_a is the receive side antenna gain.

The target interference power γ, is the power from an interferer appearing at the victim receiver input that gives rise to a defined degradation of receiver quality, usually an specified in the form of a reduced receiver sensitivity.

A6.34 In the calculation of the EIRP, use is made of the Adjacent Channel Interference Ratio (ACIR) parameter as specified within Report ITU-R M.2030[68]. This parameter is a measure of the degree of isolation between adjacent systems and represents the protection ratio that is afforded to the receiver. It is defined as a ratio of the total power transmitted from a source to the total interference power affecting a receiver, resulting from both transmitter and receiver impairments.

A6.35 The ACIR is derived by the addition of two other radio system parameters: an adjacent channel receiver selectivity (ACS) parameter and an adjacent channel leakage ratio (ACLR) parameter. The ACS is a function of the receiver characteristics and corresponds to the noise power that is received from an adjacent channel transmission due to imperfect receiver filtering. While the ACLR is a function of the adjacent channel transmitter characteristics, and corresponds to the out-of-band emissions produced by the adjacent channel transmission that are received co-channel. These ACLR and ACS parameters are typically specified within equipment standards or can be derived from performance compliance specifications.

A6.36 It can be readily shown that (in linear terms) $\text{ACIR}^{-1} = \text{ACLR}^{-1} + \text{ACS}^{-1}$ and in dB:

$$\text{ACIR} = -10.\text{Log}_{10}\left\{10^{\frac{-\text{ACS}}{10}} + 10^{\frac{-\text{ACLR}}{10}}\right\}$$

[68] Coexistence between IMT-2000 time division duplex and frequency division duplex terrestrial radio interface technologies around 2600 MHz operating in adjacent bands and in the same geographical area', REPORT ITU-R M.2030

A6.37 So that the general form of the equation to give a permitted EIRP (dBm) is:

$$\mathrm{EIRP} = -10.\mathrm{Log}_{10}\left\{\left(10^{\frac{-\mathrm{ACLR}}{10}}\right)+\left(10^{\frac{-\mathrm{ACS}}{10}}\right)\right\} + G_{\mathrm{tilt}} + L_{\mathrm{pl}} + G_{\mathrm{tilt}} - G_{\mathrm{a}} + \gamma$$

where γ is the target interference power (dBm), G_{tilt} is the loss due to the transmit and receive antenna tilts, assumed to be3 dB each, L_{pl} is the free space loss[69] , G_a is the victim receive antenna gain (which may include a feeder loss) assumed to be 15 dB.

$$\mathrm{EIRP} = -10.\mathrm{Log}_{10}\left\{\left(10^{\frac{-\mathrm{ACLR}}{10}}\right)+\left(10^{\frac{-\mathrm{ACS}}{10}}\right)\right\} + 3 + 72 + 3 - 15 + \gamma$$

$$\mathrm{EIRP} = -10.\mathrm{Log}_{10}\left\{\left(10^{\frac{-\mathrm{ACLR}}{10}}\right)+\left(10^{\frac{-\mathrm{ACS}}{10}}\right)\right\} + 63 + \gamma \qquad \mathrm{dBm}\,.$$

A6.38 The assumed interference power at a receiver input can be derived from a known erosion of the receiver sensitivity. By definition, an erosion of receiver sensitivity (in dB) is equal to the increase in the total noise plus interference (in dB). Therefore the permitted interference power γ at the receiver input is given by

$$\gamma = 10.\mathrm{Log}_{10}\left\{10^{\frac{\mathrm{KTB+NF+\eta}}{10}} - 10^{\frac{\mathrm{KTB+NF}}{10}}\right\} \quad \mathrm{dBm}$$

where η is the erosion of receiver sensitivity (dB) due to the interference power γ, KT = -174 dBm/Hz, B is the bandwidth in Hz and NF is the receiver noise figure (dB).

A6.39 This formula (from A6.38 above) is applied in Table 12 below for the GSM900 and UMTS900 case. For UMTS900 we assume erosion of receiver sensitivity is 1 dB in line with the 2.6 GHz award[70] and for GSM we assume the erosion of receiver sensitivity is 0.3 dB in line with Annex 3 of ECC report 41[71].

[69] FSL= 32.4+20*log(F, MHz)+20*log(d,km) =71.6 dB ≈ 72 dB at 100m and 915 MHz
[70] Par 5.30 of Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz Statement 4 April 2008
[71] Annex 3 of ECC Report 41, Adjacent Band Compatibility Between GSM And CDMA-PAMR at 915 MHz Granada, February 2004

Table 12: Calculated values of target interference power

		GSM900	UMTS900
KT	dBm/Hz	-174	-174
B	Hz	200000	3840000
NF	dB	8	5
KTB + NF	dBm	-113	-103
Eroded receiver sensitivity	dB	0.3	1.0
Target interference power γ	dBm	-124	-109

A6.40

A6.41 Table 12Taking values for γ from Table 12, then from A6.37 the proposed EIRP, per unit bandwidth (dBm EIRP/Hz), is given by:

$$EIRP = -10.\mathrm{Log}_{10}\left\{\left(10^{\frac{-ACLR}{10}}\right)+\left(10^{\frac{-ACS}{10}}\right)\right\} + 63 - 109$$

for a UMTS900 receiver

and

$$EIRP = -10.\mathrm{Log}_{10}\left\{\left(10^{\frac{-ACLR}{10}}\right)+\left(10^{\frac{-ACS}{10}}\right)\right\} + 63 - 124$$

for a GSM receiver.

The proposed methodology to calculate receiver Adjacent Channel Selectivity

A6.42 The receiver Adjacent Channel Selectivity, defined here as ACSo, can be derived from the appropriate equipment specification or from the stated blocking level. This is normally specified as a wanted signal level at which the normal receiver characteristics shall be maintained, when in addition an interferer of a given power is applied.

A6.43 For a GSM receiver ETSI TS 145 005 clause 5.1 gives the blocking specification for a GSM base station receiver. This states that channel performance shall be maintained for a wanted signal 3 dB above the reference sensitivity when an interfering signal is applied of -16 dBm for 800 kHz<Δf<3 MHz and -13 dBm for Δf > 3 MHz . The interference effectively degrades the receiver sensitivity by 3 dB.

A6.44 For a UMTS900 receiver TS 125 104 clause 7.4.1 gives the receiver adjacent channel selectivity for a UMTS base station receiver. This states that a Bit Error Ratio (BER) of 0.001 shall be maintained for a wanted signal of -115 dBm and a Wideband Code Division Multiple Access (WCDMA) modulated interfering signal 5 MHz off set (i.e. in the band 915 - 920 MHz), with mean power -52 dBm. The

wanted signal is 6 dB above the reference sensitivity, therefore the interferer effectively degrades the receiver sensitivity by 6 dB.

A6.45 And TS 125.104 Table 7.4 Case viii, gives the blocking specification for a UMTS900 base station receiver. This states that a BER of 0.001 shall be maintained for a wanted signal of -115 dBm and a WCDMA modulated interfering signal 10 MHz off set (i.e. in the band 920 - 921 MHz), with mean power -40 dBm. The wanted signal is 6 dB above the reference sensitivity, therefore the interferer effectively degrades the receiver sensitivity by 6 dB.

The ACSo is given by:

$$ACSo = (\text{Applied interference}) - (\text{Inteference appearing at the receiver input})$$

$$= (\text{Applied interference}) - 10.\text{Log}_{10}\left\{10^{\frac{KTB+NF+\eta}{10}} - 10^{\frac{KTB+NF}{10}}\right\}$$

where η is the erosion of receiver sensitivity, due to the applied interference.

Table 13 below shows the calculated values of ACSo for GSM and UMTS900 base station receivers.

Table 13: Calculated values of ACS

	Units	GSM900 F<917.8	GSM900 F>=917.8	UMTS900 915<F<920	UMTS900 920<F<925
Wanted signal	dBm	-101	-101	-115	-115
Ref sensitivity	dBm	-104[72]	-104	-121[73]	-121
erosion of receiver sensitivity	dB	3	3	6	6
KT	dBm/Hz	-174	-174	-174	-174
B	Hz	200000	200000	3840000	3840000
NF	dB	8	8	5	5
KTB + NF	dBm	-113	-113	-103	-103
Applied external Interference	dBm	-16	-13	-52	-40
Interfering signal at the receiver input	dBm	-113	-113	-98	-98
ACSo	dB	97	100	46	58

A proposed methodology to take account of a receiver filter

A6.46 The ACS and ACLR both influence the permitted output power. A method is developed in the following paragraphs that can be used to calculate the permitted in

[72] ETSI TS 145 005 par 6.2 GSM 900 normal BTS
[73] ETSI TS 125 104 Table 7.1 Wide Area BS

band and out of band powers for a wide band channel, taking into account also the receive side filter characteristics across the band.

A6.47 A receive side filter (or duplexer) may be described as a loss of close to negligible for $F < F_o$ and a loss $A*(F - F_o)$ for $F > F_o$ where A is the filter attenuation slope in dB/MHz. The slope extends into the 917 – 921 MHz bands and will give rise to an increasing ACS across the band.

