



**TRANSFINITE**  
SYSTEMS



## **Spectrum usage rights**

**Ofcom**

**Final Report**  
**Executive summary**

1721/TNR/ES/1

10<sup>th</sup> February 2006





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## 1 INTRODUCTION

Following on from the Independent Spectrum Review (Cave Report) Ofcom announced its intention to liberalise use of the spectrum such that the market will be allowed to determine best use of the spectrum. It is proposed that this liberalisation be introduced in two phases. Initially Ofcom will assess whether a proposed change in spectrum use is acceptable but eventually it is expected that change in spectrum use will be negotiated in the market within a suitable technical and procedural framework.

The Spectrum Framework Review (SFR) set out at a high level a possible mechanism whereby technology-neutral spectrum usage rights could be introduced. The SFR proposed that such usage rights might consist of two elements - transmit rights and a degree of protection for receivers. Ofcom asked the study team, comprising Aegis, Indepen and Transfinite, to consider the options for implementing spectrum usage rights and to propose a longer term framework which takes account of the various technical issues and allows for flexibility in terms of spectrum usage within a controlled interference environment.

The study encompassed the following activities:

- Discussions with stakeholders who responded to the SFR on the issue of technology neutral rights
- Discussions with spectrum managers in countries that have liberalised spectrum use
- Analysis of the current proposals leading to more detailed technical proposals for spectrum usage rights
- Analysis of the potential for market failure and recommendations on how to address any identified market failures.
- Application of the proposed framework to a number of case studies to test whether it is workable.

It is important to note that the introduction of technology-neutral spectrum usage rights is not being done with respect to empty spectrum. The rights of existing licensees need to be taken into account at the same time recognising that some spectrum users (e.g. MoD) do not have specifically defined rights. It can be further noted that recently announced releases of spectrum are to a large extent already being provided on a technology-neutral basis on a case by case basis i.e. not in the context of an over-arching framework.

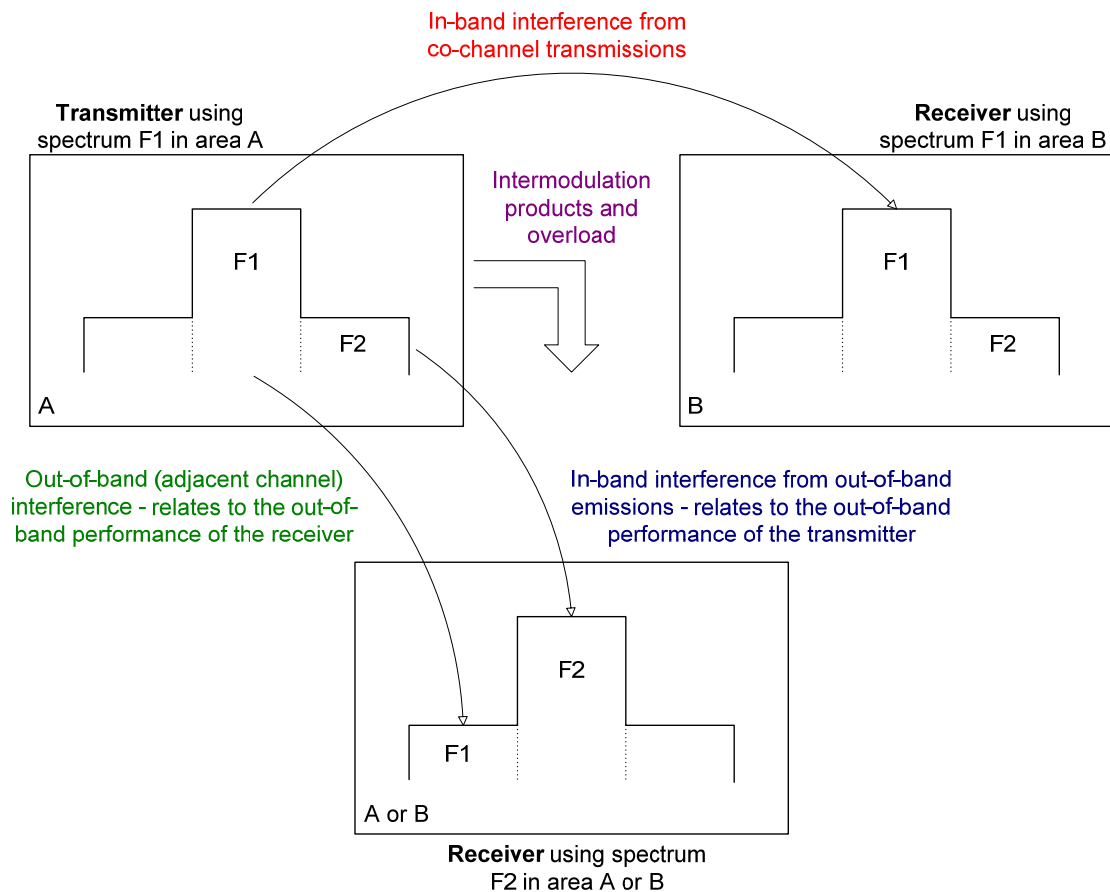
Proposals made in this report have been made with a long term view in mind and without detailed legal advice. As such, it is likely that current legislation may not allow some parts of the proposed approach to be implemented. It has been assumed by the study team that changes to legislation would be possible at some point in the future. Even if this were not to be the case it is considered that