To account for a receive side filter:

$ACS = ACSo + A.(F - F_o)$ in the region where $F > F_o$

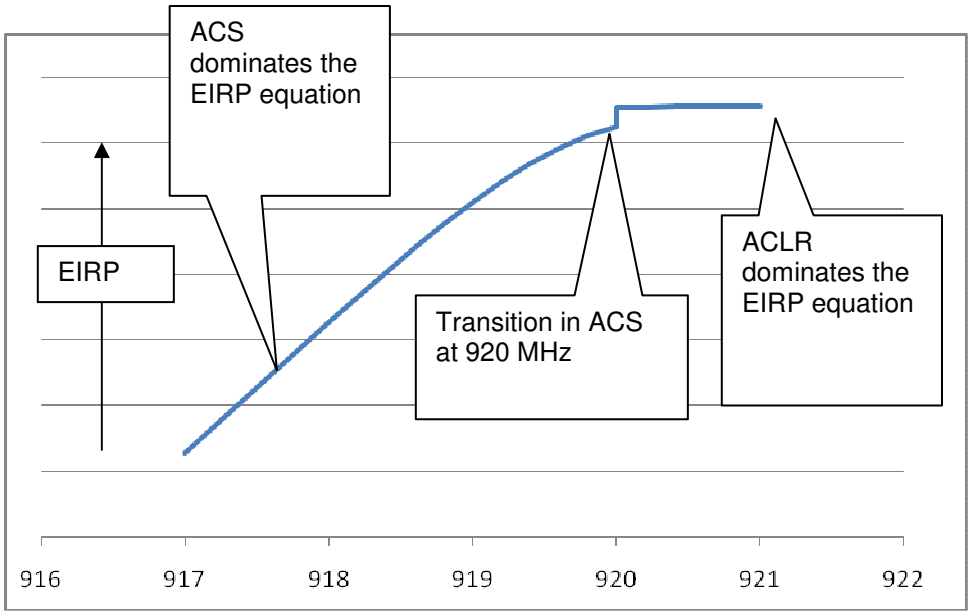
where ACSo is the receiver internal Adjacent Channel Selectivity.

A6.48 Taking account of a receive side filter, the ACIR components of ACS and ACLR combine to give:

$$EIRP(F) = -10.\mathrm{Log}_{10}\left\{\left(10^{\frac{-ACLR}{10}}\right)+\left(10^{\frac{-ACSo-A(F-F_o)}{10}}\right)\right\} + 63 + \gamma \quad \text{dBm/Hz}$$

A6.49 A typical plot of this function is given below in Figure 14 below.

Figure 14: Typical function of EIRP v Frequency



Frequency (MHz)

A6.50 For a single narrow band carrier it is sufficient to evaluate the function at a specified frequency, to give the permitted EIRP and if there are N carriers the power of each is reduced by 10.Log(N).

A proposed methodology to calculate EIRP for a wide band carrier

A6.51 In the case for a wide band carrier the permitted EIRP can be evaluated by averaging the function across the band of interest from f_1 to f_2, thus:

$$\mathrm{EIRP} = 10.\mathrm{Log}_{10}\left\{\frac{1}{(f_2 - f_1)}\int_{f_1}^{f_2} 10^{\frac{\mathrm{EIRP}(f)}{10}}\,df\right\} \qquad dBm$$

the integral is not straight forward. However the EIRP across a band can be derived by considering the average value of ACS and the average value of ACLR across the band of interest.

A6.52 The average value of ACS, in the region where $f > f_0$ can be found from the integral[74]:

$$\mathrm{ACS} = \frac{1}{(f_2 - f_1)}\int_{f_1}^{f_2}\left(10^{\frac{-ACSo - A(f - f_o)}{10}}\right)df$$

$$\mathrm{ACS} = \frac{1}{(f_2 - f_1)}10^{\frac{-ACSo + A.f_o}{10}}\int_{f_1}^{f_2}\left(10^{\frac{-A.f}{10}}\right)df$$

$$\mathrm{ACS} = \frac{1}{(f_2 - f_1)}10^{\frac{-ACSo + A.f_o}{10}}\left\{\frac{10^{\frac{-A.f}{10}}}{\frac{-A}{10}Log_e(10)}\right\}_{f_1}^{f_2}$$

$$\mathrm{ACS} = \frac{1}{(f_2 - f_1)}10^{\frac{-ACSo + A.f_o}{10}}\left\{\frac{10^{\frac{-Af_2}{10}} - 10^{\frac{-Af_1}{10}}}{-A\times 0.230259}\right\}$$

$$\mathrm{ACS} = \frac{1}{(f_2 - f_1)(\ A\times 0.230259\ )}10^{\frac{-ACSo}{10}}\left\{10^{\frac{A(f_o - f_1)}{10}} - 10^{\frac{A(f_o - f_2)}{10}}\right\}$$

[74] See for example: http://integrals.wolfram.com/index.jsp

A6.53 The average ACLR can be derived from the out of band emission specification relative to the in band power. In the case where the out of band emission value in units of dBc, in a specified bandwidth, this parameter is aready normalised to the in band power and the ACLR is estimated from:

$$\mathrm{ACLR} = \frac{BW_{\mathrm{victim}}}{BW_{\mathrm{oob}}} 10^{\frac{\mathrm{EIRP\_oob}}{10}}$$

where BW_{victim} is the bandwidth of the victim receiver, BW_{oob} is the bandwidth over which the out of band emission is specified, $\mathrm{EIRP}_{\mathrm{oob}}$ is the out of band emission level in dBc in a band width of BW_{oob}.

A6.54 So that the complete equation is:

$$\mathrm{EIRP}\left(\text{over the band } f_1 \text{ to } f_2\right)$$

$$= -10.\mathrm{Log}_{10}\left\{\left(\frac{BW_{\mathrm{victim}}}{BW_{\mathrm{oob}}} 10^{\frac{\mathrm{EIRP\_oob}}{10}}\right) + \frac{1}{\left(f_2 - f_1\right)} 10^{\frac{-\mathrm{ACSo}}{10}} \left\{\frac{10^{\frac{\mathrm{A}(f_o - f_1)}{10}} - 10^{\frac{\mathrm{A}\,(f_o - f_2)}{10}}}{\mathrm{A} \times 0.230259}\right\}\right\} + 63 + \gamma \quad \text{dBm}$$

For a UMTS900 victim:
ACSo = 46 dB for f_1, f_2< 920 MHz
ACSo = 58 dB for f_1, f_2>= 920 MHz
(from Table 13)

The target interference power at the victim receiver
γ= -109 dBm for a UMTS900 receiver
(from Table 12)

For a GSM victim:
ACSo = 97 dB for f_1, f_2< 917.8 MHz
ACSo = 100 dB for f_1, f_2>= 917.8 MHz
(from Table 13)

The target interference power at the victim receiver
γ= -124 dBm for a UMTS900 receiver
(from Table 12)

A6.55 This assessment assumes that the port to port antenna coupling over a distance of 100m from the 917 – 921 MHz band base station antenna port to the 900 MHz band base station antenna port is:

$G_t - G_{\mathrm{tilt}} - L_{\mathrm{pl}} - G_{\mathrm{tilt}} + 15$
$= G_t - 3 - 72 - 3 + 15$
$= G_t - 63$ dB

where G_t is the transmit side antenna gain. A value is not specified here for G_t because the permitted transmission power is given in units of EIRP (which includes the transmit gain).

A6.56 Antenna configurations that give the same or greater port-to-port antenna coupling would give the same EIRP as A6.54. This would enable different antenna configurations to be used, such as antenna on a shared head frame, subject to the agreement of the effected operators.

A proposed methodology to calculate EIRP for a wide band channel that extends across a step change in the ACS

A6.57 From Table 13 we note that the ACSo value exhibit a step change at some frequency *F*.

A6.58 A channel that extends over the ACS boundary where $f_1<F<f_2$ can initially be treated as 2 separate channels one from f_1 to *F* and one from *F* to f_2. The EIRP for each can be calculated independently, just as if only the one channel from f_1 to *F* or *F* to f_2 existed. Then the powers can be combined to give the power for a single channel in the range f_1 to f_2.

A6.59 If the powers for the individual carriers in the f_1 to *F* and *F* to f_2 are E_1 and E_2 respectively, in mW, so that the power from each individually would give rise to the interference power γ.

$$E_1.ACIR_1 = \gamma \quad and \quad E_2.ACIR_2 = \gamma$$

$$ACIR_1 = \frac{\gamma}{E_1} \quad and \quad ACIR_2 = \frac{\gamma}{E_2}$$

In linear form, where γ is the required interference power, in mW, in order to meet the specified erosion of receiver sensitivity, $ACIR_1$ is the linear ACIR for the band f_1 to *F* and $ACIR_2$ is the linear ACIR for the band *F* to f_2.

A6.60 If a total power of E is applied across the whole band f_1 to f_2, the power will be distributed in the bands f_1 to *F* and *F* to f_2 in simple proportion. The sum of the interference power in the band f_1 to *F* plus the interference power in the band *F* to f_2 must equal the interference power:

$$E.\frac{F-f_1}{f_2-f_1}.ACIR_1 + .\frac{f_2-F}{f_2-f_1}ACIR_2 = \gamma$$

$$E.\frac{F-f_1}{f_2-f_1}.\frac{\gamma}{E_1} + .\frac{f_2-F}{f_2-f_1}\frac{\gamma}{E_2} = \gamma$$

$$E. = \frac{1}{\frac{F-f_1}{f_2-f_1}.\frac{1}{E_1} + .\frac{f_2-F}{f_2-f_1}\frac{1}{E_2}}$$

$$E. = 10.Log_{10}\left\{\frac{(f_2 - f_1).}{\frac{(F - f_1)}{E_1} + \frac{(f_2 - F)}{E_2}}\right\} dBm\ EIRP$$

A6.61 Finally if there are N channels each is reduced by 10.Log(N) and the total power summed across all transmitters is limited to 60 dBm EIRP.

Protection of UMTS900 base station

A6.62 In this paragraph we derived the proposed power, by example, in 917 – 921 MHz band assuming a UMTS900 base station receiver at frequencies up to 915 MHz using the methodology above and the assumptions below:

- 100m from 872/917 MHz bands transmitter to victim receiver, with antennas facing each other;
- A UMTS900 base station victim is assumed in accordance with ETSI TS 125 104;
- The target interference power is -109 dBm from Table 12;
- A representative interfering mobile broadband transmitter is assumed in accordance with ETSI EN 301 449;
- The ACS of the UMTS900 base station receiver from Table 13 is: ACSo = 58 dB for $f_1, f_2 >= 920$ MHz and ACSo = 46 dB for $f_1, f_2 < 920$ MHz;
- ACS is enhanced by an industry standard receiver side duplexer, with attenuation slope of A=10 dB per MHz such that ACS = ACSo + $10 \times (f - 916.5)$[75];
- The transmit side out of band emissions are in accordance with EN 301 449 Table 5, with special provision to protect GSM base stations = -100 dBc/30 kHz.

[75] Simplified from ECC Report 41.

A6.63 So that the equation for EIRP in a bandwidth from f_1 to f_2 is, from A6.54:

$$\mathrm{EIRP}\left(\text{over the band } f_1 \text{ to } f_2\right)$$

$$= -10.\mathrm{Log}_{10}\left\{\left(\frac{3840}{30}10^{\frac{-100}{10}}\right)+\frac{1}{(f_2-f_1)}10^{\frac{-\mathrm{ACSo}}{10}}\left\{\frac{10^{(916.5-f_2)}-10^{(916.5-f_1)}}{-2.30259}\right\}\right\}+63-109 \quad \text{dBm}$$

$$= -10.\mathrm{Log}_{10}\left\{1.28\times10^{-8}+\frac{1}{(f_2-f_1)}10^{\frac{-\mathrm{ACSo}}{10}}\left\{\frac{10^{(916.5-f_1)}-10^{(916.5-f_2)}}{2.30259}\right\}\right\}-45 \quad \text{dBm}$$

The method for $f_1<920<f_2$ is given in A6.57.

Table 14 below indicates the example transmitter power in the 917 – 921 MHz band for this configuration.

Table 14: Example EIRP in the 917 - 921 MHz band for an adjacent UMTS900 base station

Configuration	ACLR	ACS	Permitted EIRP
Transmit side OOB emissions in accordance with ETSI specification Industry standard duplex/filter at the receiver.	OOB emission limits OOB =-100 dBc/30 kHz ACLR = 77.8 dB across a 3.840 MHz channel	ACSo = 46.41 F< 920 MHz ACSo = 58.41 F>= 920 MHz Standard receiver duplexer Fo = 916.5 MHz Filter slope A = 10 dB per MHz Average ACS across the band 918.26 – 919.53 MHz = 68.9 dB Average ACS across the band 919.53 – 920 MHz = 78.9 dB Average ACS across the band 920 - 920.8 MHz = 96.8 dB	Average power across the band 918.26 - 919.53 MHz =19 dBm EIRP Average power across the band 919.53 – 920.8 MHz =27.3 dBm EIRP Total power = 28 dBm EIRP

A6.64 This example power is less than the example power for a GSM base station in Table 15. Therefore the protection of a UMTS900 base station described in Table 14 above is proposed as the reference configuration for determining the transmission power in the 917 - 921 MHz bands and the separation distances to GSM stations not fitted with duplexers and railway tracks equipped with GSM-R.

To increase the 917 – 921 MHz band power with a UMTS900 victim

A6.65 Higher power could be available in the award band 917 - 921 MHz if the ACS of the UMTS900 base station receiver, operating at 910 – 915 MHz channel, was enhanced.

A6.66 It can be readily shown that if the ACS is considered constant across the whole band of interest, then an integral is not necessary and from the following calculation from 0 applies.

A6.67 For example, two channels of 47dBm EIRP can be achieved with a ACS of 96 dB and an ACLR of 110 dB.

$$57+3 = -10.\mathrm{Log}\left\{\left(10^{\frac{-\mathrm{ACLR}}{10}}\right)+\left(10^{\frac{-\mathrm{ACS}}{10}}\right)\right\} + 63 - 109$$

A6.68 An ACLR of 110 dB can be achieved with an OOB emission enhanced by 31 dB[76], such that out of band emissions = -100[77] - 31 dBc/30 kHz. Figure 7 of Ref[78] shows that out of band emissions from a station equipped with a transmit side duplexer (or equivalent filter) can be reduced by 40 dB compared to the level without duplexer of filter.

A6.69 The equipment ACSo is a minimum value of 46 dB, therefore an additional loss of 96 – 46 = 50 dB (from a duplexer or filter) will be required in the receive path to enhance the ACS.

A6.70 Research sponsored by Ofcom[79] suggests that a suitable filter with a pass band of F < 915 MHz, Error Vector Magnitude (EVM)[80] of 8.2 % across a UMTS channel centred on 912.6 MHz[81] and an attenuation of 50 dB at F>917 MHz is realisable.

A6.71 Therefore 2 carriers with combined power 50 dBm EIRP can be accommodated in the frequency band 917 – 921 MHz, through use of appropriate filtering at transmitting and receiving base stations.

A6.72 This is also in line with a report published by ETSI[82] which suggests that a pass band filter with an attention of 60 dB in 2.2 MHz is realisable.

---

[76] This value is not sensitive but has been set at 31 dB to align with A6.79.
[77] See A6.62
[78] Fig 7 of ECC Report 41, Adjacent band compatibility between GSM and CDMA-PAMR at 915 MHz , Granada, February 2004, shows that OOB emissions from a station equiped with a duplexer (or equivalent filter) are reduced by 40 dB compared to the level without duplexer of filter.
[79] High Q Filter Feasibility Study For Base-Station Applications: Isotek Electronics Limited.
[80] Par 6.8.2.1 of 3GPP TS 25.104 states that the The Error Vector Magnitude shall not be worse than 17.5 % when the base station is transmitting a composite signal using only QPSK modulation and the Error Vector Magnitude shall not be worse than 12.5 % when the base station is transmitting a composite signal that includes 16QAM modulation.
[81] The highest UMTS frequency is defined as 912.6MHz from par 5.4.2 and table 5.1 ETSI 25.101.

A6.73 Higher power may be possible with improved filters or by moving the carriers in the 917-921 MHz band away from the 917 MHz boundary.

Long Term Evolution (LTE)

A6.74 The report from the Independent Spectrum Broker[83] notes that future spectrum releases from Ofcom will be suitable for LTE.

A6.75 In this Annex we have not made a separate assessment of the impact of emissions in the 872/917 MHz bands; however given the similarity between the specifications for UMTS[84] and LTE[85] it is reasonable to suggest that power restrictions proposed in this Annex will give protection to LTE.

Protection of GSM base stations

A6.76 In this paragraph we show that the proposed power in the 917 - 921 MHz band is also low for a GSM base station victim assuming:

- 100m from award band transmitter to victim receiver, with antennas facing each other;
- A GSM base station victim is assumed in accordance with TS 145 005;
- An interfering mobile broad band transmitter is assumed in accordance with ETSI EN 301 449;
- The proposed target interference power is -124 dBm from Table 12;
- The ACS of the GSM base station receiver from Table 13, ACSo = 100 dB for f>= 917.8 MHz and ACSo = 97 dB for F<917.8 MHz;
- ACS is enhanced by an industry standard receiver side duplexer, with attenuation slope of A = 10 dB per MHz such that ACS = ACSo + 10(f - 916.5); and
- The transmit side out of band emissions are in accordance with EN 301 449 Table 5 with special provision to protect GSM base stations.

[82] See for example Fig C.1 from ETSI TR 102 627 V1.1.1 (2008-11), Technical Report, Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Land Mobile Service; Additional spectrum requirements for PMR/PAMR systems operated by railway companies (GSM-R).
[83] Report from the Independent Spectrum Broker: findings and policy proposals Final Report 12th May 2009.
[84] 3GPP TS 25.104, Technical Specification 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; BS Radio transmission and Reception (FDD).
[85] 3GPP TS 36.104 V8.5.0 (2009-03), Technical Specification 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (Release 8).

A6.77 So that the equation for the EIRP in a bandwidth f_1 to f_2 is, from A6.54:

$$\mathrm{EIRP}\left(\text{over the band } f_1 \text{ to } f_2\right)$$

$$= -10.\mathrm{Log}_{10}\left\{\left(\frac{200}{30}10^{\frac{-100}{10}}\right)+\frac{1}{\left(f_2-f_1\right)}10^{\frac{-\mathrm{ACSo}}{10}}\left\{\frac{10^{(916.5-f_2)}-10^{(916.5-f_1)}}{-2.30259}\right\}\right\}+63-124 \quad \mathrm{dBm}$$

The method for $f_1<920<f_2$ is given in A6.57.