significant parts of the proposed framework could still be implemented within current legislation.

## 2 THE INTERFERENCE ENVIRONMENT

In a liberalised regime, the only constraint on spectrum use should be the controls necessary to avoid harmful interference and the study team has therefore sought to determine a set of controls that offer flexibility in spectrum use while not increasing the level of harmful interference.

In a simplified form the interference environment can be represented by the diagram below, noting that apart from the out-of-band emissions resulting from the modulation process, there are also spurious emissions that can be generated beyond the immediately adjacent bandwidth.



**Figure 1: The interference environment**

The emphasis here is very much on the impact of the various emission types emanating from a transmitter on a victim receiver, rather than the impact of unintentional emissions from a receiver on other receivers.

The main types of interference are:

- The in-band interference from co-channel transmissions across geographic boundaries (as shown in red)

- The in-band interference from out-of-band emissions falling across frequency boundaries (as shown in blue)
- The out-of-band (adjacent channel) interference (as shown in green) is determined by the in-band power of the transmitter and the out-of-band performance of the victim receiver.
- The intermodulation products and overload (as shown in purple) are to some extent controlled by the out-of-band limits applying to the transmitter. There are, however, situations where intermodulation products arise unexpectedly in a receiver or passively due to non-linear conductivity in metal. Other spurious emissions (e.g. harmonics / frequency conversion products) exist, both for transmitters and receivers.

It is these four types of interference (or interference entries) that have to be considered when deciding the degree of control that should be exercised under a liberalised regime.

The study team examined these types of interference and the technical factors which give rise to them. As a result of these considerations particular technical issues which have to be confronted when seeking to control the interference environment in a liberalised regulatory regime were identified. The regulatory methods for controlling the interference environment were then considered as described in detail in the main report and summarised below.

## 2.1 Technical issues

In examining the different types of interference noted above, the study team identified the following issues as having a bearing on the means by which a piece of spectrum can be delineated:

- **Aggregation of interference** – Insofar as a victim receiver is concerned it is generally the aggregate level of interference that is of concern even though in some instances the aggregate level will be dominated by one of the sources of interference. It is therefore recommended that a licence should have an aggregate emission limit both for in-band emissions and out-of-band emissions, although as will be seen later the mechanism for controlling the latter is not straightforward.

It is further recommended that the link between receiver tolerable interference and the aggregate emission limit for a single licence should be declared, including any assumptions made about the apportionment of the total interference budget (i.e. the apportionment of the receiver tolerable interference between a number of licences in terms of their emission limits). This declaration should be made by Ofcom when the rights to use spectrum are first established.