Table 15: Example EIRP in the 917 - 921 MHz band for an adjacent GSM base station receiver

Configuration	ACLR	ACS	Permitted EIRP
Transmit side OOB emissions in accordance with ETSI specification Industry standard duplex/filer at the receiver.	OOB emission limits OOB = -100 dBc/30 kHz ACLR = 91.7 dB across a 200 kHz channel	ACSo = 97 F< 917.8 MHz ACSo = 100 F>= 917.8 MHz Standard receiver duplexer Fo = 916.5 MHz Filter slope A = 10 dB per MHz Average ACS across the band 918.26 – 919.53 MHz = 122 dB Average ACS across the band 919.53 – 920.8 MHz = 135 dB	Average power across the band 918.26 - 919.53 MHz =27.4 dBm EIRP Average power across the band 919.53 – 920.8 MHz =27.4 dBm EIRP Total = 30.4 dBm EIRP

To increase the 917 – 921 MHz band power with a GSM victim

A6.78 In the case of a GSM base station victim the main influence on interference is the out of band leakage from an 917 – 921 MHz band transmitter into a GSM channel at frequencies up to 915 MHz.

A6.79 Higher power could be possible in the band 917 - 921 MHz, if the ACLR of the award band base station was enhanced.

A6.80 The transmit side out of band emissions are in accordance with EN 301 449 Table 5 with special provision to protect GSM base stations plus a 31 dB enhancement due to a duplexer (or equivalent filter) at the transmit side.

A6.81 Other assumptions are unchanged from A6.76.

A6.82 The equation for the proposed EIRP in the band from f_1 to f_2 from A6.54 is therefore:

$$\mathrm{EIRP}\left(\text{over the band } f_1 \text{ to } f_2\right)$$

$$= -10.\mathrm{Log}_{10}\left\{\left(\frac{200}{30}10^{\frac{-130}{10}}\right)+\frac{1}{(f_2-f_1)}10^{\frac{-\mathrm{ACSo}}{10}}\left\{\frac{10^{(916.5-f_2)}-10^{(916.5-f_1)}}{-2.30259}\right\}\right\}+63-124 \quad \mathrm{dBm}$$

A6.83 This would enable a higher power in the 917 – 921 MHz band as indicated in Table 16 below.

A6.84 In this case the duplexer at the GSM base station provides a sufficient enhancement of the ACS, without the need for additional filtering in the GSM station receive path.

Table 16: Example EIRP in the 917 - 921 MHz band for an adjacent GSM base station receiver

Configuration	ACLR	ACS	Permitted EIRP
Transmit side OOB emissions plus filter/duplexer at the transmit side Industry standard duplex/filer at the receiver.	Enhanced OOB emission limits OOB = -131 dBc/30 kHz ACLR = 122.7 dB across a 200 kHz channel	ACSo = 97 F< 917.8 MHz ACSo = 100 F>= 917.8 MHz Standard receiver duplexer Fo = 916.5 MHz Filter slope A = 10 dB per MHz Average ACS across the band 918.26 – 919.53 MHz = 125.5 dB Average ACS across the band 919.53 – 920.8 MHz = 135.2 dB	Average power across the band 918.26 - 919.53 MHz =55.2 dBm EIRP Average power across the band 919.53 – 920.8 MHz =58.1 dBm EIRP Total power = 59.9 dBm EIRP

GSM stations without duplexers or receive side filters

A6.85 The band 910 - 915 MHz may not be used for UMTS900 immediately; GSM base stations may be in service for some time.

A6.86 A number of older generation GSM base stations are not equipped with duplexers or any front end filtering existing in their receivers resulting in little or no attenuation of potential interference originating from within the 917 - 921 MHz band. Consequently, greater physical separations could be required between licensee transmitters and such base stations.

A6.87 For a GSM victim receiver, without front end filtering and removing the path loss as a separate term, from A6.37:

$$\text{EIRP} = -10.\text{Log}_{10}\left\{10^{\frac{-\text{ACLR}}{10}} + 10^{\frac{-\text{ACSo}}{10}}\right\} - 9 + L_{\text{pl}} - 124 \qquad \text{dBm}$$

A6.88 From Table 13 the ACS of a GSM base station without a duplexer = 100 dB.

A6.89 If we allow for a total transmitter power of 28 dBm EIRP in line with the reference case for the transmission specification, given in Table 14 and out of band emissions at -100 dBc/30 kHz then:

$$\text{ACLR} = -10.\text{Log}_{10}\left\{\left(\frac{200}{30}\right)10^{\frac{-100}{10}}\right\} = 91.8 \text{ dB}$$

A6.90 So that the path loss required to protect GSM base stations without duplexers is:

$$L_{\text{pl}} = 10.\text{Log}_{10}\left\{10^{\frac{-91.8}{10}} + 10^{\frac{-100}{10}}\right\} + 28 + 9 + 124$$

$$= 69.8 \text{ dB}$$

A6.91 The free space distance[86] equivalent to this loss is 81m at 915 MHz.

A6.92 Noting that the powers in the 917 - 921 MHz bands are based on a distance of 100m between the transmitter and victim receiver, we propose that the separation distance of 100m is valid for GSM base stations not fitted with duplexers.

[86] Free space loss (dB) = 32.44 + 20 Log f (MHz) + 20 Log d (km)

A6.93 The similarity between the separation distance to GSM base stations with duplexers and GSM stations without duplexers arises because the dominant interference mechanism is 'out of band emissions'. This would not hold true if the 'out of band emissions' limits were decreased to permit higher power in the 917 – 921 MHz band, as demonstrated below.

A6.94 An increased separation distance may be required if the 872/917 MHz bands licensee is able to transmit at a higher power, for example if it is agreed that a 900 MHz band licensee delays the introduction of UMTS900 and operates a GSM service for some time.

A6.95 For example, if the out of band emissions are at -118 dBc/30 kHz and the total power from a GSM base station is 60 dBm EIRP (in line with Table 16); the ACLR is given by:

$$\text{ACLR} = -10.\text{Log}_{10}\left\{\left(\frac{200}{30}\right)10^{\frac{-118}{10}}\right\} = 110 \text{ dB}$$

A6.96 The path loss required to protect GSM base stations without duplexers is:

$$L_{\text{pl}} = 10.\text{Log}_{10}\left\{10^{\frac{-110}{10}} + 10^{\frac{-100}{10}}\right\} + 60 + 9 + 124$$

$$= 93 \text{ dB}.$$

A6.97 The free space distance equivalent to this loss is 1169m at 915 MHz.

A6.98 However free space propagation formulae will only give an approximate indication of path loss when used in a base to base situation, due to local obstruction, even so coordination over a distance of approximately 500m may be appropriate.

A6.99 Reduced distances could potentially be negotiated with the incumbent GSM licensee for specific sites. This might be the case, for example, where obstructions provide increased path loss between the transmitter and the GSM base station, or where site engineering or improved filtering may mitigate the impact of interference.

Out of band emissions below 917 MHz

A6.100 We propose OOB emission level of -100 dBc/30 kHz at frequencies below 917 MHz, in line with EN 301 449 Table 5, which would support the low power scenarios given in Table 14 and Table 15.

A6.101 However, if arrangements were made to enable higher powers in the 917 – 921 MHz band than the out of band emissions would need to be at levels of around -131 dBc/30 kHz.

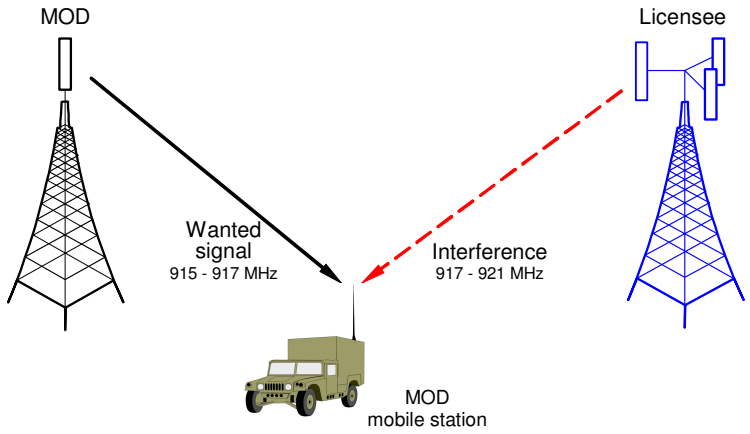
A6.102 An alternative approach, not analysed here, is to consider ACS and ACLR independently and require each to give one half of the proposed target interference power. Effectively not using any trade off between ACS and ACLR.

Co-existence with the MOD in the 915 - 917 MHz

A6.103 The 915 - 917 MHz band is used for downlink communications by the MOD.

A6.104 Figure 15 illustrates the interference scenario involving a licensee transmitting in the 917 - 921 MHz band, and a MOD mobile station.

Figure 15: Interference scenario relating to the 915 - 917 MHz band.