- **Deployment of systems** – Moving from a command and control system to a liberalised regime potentially means that deployment becomes variable. Changing spectrum use from a fixed system to a mobile system causes the biggest uncertainty and potential for interference if carried out without

coordination with other spectrum users. It is therefore proposed that when current licences are converted into liberalised spectrum usage rights any deployment restrictions (whether explicit or implied) associated with current licences should be carried over, at least initially. Such restrictions can then be relaxed or removed if required through negotiation with other spectrum users. In the case of new licences it would be possible to define the rights either with or without deployment restrictions. An absence of deployment restrictions would be preferable but whether this can be achieved will depend on existing spectrum neighbours.

- **Determination of neighbouring users with whom negotiation is necessary**
  - There are two aspects to this determination; what triggers a need to negotiate a change of use and who are the neighbours with whom one has to negotiate, both at the frequency boundary and at the geographic boundary?

The trigger for negotiation occurs when a proposed change of use requires modification to any of the parameter values contained in a licence such that the modifications could cause increased levels of interference to other users of the radio spectrum operating in accordance with their licences.

The identity of frequency boundary neighbours should be determined by out-of-band emission overlap and not spurious emissions except in the case of high power transmitters, although if the OOB emission mask is specified in absolute terms the potential for interference from high power transmitters should not matter – the potential for blocking does however remain. Geographic boundary neighbours should be determined by distance from the boundary depending on proposed power increase, frequency band and possibly height. In establishing suitable distances there are two options:

- Ofcom issues non-mandatory guidelines on a distance appropriate to the power increase, frequency etc
- Users initiating a change of use determine an appropriate distance based on their own expertise or advice from others.

In both cases, and subsequent to a change of use being implemented, it will still be open to other users with whom no negotiation has been carried out to take action through the courts or an arbitration procedure to enforce their rights however defined.

Access to relevant data will be required for spectrum users to be able to identify their neighbours.

- **Spectrum quality** – Given the uncertainties in propagation it is difficult to guarantee that a particular level of interference will not occur unless significant margins are built in thereby leading to a degree of inefficiency. It can also be argued that transmit rights should be sufficient to determine the interference environment in which receivers operate. Information on spectrum users' transmit rights has to be made publicly available for this to be the case.



However, from a spectrum user's point of view there are two main questions that have to be addressed if the transmit rights-only approach is adopted:

- If I want to change my transmit rights how do I determine whether the proposed change is going to be acceptable to my neighbours?
- With respect to my receivers at what point can I claim that I am receiving too much interference, or conversely, what level of interference should I assume when planning my system?

In order to make an assessment in the first case, knowledge of other spectrum users' system deployments and planning criteria would be required. This will not necessarily be in the public domain and will therefore need to be obtained as part of direct negotiation with the other spectrum users.

Insofar as the second case is concerned, it will be difficult for a spectrum user to determine the overall level of interference they might expect from the transmit rights of their neighbours with any accuracy. This could potentially lead to gross inefficiencies when users make assumptions as part of their planning process. Furthermore, as noted later, a level that if exceeded would support a request for an investigation by Ofcom is also required.

It is therefore considered appropriate that an Indicative Interference Level or some other similar benchmark be retained in order to indicate likely spectrum quality for planning (and enforcement) purposes and for the basis of discussions in negotiations with neighbours.

- **Receiver performance** – The performance of receivers has not in the past been an explicit requirement insofar as licence conditions are concerned. In making a frequency assignment there is however an implicit link to receiver characteristics which are used to determine whether an assignment is possible or not. It is clear that any assessment of interference requires some knowledge of receiver performance. If future assessment of interference, as part of the negotiation process between spectrum users, is to be left to the market place then it seems necessary that reference to a minimum receiver performance be maintained where currently available (e.g. in Ofcom's Technical Frequency Assignment Criteria) and introduced where not.

It is important to note that the minimum receiver performance is not meant to be mandated. It serves as a benchmark with which the interference environment can be assessed. If an operator chooses to use receivers having a performance in some way inferior to the minimum receiver performance, then they will not be protected from interference levels higher than those used for the assessment. They may however choose to negotiate with a neighbour to reduce the neighbour's emissions such that their inferior receivers operate satisfactorily. At this point the parties may agree to embody the agreement in the rights or not.

If it is intended that a spectrum user be able to exploit spectrum to its fullest extent then it will be necessary to associate the negotiable minimum receiver performance with the usage rights themselves.

In a framework that only includes the definition of transmit characteristics it becomes difficult to assess who you have to negotiate with and how they will be impacted by a proposed change of use. An indication of minimum receiver performance avoids this problem.

- **Intermodulation & overload** – There are varying views on whether this is a significant enough issue to incur additional regulatory burden. It appears there are three options:
  - On the basis that it does not occur very often do not introduce any regulatory requirements (apart from OOB / spurious limits for transmitters which will be there anyway) on the grounds that the benefits of additional regulation are not sufficient to outweigh the costs of enforcement/restrictions on spectrum use. Overall both the costs and benefits are likely to be small given the infrequency with which these problems occur.
  - Specify a minimum receiver performance to reduce the risk. Receivers not meeting this specification cannot expect to be protected. However, it may not be possible to protect receivers that do meet the specification unless the next option is also implemented.
  - In order to ascertain responsibility for correcting the problem (i.e. who has priority) it will be necessary to register all transmitters (above a certain power) and receivers (if they require protection). This first-in-time method has been adopted in Australia.

Only two comments have been made on this issue by interested parties with many not expressing an opinion one way or the other. One party preferred minimal regulatory control and was prepared to take the risk associated with such an approach, whereas the other party regarded receiver registration as an acceptable burden if it ensured protection. Receiver registration could be made optional.

The option to choose might usefully be derived from the Ofcom consultation process.

- **Coordination & mitigation techniques** – Aggregate power limits at geographic boundaries (measured in terms of power flux density (PFD) or other appropriate measure of field strength) are likely to result in significant buffer zones where operations will not be possible without some sort of agreement being negotiated. The form of negotiation and the methodology to determine a satisfactory sharing arrangement may or may not be defined. Coordination methods have been defined by Ofcom with respect to a number of existing frequency bands and these coordination methods are referenced in licences where appropriate. While it is often the case that coordination methodologies

are developed and agreed within international technical gatherings (e.g. ITU and CEPT) it is not necessarily the case that such methodologies cover all situations.

In situations where coordination methodologies do not exist it might be expected that spectrum users would establish an approach to arrive at an agreement.

In any event whenever a change to a PFD limit is negotiated and agreed the new limit has to be recorded as part of the licence.

- **Propagation modelling & measurements** – In undertaking system planning and for negotiations between spectrum users it might reasonably be expected that internationally agreed propagation models would be used. It is however recognised that these models do not cover every situation.

The framework should therefore allow alternative propagation models to be used to determine the interference environment, if agreed by relevant parties, and should not preclude the use of measurements for the same purpose.

- **Enforcement** – Enforcement of licence conditions by Ofcom will continue to be an essential part of the new regulatory regime and it might reasonably be expected to take on a more important role. Enforcement is designed to prevent harmful interference from happening but there is a certain imprecision associated with this measure.

The question arises as to what the measure should be that allows a spectrum user to make an enforcement request. If the trigger were to be based on the aggregation of the PFD limits for all licences (each of which has its own aggregate limit) this would result in an unrealistically high level having to be reached before an investigation could be requested. It is recommended that an aggregate receive PFD level based on realistic assumptions be set such that if higher levels than this are experienced an investigation may be called for.

## 2.2 Conclusions

The study team has identified the most appropriate technical parameters that should delineate a licence (see later), and these are based on the technical considerations summarised in section 2.1 above. At the same time we have also concluded that there is no single correct answer when trying to establish a regulatory regime, in terms of limitations (i.e. which parameters to control and the degree to which they should be controlled) and processes, that support liberalised use of the spectrum. There is a continuum of regulatory control that ranges from:

- Tight – which provides a low risk of interference but only partial flexibility, to
- Limited – which provides a higher risk of interference and more extensive flexibility

It is not easy to establish where the optimal balance between these two extremes sits as there will be a multitude of factors, many of which are unpredictable, having an influence on its position. It would be reasonable to expect that taking all factors

into account, and especially the desire to see an increased level of flexibility foreseen by the term liberalisation, that the balance would move away from the low risk of interference / tight control, as provided by “command and control” regulatory regimes, towards a higher risk of interference / more extensive flexibility. However it is also important to recognise that it should not be necessary to seek a single point representing the balance of risk of interference and flexibility. Different users will have different requirements with regard to this balance and these requirements need to be accommodated within any proposed framework.