A6.105 There is little information available on the MOD use of the 917 - 921 MHz band, and as such it is not possible to perform a formal analysis based on the relevant MOD receiver characteristics.

A6.106 However, one may tackle this issue indirectly by taking into account the following factors:

A6.107 If the in-band transmission rights defined according to Table 14 then the maximum licensee EIRP is 28 dBm EIRP/2.54 MHz (equivalent to 17 dBm EIRP/200 kHz) we suggest that will be comparable to the existing MOD down link powers.

A6.108 The MOD services in the 915 - 917 MHz band already co-exist with GSM uplink transmissions in the adjacent 910 - 915 MHz band. These correspond to a typical GSM mobile station EIRP of 33 dBm.

A6.109 The above factors suggest that, the proposed power levels envisaged for the 917 – 921 MHz band offer sufficient levels of protection to the MOD.

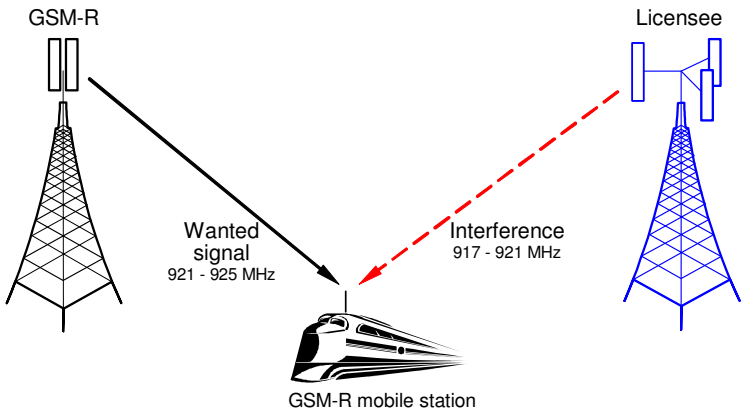
Co-existence with GSM-R in the 921 - 925 MHz band

A6.110 Frequencies in the range 921 – 925 MHz are used by Railway Companies to provide voice and data services to trains[87].

A6.111 Figure 16 illustrates the interference scenario involving a licensee transmitting in the 917 - 921 MHz band, and a GSM-R train mounted mobile station:

[87] ETSI TS 100 910

Figure 16: Interference scenario relating to the 921 - 925 MHz band.



A6.112 Our proposals for the possible emission requirements is based on protecting the lowest GSM-R base User Station receive frequency of 921.2 MHz.

A6.113 It should be noted that Vodafone currently uses frequencies above 925 MHz for E-GSM base stations and these stations coexist with network rail mobile stations, suggesting interference from base stations in the 917 - 921 MHz band to GSM-R mobile stations should not present an unacceptable interference situation.

A6.114 Compatibility of CDMA-PAMR with the GSM-R system was first addressed in the ECC Report 38 [88] and presented in the April 2006 Consultation[89]. The ERC report proposed that uncoordinated operation of a CDMA system is possible if the distance from the CDMA base station to the railway track is greater than 141m in an urban environment or 270m in a suburban environment.

The April 2006 Consultation proposed:

> *Any base station operating in the Permitted Frequency Band 917.0 MHz to 921.0 MHz shall be located in such a way that there remains a minimum Separation distance from the edge of any railway track …. (of)*
>
> > *(a) 75 metres if the base station is operating in such a way that the EIRP for its transmission site is no greater than 32 dBm;*
> >
> > *(b) 250 metres if the base station is operating in such a way that the EIRP for its transmission site exceeds 32 dBm.*

A6.115 The ECC report and Ofcom proposals were based on a minimum coupling loss model, and assumed that the tolerable interference level was equal to the blocking specification of -43 dBm. By definition this would be equivalent to a receiver desensitisation of 3 dB.

[88] Annex 2 of ECC report 38. The techical impact of introducing CDMA-PAMR on the UIC DMO and GSM-R Radio systems in the 900 MHz Band. Granada February 2004

[89] Item 10 of Draft Licence Schedule of Award of available spectrum: 872 - 876 paired with 917 - 921 MHz. Consultation 11 April 2006.

A6.116 A more rigorous assessment allows for a receiver desensitisation of 0.3 dB, in a similar fashion to the protection offered to GSM base stations and also sums the interfering contributions from the ACS and OOB emissions.

A6.117 ACS may be derived by reference from clause 5.1 of ETS 145 005 which states that for a GSM-R mobile station:

> The reference sensitivity performance shall be met when the following signals are simultaneously input to the receiver;
>
> A useful signal modulated with the relevant supported modulation, at frequency f_0, (and a power) 3 dB above the reference sensitivity level;
>
> A continuous, static sine wave (blocking) signal at a level as in Table 17 below and at a frequency fb which is an integer multiple of 200 kHz.

Table 17: GSM mobile station blocking levels from clause 5.1 of ETSI TS 145 005 v7.18.0 (2009-06)

Blocker offset from wanted carrier (MHz)	*Received blocker power (dBm)*
0.6 ≤ | fb - f_0 | < 0.8	*- 43*
0.8 ≤ | fb - f_0 | < 1.6	*- 43*
1.6 ≤ | fb - f_0 | < 3.0	*- 33*
3. ≤ |f-f_0 |	*- 23*

A6.118 By definition, the interference results in a 3 dB desensitisation of the victim receiver. Given the adjacency of the bands used by the interferer and the victim, in order to adequately protect the GSM-R mobile, at the lowest operational frequency centred on 921.2 MHz, and in scenarios where the licensee operates close to the upper boundary of the 917 – 921 MHz band, the most stringent received blocking level of - 43 dBm is used in the following analysis. Furthermore, receiver filtering at the GSM-R is not assumed.

A6.119 The derivation of ACS from the blocking level is given in A6.42.

$$\mathrm{ACSo} = (\text{Applied\_interference}) - (\text{Inteference appearing at the receiver input})$$

$$= (\text{Applied\_interference}) - 10.\mathrm{Log}_{10}\left\{10^{\frac{\mathrm{KTB+NF+\eta}}{10}} - 10^{\frac{\mathrm{KTB+NF}}{10}}\right\}$$

where η is the erosion of receiver sensitivity due to the applied interference, this is evaluated in Table 18 below.

Table 18: Derivation of ACS for GSM-R mobile station

Wanted signal	dBm	-101
Ref sensitivity	dBm	-104
η erosion of receiver sensitivity	dB	3
KT	dBm/Hz	-174
B	Hz	200000
NF	dB	8
KTB + NF	dBm	-113
Applied external Interference	dBm	-43
Interfering signal at the receiver input	dBm	-113
ACS	dB	70

A6.120 If we allow for a total transmitter power of 28 dBm EIRP in line with the reference case for the transmission specification, given in Table 14 and out of band emissions at -100 dBc/30 kHz:

$$\text{ACLR} = -10.\text{Log}_{10}\left\{\left(\frac{200}{30}\right)10^{\frac{-100}{10}}\right\} = 91.8 \text{ dB}$$

A6.121 The path loss required to protect a GSM-R mobile station can be found from the formulae at A6.37 assuming: receiver side antenna tilt loss, G_{tilt} = 0, receive side antenna gain, G_a = 0, Target interference power γ = -124 dBm (from Table 11 for a 0.3 dB erosion of receiver sensitivity).

$$\text{EIRP} = -10.\text{Log}_{10}\left\{\left(10^{\frac{-91.8}{10}}\right)+\left(10^{\frac{-70}{10}}\right)\right\} - 124$$

$$L_{pl} = 10.\text{Log}_{10}\left\{\left(10^{\frac{-91.8}{10}}\right)+\left(10^{\frac{-70}{10}}\right)\right\} + 124 + 28$$

$$= 82 \text{ dB}$$

A6.122 The distance equivalent to this path loss can be derived from the Extended Hata loss equation[90], Hb = 20m, Hm = 2m, F = 915 MHz and zero fade margin and is shown in Table 19 below.

[90] http://seamcat.iprojects.dk/raw-attachment/wiki/Manual/PropagationModels/ExtendedHata/Hata-and-Hata-SRD-implementation.pdf

Table 19: Proposed separation distance from 917 – 921 MHz band base station to GSM-R mobile station

Environment	Minimum separation (m)
Urban	46
Suburban	89

A6.123 The terms urban, suburban and rural are not defined from regulatory point of view; therefore we propose that coordination is required if the distance from an 917 – 921 MHz band base station to a railway track equipped with GSM-R is less than 100m.

A6.124 Note that an increased coordination distance may be required if the 917 – 921 MHz band licensee is able to transmit at a higher power, for example if a 900 MHz band licensee elects to delay the introduction of UMTS900 and operate a GSM service for some time.

A6.125 For example, if the permitted power is 60 dBm EIRP and the out of band emissions are at a level of -88 dBc/30 kHz. then the ACLR is:

$$\text{ACLR} = -10.\text{Log}_{10}\left\{\left(\frac{200}{30}\right)10^{\frac{-88}{10}}\right\} = 80\text{dB}$$

A6.126 The path loss required to protect GSM-R user stations can be found from:

$$\text{EIRP} = -10.\text{Log}_{10}\left\{\left(10^{\frac{-80}{10}}\right)+\left(10^{\frac{-70}{10}}\right)\right\} - 124$$

$$L_{\text{pl}} = 10.\text{Log}_{10}\left\{\left(10^{\frac{-80}{10}}\right)+\left(10^{\frac{-70}{10}}\right)\right\} + 124 + 60$$

$$= 114 \text{ dB}$$

A6.127 The distance equivalent to this path loss can be derived from the Extended Hata loss equation[90,] Hb = 20m, Hm = 2m, F = 915 MHz and zero fade margin and is shown in Table 20 below.