An oft-stated objective of liberalisation is to move away from a “command and control” regime to a market led approach<sup>1</sup>. It must not be forgotten however that even though the centralised technical spectrum management functions sitting behind the “command and control” system are being relinquished it is still necessary for most if not all of these functions to be carried out if efficient use of the spectrum is to be achieved.

The study team consider that there is a requirement for a framework that accommodates:

- Existing licensed systems (operating in much the same way as present)
- System planning within each piece of spectrum for single / multiple users and systems types
- Different organisations and types of organisation undertaking the system planning
- Different degrees of flexibility / risk of interference<sup>2</sup> / quality of service
- The ability to change the usage of a piece of spectrum

### 3 REGULATORY CONTROL

It is clear that spectrum can be defined by way of a number of dimensions which allow for flexible use as suggested in Ofcom’s Spectrum Framework Review.

It is equally clear that the use of spectrum so defined only becomes practical with the definition of operations at an equipment level, which comes out of system planning.

Any proposed regulatory framework must be able to accommodate these fundamental requirements, along with the requirements identified at the end of the previous section.

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<sup>1</sup> Notwithstanding the “Commons” approach which is lightly controlled and relies on technology to provide whatever quality of service is needed within the limitations of what is possible in the resulting interference environment.

<sup>2</sup> But not to users of other pieces of spectrum

It is therefore proposed that the framework described below be applied across the spectrum.

### 3.1 The framework

It is proposed that every piece of spectrum can be defined by Ofcom in terms of Spectrum Management Rights (SMR) with Spectrum Usage Rights (SUR) falling within the Spectrum Management Rights. The owner of Spectrum Management Rights is responsible for exploiting use of that piece of spectrum and managing the use of the band including in the first instance interference within the Spectrum Management Rights. The owner may issue Spectrum Usage Rights as they see fit so long as the conditions of the Spectrum Management Rights are met. Otherwise it would be necessary for the Spectrum Management Rights owner to negotiate a change of its SMR parameters with any affected neighbours.

The generic framework being proposed is based upon two new instruments, namely:

**Spectrum Management Rights (SMR):** describes general rights over segments of spectrum extending in frequency and geography<sup>3</sup>. SMR owners would have the right to issue Spectrum Usage Rights that are compatible with their SMR terms and conditions under a defined process. It could be anticipated that these rights would be national<sup>4</sup> and cover significant blocks of spectrum so as to reduce transaction costs when users wish to seek a change of use.

**Spectrum Usage Rights (SUR):** describes the right to transmit and/or receive at a specific location or service area<sup>5</sup> with specific characteristics. Each SUR would be associated with its parent SMR.

Note that receive only systems would not necessarily be required to operate with Spectrum Management Rights or with Spectrum Usage Rights. However there would be benefit in gaining one to ensure their need to be protected is recognised. It is noted that RSA has not yet undergone a complete consultation cycle with stakeholders and so there remains uncertainty about its role. The proposed structure is designed to accommodate such instruments should Ofcom decide to use them.

Some existing licence types would map onto Spectrum Management Rights (such as mobile 2G and 3G, FWA) while others onto Spectrum Usage Rights (such as Fixed Links and Business Radio).

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<sup>3</sup> The dimension of time can also be associated with the management and usage rights. This has been put to one side for the purposes of clarity.

<sup>4</sup> Regional rights similar to the 28 GHz Broadband Fixed Wireless Access licences would also be possible.

<sup>5</sup> For example the service area of a Business Radio network or Broadcast transmitter.

New legislation may be required to define the rights and the processes by which new rights are created, modified and cancelled. All rights would be limited by Ofcom's overarching powers to modify rights or take back spectrum where this is required for reasons of national security, to comply with European or international regulations and for spectrum management reasons.

## 3.2 Registration

We envisage there would be a register of rights, comprising the Spectrum Management Rights Register and the linked Spectrum Usage Rights Register, and that registration would confer legal title to the rights. This is essential to ensure the legal integrity of the system, for otherwise there is a risk that rights will be sold illegally (as happens with land in countries where the land registration system is incomplete). Furthermore having all spectrum use information in one place reduces transaction costs for organisations wishing to undertake trades or a change of use.

**Spectrum Management Rights Register:** containing all SMRs, terms and conditions, constraints etc. An SMR confers a right to transmit emissions and to receive certain specified levels of protection via the creation of Spectrum Usage Rights.

**Spectrum Usage Rights Register:** containing all SURs including all terms and conditions of the SUR (e.g. sites and the characteristics of transmissions from these sites). An SUR confers a right to transmit emissions and to receive certain specified levels of protection.

SMRs can only be issued by Ofcom, but may be traded and aggregated or disaggregated. Only SMR holders and Ofcom may issue SURs. Ofcom will become an SMR holder for those bands it continues to manage.

While an SMR holder might not be obliged to register its own use of the spectrum (as this is granted by the SMR) it is likely to be prudent for it to do so, for reasons of legal certainty and to enhance its rights in case arbitration of interference disputes is based in part or in whole on first in time considerations. Whether an SMR holder should be obliged to register its use of the spectrum is an open issue. Registration has the advantage that all information on spectrum use is in a single place and could be available to other users wanting to investigate the impact of a change of use and/or co-ordinate their use. In our view, obliging an SMR holder to register is preferable as the cost would be low and the benefits could be significant.

The SMR Register could be managed by Ofcom or a third party under contract to Ofcom. We anticipate that Ofcom will have a role here because it needs to maintain such a register to fulfil its spectrum management duties and because there needs to be clear way of establishing legal title to use the spectrum and receive protection from interference.

There could also be *notional* SMRs defined and registered to ensure that there is information available on the rights of and protections to be given to users that are not currently licensed by Ofcom such as licence exempt users and Crown users.

Each SMR would have associated with it all the SURs generated under its rights. SURs might derive from licences originally issued by Ofcom or might be created by SMR owners for their own use or the use of third parties.

SURs would need to be registered in the database to establish legal title and so there is information available for spectrum planning purposes. However, there will be some exceptions on grounds of national security e.g. MoD and security services where SURs may not be registered and the user would simply operate within the constraints of its Spectrum Management Rights.

### 3.3 The Rights

Spectrum Management Rights could be held by either private companies or public bodies such as Ofcom, CAA and MoD. Spectrum Usage Rights could be owned by the same organisation as the parent SMR or a different one. For example a mobile network operator would own both an SMR and associated SURs. In this case each SUR would have similar characteristics (as typically it will be for a single application and service).

However a band managed by Ofcom or other SMR holder might contain SURs that are owned by different types of users and each SUR could have a variety of characteristics because they would be used to provide different applications and services.

In bands managed by Ofcom the objective would not be commercial but would be to meet its statutory obligations under the Communications Act. In principle, it would seem desirable to give similar flexibility in modification of rights in Ofcom managed bands as in bands managed by commercial organisations. However at the SMR level we think this could conflict with Ofcom's statutory duties.

#### 3.3.1 Spectrum Management Rights

The SMR owner's rights would include but not be limited to the following:

1. "Exclusive" management rights to use radio spectrum within specified range of (frequency, geography). It is important to note that the extent of exclusivity is likely to be circumscribed by Ofcom's powers to change rights for spectrum management reasons and this could include deployment of technologies such as UWB;
2. Right to introduce/modify SURs following a specified procedure. The details of this procedure would need to be developed but may include a minimum set of parameters for the SUR, a requirement to register SURs and a requirement to obtain the consent of the SUR holder in the case of modifications;

3. Right to operate up to an envelope of parameters (e.g. EIRP). These parameters are discussed further below;
4. Right to negotiate changes to the SMR parameters with neighbours in geography or frequency subject to certification that changes will not cause harmful interference to other parties and site clearance is obtained where required;
5. Right to trade all or part of the SMR.