Table 20: Proposed separation distance from 917 – 921 MHz band base station to GSM-R mobile station

Environment	Minimum separation (m)
Urban	375
Suburban	721

A6.128 Reduced distances could potentially be negotiated with the incumbent 900 MHz band licensee for specific sites. This might be the case, for example, where obstructions provide increased path loss between the transmitter and the 900 MHz band base station, or where site engineering or improved filtering may mitigate the impact of interference.

Proposal for a light regulatory approach in the band 917 - 921 MHz

A6.129 The technical analysis presented above for emissions in the band 917 - 921 MHz has been based on a mobile broadband transmitter using a conventional base station design.

A6.130 We aware of work proceeding in CEPT and ETSI to examine the opportunities for licence exempt services in this band and also the coexistence of licensed (GSM-R) and licence exempt services.

A6.131 To date little technical work has been carried out on licence exemption (LE) use of this band. However, two example cases are considered below.

A6.132 The proposed characteristics for a LE example have been derived from ETSI TR 102 649-2[91]. This standard gives information about RFID devices that might be implemented in the band 917 - 921 MHz.

A6.133 From[91] Figure 4, four RFID carriers of 4W ERP = 6.56W EIRP may be considered. These carriers are 400 kHz wide and centred on 916.2, 917.4, 918.6 and 919.8 MHz. The first carrier is not considered here because it is outside the 917 – 921 MHz band, considered in this consultation.

A6.134 The out of band emissions may be taken from[91] Figure. B2. This specification is relevant for 2W devices in the lower band (865 - 868 MHz); we have assumed that a similar specification is appropriate for 4W devices in the band 917 - 921 MHz.

A6.135 The ACLR into a 3.84 MHz UMTS900 channel and a 200 kHz GSM channel can be derived as follows:

Table 21: Derived ACLR for RFID readers interfering into a GSM or UMTS900 channel

		UMTS900	GSM
Tx P	W ERIP	6.56	6.56
OOB	dBm/3kHz	-46	-46
ACLR	dBc/3kHz	84.2	84.2
Rx BW	kHz	3840	200
ACLR	dB	53.1	65.9

A6.136 RFID transmitters are normally used indoors, although outdoor is possible. In the following analysis we have conservatively assumed a local shielding of 10 dB.

[91] ETSI TR 102 649-2 V1.1.1 (2008-09), Technical Report, Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRD and specific SRD.

Interference into a UMTS900 base station

A6.137 We consider the effect of LE services in the band 917 - 921 MHz on an UMTS900 base station with a receive frequency 910 - 915 MHz. It is assumed that the base station is fitted with an industry standard duplexer; see A6.45 for more information on this choice.

A6.138 We assume that three LE devices (RFID readers) are active at frequencies of 917.4 MHz, 918.6 MHz and 919.8 MHz.

A6.139 The ACS will be different for each of the interfering channels. Using the method given in A6.52; taking the critical case of interference into a UMTS900 channel assuming an ACS due to the equipment of 46 dB (from Table 13) and a duplexer with a slope of 10 dB and fo = 916.5 MHz, such that the loss due to the duplexer is given by 10×(f - 916.5), the ACS can be derived for each of the interfering channels as follows,

Table 22: Derived ACS for RFID readers interfering into a UMTS900 channel

		RFID Channel 2	RFID Channel 3	RFID Channel 4
f_c	MHz	917.4	918.6	919.8
f_1	MHz	917.2	918.4	919.6
f_2	MHz	917.6	918.8	920
A	dB/MHz	10	10	10
f_o	MHz	916.5	916.5	916.5
ACS_o	dB	46	46	46
ACS_{eff}	dB	54.8	66.8	78.8

Where ACS_{eff} if the effective ACS, including the equipment ACSo and a receive side duplexer.

A6.140 The effective ACIR for each of the interfering channels can be derived from A6.36.

Table 23: Derived ACIR for RFID readers interfering into a UMTS900 channel

		RFID Channel 2	RFID Channel 3	RFID Channel 4
f_c	MHz	917.4	918.6	919.8
f_1	MHz	917.2	918.4	919.6
f_2	MHz	917.6	918.8	920
ACS	dB	54.6	66.8	78.8
ACLR	dB	53.1	53.1	53.1
ACIR	dB	50.9	52.9	53.1

A6.141 The required path loss to the victim receiver may be calculated from:

$$L_{\text{pl}} = \sum_{\text{All RFID emitters}} \left(\text{EIRP-ACIR}\right) + G_{\text{a}} - L_f - \gamma$$

Any loss due to antenna tilt is not taken into account because the RFID will normally be ground level. G_a= 15 dB, L_f = 10 dB (from A6.136), γ = -108 dBm (from Table 12)

Required path loss, L_{pl} = 102 dB.

A6.142 The distance equivalent to this path loss can be derived from the Extended Hata loss equation [90], Hb = 20m, Hm = 2m, F = 919 MHz and zero fade margin and is shown in Table 23 below. Noting that the Extended Hata equation offers reciprocity, that is up link path loss ≈ down link path loss at a given frequency.

Table 24: Proposed separation distance from RFID readers in the 917 - 921 MHz band to UMTS900 base station.

Environment	Minimum separation (m)
Urban	170
Suburban	330

Interference into a GSM base station

A6.143 We consider the effect of LE services in the band 917 - 921 MHz on a GSM base station with a receive frequency up to 915 MHz. It is assumed that the base station is fitted with an industry standard duplexer.

A6.144 We assume that three RFID readers are active at frequencies of 917.4, 918.6 and 919.8 MHz.

A6.145 The ACS will be different for each of the interfering channels. Using the method given in A6.52; assuming an ACS due to the equipment of 97 or 100 dB (from Table 13) a duplexer with a slope of 10 dB and f_o = 916.5 MHz, such that the loss due to the duplexer is given by 10×(f - 916.5). The ACS can be derived for each of the interfering channels.

Table 25: Derived ACS for RFID readers interfering into a GSM channel

		RFID Channel 2	RFID Channel 3	RFID Channel 4
f_c	MHz	917.4	918.6	919.8
f_1	MHz	917.2	918.4	919.6
f_2	MHz	917.6	918.8	920
A	dB/MHz	10	10	10
f_o	MHz	916.5	916.5	916.5
ACS_o	dB	97	100	100
ACS_{eff}	dB	105.8	120.8	132.8

where ACS_{eff} if the effective ACS, including the equipment ACSo and a receive side duplexer.

A6.146 The effective ACIR for each of the interfering channels can be derived from A6.36

Table 26: Derived ACIR for RFID readers interfering into a GSM channel

		RFID Channel 2	RFID Channel 3	RFID Channel 4
f_c	MHz	917.4	918.6	919.8
f_1	MHz	917.2	918.4	919.6
f_2	MHz	917.6	918.8	920
ACS	dB	105.8	120.8	132.8
ACLR	dB	65.9	65.9	65.9
ACIR	dB	65.9	65.9	65.9

A6.147 The required path loss to the victim receiver may be calculated from:

$$L_{pl} = \sum_{\text{All RFID emitters}} (\text{EIRP-ACIR}) + Ga - L_f - \gamma$$

Any loss due to antenna tilt is not taken into account because the RFID will normally be ground level. So that Ga= 15 dB, L_f = 10 dB (from A6.136), γ = -124 dBm (from Table 12).

Required path loss = 104 dB.

A6.148 The distance equivalent to this path loss can be derived from the Extended Hata loss equation [90], Hb = 20m, Hm = 2m, F = 919 MHz and zero fade margin and is shown in Table 27 below. Noting that the Extended Hata equation offers reciprocity, that is up link path loss ≈ down link path loss at a given frequency.

Table 27: Proposed separation distance from RFID readers in the 917 - 921 MHz band to GSM900 base station.

Environment	Minimum separation (m)
Urban	220
Suburban	430

Interference into a GSM-R mobile station

A6.149 In this section we consider the effect of a LE device in the band 917 - 921 MHz on a GSM-R mobile station in the band 921 – 925 MHz.

A6.150 We assume that three LE devices are active at frequencies of 917.4, 918.6 and 919.8 MHz.

A6.151 The ACS = 70 dB, from Table 18 and the ACLR = 65.9 dB from Table 21. So that the ACIR = 64.5 dB.

A6.152 The required path loss to the victim receiver may be calculated from:

$$L_{pl} = \sum_{\text{All RFID emitters}} (\text{EIRP - ACIR}) + G_a - L_f - \gamma$$

where G_a= 0 dB, L_f = 10 dB (from A6.136), γ = -124 dBm (from Table 12)

Required path loss L_{pl} = 91 dB.

A6.153 The distance equivalent to this path loss can be derived from the Extended Hata loss equation including Short Range Devices modification[90], Hb = 2m, Hm = 2m, F = 919 MHz and zero fade margin and is shown in Table 28 below.