If an SUR holder was not compliant with aspects of its licence then the SMR owner would have to take legal action to enforce the SUR.

The SMR holder would be expected to sort out interference disputes within the frequency and geographic coverage area of its SMR. If such disputes could not be resolved and all parties were acting lawfully then the dispute could be taken to arbitration. If the dispute involved a case of unlawful interference then enforcement action would rest with Ofcom.

### 3.3.2 Spectrum Usage Rights

Spectrum Usage Rights would give the owner

1. Rights to operate according to a set of defined transmission parameters and receive specified levels of interference protection (see below)
2. Right for their receiver characteristics to be taken into account when other's proposed change of use is assessed
3. Right to trade the SUR. This may require the approval of the SMR holder, depending on the terms and conditions written into the SUR.<sup>6</sup>

An SUR might give rights to negotiate changes to transmission parameters with neighbours, perhaps subject to the approval of the SMR owner. However, this would depend on whether the SMR owner had granted this right when issuing the SUR.

Some existing Wireless Telegraphy Act (WTA) licences such as Business Radio and Fixed Services will be mapped directly to SURs in bands managed by Ofcom. The structure would be similar:

- Parent SMR controlled by Ofcom with characteristics as above
- New users issued with SUR

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<sup>6</sup> The extent to which an SMR holder might change the associated SURs will depend on the precise terms of the SURs. SURs issued initially by Ofcom could have different durations and payment terms (probably related to those for existing WTA licences) from those issued by the SMR holder.



- Process to manage the introduction of new SURs without causing interference to other users
- Process to manage the change of use of existing SURs without causing interference into other users.

### 3.4 Parameters

The main report addresses the parameters that would define spectrum management and usage rights in detail. The sections below summarise the parameters that have been addressed. A number of case studies were undertaken in order to examine the implications of some of these parameters, especially where options exist. The case studies are also detailed in the main report.

#### 3.4.1 SMR Parameters

The SMR will define at least the envelope of parameters within which SURs could be issued.

The envelope of parameters will define limits on the:

- Type of service (e.g. Fixed, Mobile or unconstrained)
- Frequency range of service;
- Geographic range of service;
- PFD (or similar) limit at and beyond the geographic boundary
- EIRP (both in-band and OOB);
- Additional controls on OOB emissions (various options)
- Antenna height;

Additionally it could include:

- Reference receiver characteristics;
- Reference receiver interference thresholds.

In the absence of reference receiver characteristics and interference thresholds being defined at the SMR level there is a danger that operators might define SURs with spuriously stringent interference protection requirements.

In addition receiver characteristics and interference thresholds should be defined in the SUR approval process. In this case the SMR would not have explicit receiver “rights” except the right to be considered during negotiations.

An SMR providing recognised spectrum access would just define:

- Frequency range of service;
- Geographic range of service;

i.e. EIRP and antenna height would not be defined.

### 3.4.2 SUR Parameters

The technical parameters for an SUR are those required to define the system at such a level as to permit interference analysis. Therefore the register would have to capture the essential transmit and receive characteristics of each possible system.

This is an extension to the approach in New Zealand which primarily defines the transmit characteristics without details on the receive side. It is considered the New Zealand approach could lead to potential problems as the receiver performance requirements could be interpreted differently between parties.

The SUR parameters would be as follows:

- Locations as points or areas;
- Type (fixed vs. mobile)<sup>7</sup>;
- Frequency and bandwidth;
- EIRP and variation of EIRP in time and frequency;
- Antenna gain patterns (Tx and Rx);
- Antenna heights and pointing angles
- System factors such as activity, frequency hopping, TDD, maximum number of simultaneously active users;
- Reference receiver including blocking filter;
- Receiver interference thresholds and associated percentages of time and / locations.