Table 28: Proposed separation distance from RFID readers in the 917 - 921 MHz band to GSM-R mobile station.

Environment	Minimum separation (m)
Urban	110
Suburban	220

Summary of applications under a light regulatory approach

A6.154 We propose that some applications operating under a light regulatory approach, such as RFID devices operating in band 917 - 921 MHz have potential to interfere with GSM and UMTS900 base stations in the band 910 - 915 MHz and GSM-R base stations in the band 921 - 925 MHz.

A6.155 However, the situation will be eased if the OOB emission specification for RFID devices is improved. However the extent to which can be achieved for RFIDs has yet to be determined.

A6.156 If separation distances are needed then a form of light licensing may be required. Further analysis will be required to confirm whether in practice the potential for interference from RFIDs could be deemed unacceptable. The analysis presented above is based on a minimum coupling loss consideration which, by its nature, is a conservative approach. RFID are likely to be operated in an intermittent manner which would need to be factored into account. Comments are welcome on the use of the 872-876/917-921MHz band for RFIDs applications.

Annex 7

Statutory duties

Introduction

A7.1 This section provides a brief overview of the main UK and European legislative provisions relevant to wireless telegraphy licensing and the assignment of spectrum bands. It does not provide a comprehensive statement of all the legal provisions which may be relevant to Ofcom's functions and to the assignment of the 872/917 MHz bands.

A7.2 Interested parties should seek their own legal advice in relation to legal provisions that are relevant to the available spectrum bands and potential plans they may have for their use.

Ofcom's statutory duties

A7.3 In exercising Ofcom's powers to manage spectrum, Ofcom has some general statutory duties and some specific ones (see below), and has to take into account certain considerations when performing those duties. These can be thought of as Ofcom's objectives or decision criteria which it must consider when making a particular spectrum management decision. These are set out in full in the Communications Act 2003 (the 2003 Act) and the Wireless Telegraphy Act 2006 (the 2006 Act) and, and in particular at sections 3 and 4 of the former and 3 of the latter. The most relevant points for the matters discussed in this document are set out below.

A7.4 Under section 3(1) of the 2003 Act it is the principal duty of Ofcom in carrying out its functions:

- to further the interests of citizens in relation to communications matters; and
- to further the interests of consumers in relevant markets, where appropriate by promoting competition.

A7.5 In doing so, Ofcom should secure, amongst other things:

- the optimal use for wireless telegraphy of the electro-magnetic spectrum (section 3(2)(a) of the 2003 Act); and
- the availability throughout the UK of a wide range of electronic communications services (section 3(2)(b));

and have regard, amongst other things, to:

- principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed (section 3(3) of the 2003 Act);
- the desirability of promoting competition (section 3(4)(b));

- the desirability of encouraging investment and innovation (section 3(4)(d));
- the desirability of encouraging availability and use of broadband services throughout the UK (section 3(4)(e));
- the different needs and interests of all users or potential users of spectrum (section 3(4)(f)); and
- the different interests of persons in different parts of the UK (section 3(4)(l)).

A7.6 In addition, as the management of the UK radio spectrum is governed by the European Communications Directives, which aim to harmonise the regulation of electronic communications networks and services throughout the EU, section 4 of the 2003 Act applies to the matters discussed in this document. Section 4 requires Ofcom to act in accordance with the "six community requirements" set out in that section when managing the wireless spectrum in the UK. Of particular relevance are the following:

- the requirement to promote competition (section 4(3));
- the requirement to secure that Ofcom's activities contribute to the development of the European internal market (s4(4));
- the requirement to promote the interests of all persons who are citizens of the European Union (s4(5));
- the requirement to act, so far as practicable in a 'technology neutral' way (section 4(6)); and
- the requirement to encourage such compliance with international standards as is necessary for- (a) facilitating service interoperability; and (b) securing freedom of choice for the customers of communications providers (section s4(9) and (10)).

Ofcom's duties when carrying out spectrum functions

A7.7 As well as these general duties and considerations, section 3 of the 2006 Act sets out a number of specific duties which apply to the management of the spectrum. In summary these require Ofcom to have regard to:

- the extent to which the spectrum is available for use or further use for wireless telegraphy (section 3(1)(a));
- the demand for use of spectrum for wireless telegraphy (section 3(1)(b));
- the likely future demand for spectrum for wireless telegraphy (section 3(1)(c));

and the desirability of promoting:

- the efficient management and use of the spectrum available for wireless telegraphy (section 3(2)(a));
- the economic and other benefits that may arise from the use of wireless telegraphy (section 3(2)(b));
- the development of innovative services (section 3(2)(c)); and

- competition in the provision of electronic communications services (section 3(2)(d)).

A7.8 If there is a conflict between these various duties, the duties under section 4 of the 2003 Act will prevail over each of the others and the duties under section 3 of the 2003 Act will prevail over those in section 3 of the 2006 Act.

Granting wireless telegraphy licences

A7.9 Ofcom's legal power to grant wireless telegraphy licences is set out in 2006 Act. Section 8(1) of the 2006 Act makes it unlawful for any person to establish or use any station for wireless telegraphy or to install or use any apparatus for wireless telegraphy except under and in accordance with a licence granted by Ofcom under that section (a wireless telegraphy licence).

A7.10 Section 9(1) of the 2006 Act gives Ofcom the power to grant wireless telegraphy licences subject to such terms as Ofcom thinks fit.

A7.11 However, Ofcom's broad discretion in relation to the terms that can be imposed in a wireless telegraphy licence is subject to the rule that Ofcom must impose only those terms that it is satisfied are objectively justifiable in relation to the networks and services to which they relate, not unduly discriminatory, and proportionate and transparent as to what they are intended to achieve (section 9(7) of the 2006 Act).

A7.12 Under section 8(3) and (4) of the 2006 Act Ofcom also has powers to make regulations exempting the establishment, installation or use of wireless telegraphy stations or apparatus from the need for a licence.

Providing for an auction of wireless telegraphy licences

A7.13 Ofcom has power under section 14 of the 2006 Act (having regard to the desirability of promoting the optimal use of the electro-magnetic spectrum) to make regulations providing that applications for the grant of wireless telegraphy licences must be made in accordance with a procedure which involves the applicants making bids for licences (for example, an auction).

A7.14 Ofcom has broad powers in section 14 of the 2006 Act to make provision in regulations for the form of the licences and the auction bidding procedure.

Other legal provisions

A7.15 There are also other important legal constraints on how Ofcom can manage spectrum. Of particular relevance are the following:

- the requirement to comply with EU harmonisation measures; and
- the need to respect Government spectrum usage in accordance with the UK Frequency Allocation Table.

A7.16 Ofcom must comply with any direction issued by the Secretary of State relating to spectrum management (see in particular section 5 in each of the 2003 and 2006 Acts).

Annex 8

Glossary

2G	2G in the context of the present consulation refers to second-generation mobile phone technology, such as GSM. The main differentiator to previous mobile telephone systems, retrospectively dubbed 1G, is that the radio signals that 1G networks use are analogue, while 2G networks are digital.
3G	3G is the third generation of mobile phone technology. It is reflected in the International Telecommunication Union (ITU) Recommendation on International Mobile Telecommunications-2000 (IMT-2000). 3G technologies enable network operators to offer users a range of advanced services while achieving greater network capacity than 2G through improved spectral efficiency. Services include wide-area wireless voice telephony and broadband wireless data, all in a mobile environment.
3GPP	The 3rd Generation Partnership Project (3GPP) prepares, approves and maintains globally applicable technical specifications and technical reports for the evolved 3rd generation and beyond mobile system known as UMTS and LTE/E-UTRA. 3GPP also maintains the technical specifications and technical reports for GSM, including GPRS and EDGE.
ACIR	Adjacent Channel Interference Ratio is defined as the ratio of the power of an adjacent-channel interferer, to the power measured after a receive filter in the adjacent channel and is a result of both transmitter and receiver imperfections.
ACLR	Adjacent Channel Leakage (Power) Ratio. The ACLR of a signal is defined as the ratio of the signal's power to the power of the signal when measured at the output of a (nominally rectangular) receiver filter centred on an adjacent frequency channel.
ACS	Adjacent Channel Selectivity (ACS) is a measurement of a receiver's ability to process a desired signal while rejecting a strong signal in an adjacent frequency channel. ACS is defined as the ratio of external interference to the interference appearing at a receiver input.
ACSo	Is a measure of a receiver's Adjacent Channel Selectivity (ACS) at the receiver input, without taking into account any filter in the receive path.
BTS	In a cellular system the Base Transceiver Station terminates the radio interface. Each BTS may consist of a number of TRX (Transceivers), typically between 1 and 16 in a GSM system.
CDMA	Code Division Multiple Access (CDMA) is a multiple access scheme for digital radio, to send voice, data, and signalling data between mobile phones and cell sites. CDMA channels are defined

	with codes and permit many simultaneous transmitters on the same frequency channel.
CEPT	The European Conference of Postal and Telecommunications Administrations - CEPT - was established in 1959. CEPT is the European regional organisation dealing with postal and electronic communications service issues. CEPT's activities included co-operation on commercial, operational, regulatory and technical standardisation issues. CEPT currently has 45 members. www.cept.org
dB	The decibel (dB) is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power) relative to a specified or implied reference level.
dBc	dBc is decibels relative to the carrier. dBc/Hz is decibels relative to the carrier per hertz. These units are used to describe in decibels how far down emissions are, relative to a known signal.
dBm	dBm is an abbreviation for the power ratio in decibels (dB) of the measured power referenced to one milliwatt (mW). It is used in radio networks as a convenient measure of absolute power because of its capability to express both very large and very small values in a short form.
EC	The European Commission. The European Commission embodies and upholds the general interest of the European Union and is the driving force in the Union's institutional system. Its four main roles are to propose legislation to Parliament and the Council, to administer and implement Community policies, to enforce Community law (jointly with the Court of Justice) and to negotiate international agreements, mainly those relating to trade and cooperation. http://ec.europa.eu/atwork/index_en.htm
ECC	Electronic Communications Committee. Created by the CEPT to consider and develop policies on electronic communications activities in CEPT member countries, taking account of European and international legislation and regulations. www.ero.dk.
EIRP	Equivalent isotropically radiated power (EIRP/e.i.r.p) or, alternatively, effective isotropic radiated power is the amount of power that would have to be emitted by an isotropic antenna (that evenly distributes power in all directions and is a theoretical construct) to produce the peak power density observed in the direction of maximum antenna gain.
ERP	Effective Radiated Power is the amount of power that would have to be emitted by a half-wave dipole antenna to produce the peak power density observed in the direction of maximum antenna gain.
ETSI	European Telecommunication Standards Institute. ETSI produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies. ETSI is officially recognized by

	the European Commission as a European Standards Organization and is an Organizational Partner in 3GPP. http://www.etsi.org/
EU	The European Union (EU) is a unique supernational union, made up of twenty-seven member states. It was established as the European Economic Community in 1957 by the Treaty of Rome and has undergone many changes since, most notably in 1992 by the Maastricht Treaty. Since 1957 new accessions have raised the number of member states, and powers have expanded.
EV-DO	Evolution-Data Optimized EV-DO is a telecommunications standard (cdma2000 1xEV-DO) for the wireless transmission of data through radio signals, typically for broadband Internet access. It is standardized by 3rd Generation Partnership Project 2 (3GPP2) as part of the cdma2000 family of standards and is part of IMT-2000.
FDD	Frequency Division Duplex (FDD) is a means of providing duplex (bidirectional) communications in wireless networks, FDD makes use of separate frequencies for uplink and downlink channels. FDD is used with both analogue and digital wireless technologies, including cordless telephony and cellular i.e. GSM and UMTS900.
FLASH OFDM	Flash-OFDM (Fast Low-latency Access with Seamless Handoff Orthogonal Frequency Division Multiplexing) is a broadband wireless technology that is based on OFDM.
GPRS	GPRS (General Packet Radio Service) is a mobile connectivity solution based on Internet Protocols that supports a wide range of enterprise and consumer applications. With throughput rates of up to 40 Kbit/s, it has a similar access speed to dial-up modems. Further data rate increases have been achieved with the introduction of EDGE (Enhanced Data rates for Global Evolution). http://www.gsmworld.com/technology/gprs/index.shtml
GSM	Global System for Mobile communications (GSM) is the second generation digital cellular telecommunication system implemented in the UK and many other countries across the globe. http://www.gsmworld.com/technology/gsm.shtml
GSM-R	GSM-R, Global System for Mobile Communications - Railway or GSM-Railway is an international wireless communications standard for railway communication and applications. A sub-system of European Rail Traffic Management System (ERTMS), it is used for communication between train and railway regulation control centers. The system is based on GSM and *EIRENE* - *MORANE* (European Integrated Railway radio Enhanced Network - Mobile Radio for Railways Networks in Europe) specifications which guarantee performance at speeds up to 500 km/h (310 mph), without any communication loss. See also UIC below.
HSPA	High Speed Packet Access (HSPA) is a collection of mobile telephony protocols that extend and improve the performance of the (Universal Mobile Telecommunications System) radio access network.

Hz	The hertz (symbol: Hz) is the SI (International System of Units) unit of frequency. Its base unit is cycle/s or s^{-1} (also called inverse seconds, reciprocal seconds). One hertz simply means *one per second* (typically that which is being counted is a complete *cycle*); 100 Hz means *one hundred per second*, and so on.
IMT-2000	International Mobile Telecommunications-2000 is the global standard for third generation (3G) wireless communications, defined by a set of interdependent ITU Recommendations. .
ITU	International Telecommunication Union. Headquartered in Geneva, Switzerland, it is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services. http://www.itu.int
kHz	Kilohertz abbreviated kHz, is a unit of frequency equal to one thousand hertz (1,000 Hz).
LAN	A local area network (LAN) is a computer network covering a small physical area, like a home, office, or small group of buildings, such as a school, or an airport. The defining characteristics of LANs, in contrast to wide-area networks (WANs), include their usually higher data-transfer rates, smaller geographic range, and lack of a need for leased telecommunication lines.
LTE	Long Term Evolution is the name given to a project within the Third Generation Partnership Project (3GPP) to enhance the Universal Mobile Telecommunications System (UMTS) mobile phone standard. The resulting E-UTRA (Evolved Universal Terrestrial Radio Access) radio interface is based on orthogonal frequency division multiple access (OFDMA) for the downlink and single-carrier frequency division multiple access (SC-FDMA) for the uplink.
MHz	Megahertz abbreviated MHz, is a unit of alternating current or electromagnetic wave frequency equal to one million hertz (1,000,000 Hz).
MOD	Ministry of Defence (http://www.mod.uk/DefenceInternet/home).
MPT 1327	MPT 1327 is an industry standard for trunked radio communications networks published in January 1988 by the Radiocommunications Agency.
ODFM	Orthogonal Frequency-Division Multiplexing (OFDM) is a digital multi-carrier modulation scheme, which uses a large number of closely-spaced orthogonal *sub-carriers*. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation) at a low symbol rate, maintaining data rates similar to conventional *single-carrier* modulation schemes in the same bandwidth.

OOB	Out of Band emissions: Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emission.
PMSE	Programme Making and Special Events. http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/pmse/
RFID	Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. The technology requires some extent of cooperation of an RFID reader and an RFID tag. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.
RSA	Recognised Spectrum Access - a spectrum management instrument created by the Communications Act to complement WT licences
RSC	The Radio Spectrum Committee (RSC) was established under the Radio Spectrum Decision 676/2002/EC as part of the regulatory framework for electronic communications which entered into force on 24 April 2002. The RSC assists the European Commission in the development and adoption of technical implementing measures aimed at ensuring harmonised conditions for the availability and efficient use of radio spectrum, as well as the availability of information related to the use of radio spectrum. Once adopted by the European Commission, these Decisions are binding on Member States. http://ec.europa.eu/information_society/policy/ecomm/committees_working_groups/index_en.htm / http://www.ofcom.org.uk/radiocomms/international/eu/
Spectrum Commons	A Spectrum Commons Class is defined as a range of Indicator values. Applications with similar Indicator values will belong to the same class, and only applications in a class will be allowed in a particular band. As a result, only applications with like interference potential would share spectrum: http://www.ofcom.org.uk/consult/condocs/scc/statement/
SRD	A Short Range Device (SRD) is a general term, applied to various radio devices designed to operate over short range and at low power levels. This includes alarms, telemetry and telecommand devices, radio microphones, radio local area networks and anti-theft devices with maximum powers of up to 500 mW at VHF/UHF, as well as certain microwave/Doppler devices with maximum powers of up to 5 W. SRD normally operate on a non-protected, non-interference basis.
TDD	Time Division Duplexing (TDD) refers to a transmission scheme in which a common carrier is shared between the uplink and downlink, the resource being switched in time. Users are allocated one or more timeslots for uplink and downlink transmission.

TETRA	The Terrestrial Trunked Radio (TETRA) standard (formerly known as *Trans European Trunked RAdio*) was developed by the European Telecommunications Standards Institute, (ETSI), as a digital alternative to analogue trunked systems. However, TETRA, with its enhanced encryption capability, has developed into a higher tier (Public Safety) product, currently mainly used by Governments, some Airports, emergency services and utilities.
TRX	A Transceiver. A device that is capable of both transmission and reception of a signal.
UIC	Union Internationale des Chemins de fer (UIC) is the worldwide organization for cooperation of railway companies: http://www.uic.asso.fr/
UK	The United Kingdom of Great Britain and Northern Ireland, commonly known as the UK.
UMTS	Universal Mobile Telecommunications System (UMTS) is one of the third-generation (3G) mobile technologies and is included in IMT-2000. UMTS uses a wideband code division multiple access (W-CDMA) radio interface. The designation UMTS900 is used to differentiate UMTS operating the band 880 – 915 MHz and 925 – 960 MHz from UMTS operating in other frequency bands.
WAP	Wireless Access Protocol. WAP is an open international standard[1] for application layer network communications in a wireless communication environment. Its main use is to enable access to the Internet (HTTP) from a mobile phone or PDA.
WiMAX	*Worldwide Interoperability for Microwave Access*, is a telecommunications technology that provides wireless transmission of data using a variety of transmission modes, from point-to-point links to portable internet access. The technology is based on the IEEE 802.16 standard