This structure would permit a range of levels of detail – for example from basic EIRP using isotropic antenna to one with sectoral antenna using measured data. In addition there could be process management fields such as:

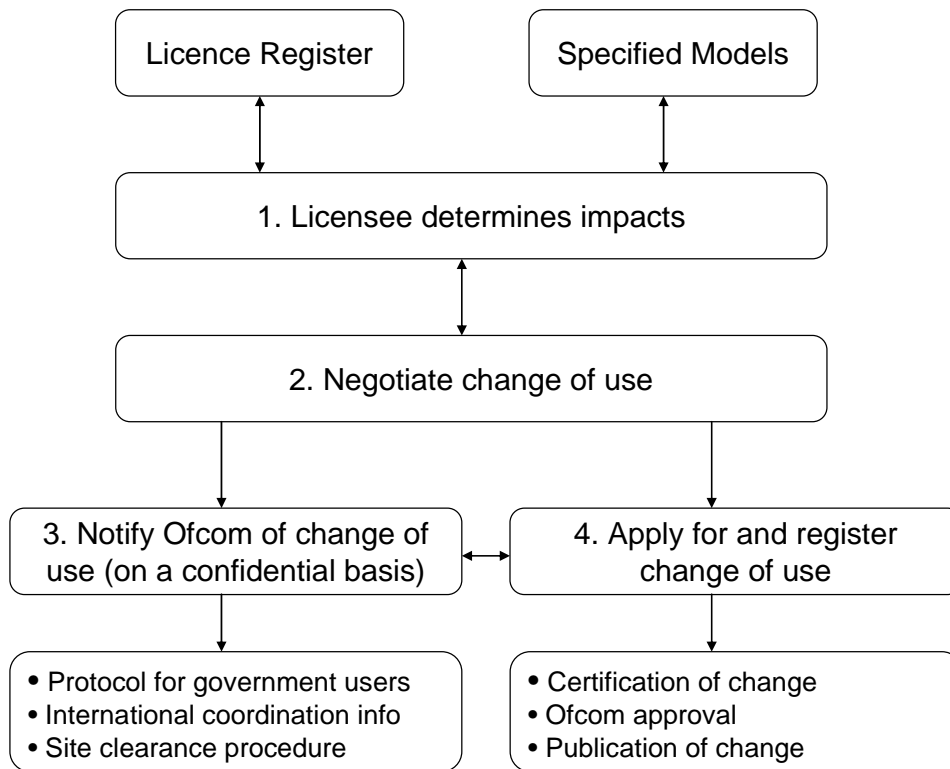
- Area SUR reference;
- Date registered;
- Date brought into use;
- Date modified;
- Reference to previous Equipment SUR record.

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<sup>7</sup> These categories are increasingly being stretched by new technologies and convergence. A base station might be located for a short period for an event (transportable) or represent a continuous moving source of interference such as in a train that passes along a track at regular intervals (fixed moving).

## 4 CHANGE OF USE

A summary of our proposals for a change of use process is given in Figure 2.



**Figure 2: Elements of the Change of Use Process**

The key procedural elements are 1) the notification of a change of use, which triggers a number of information release/negotiation processes including the protocol for dealings with Crown users and site clearance procedures, and 2) registration of change of use which requires Ofcom approval. A licence register provides the main information source for assessing the impact of the change of use on other licensees. Information pertaining to various other spectrum users that is not on the register, say for national security reasons (e.g. information concerning government users, international users), will need to be supplied by Ofcom.

Competition issues will be dealt with through competition law. Bi-lateral negotiations over change of use might be aided by the use of mediation or arbitration but this would be for the parties to the negotiation to decide.

Ofcom’s role would involve providing an interface for dealings with government users, supply of information on international co-ordination requirements, and approving the change of use. We have suggested that the compatibility analysis underpinning applications for a change of use would need to be certified by an engineer. Ofcom could only refuse applications on grounds of national security or if

the application violated EU law, international co-ordination agreements or directions from the Secretary of State.

Unlawful interference disputes would be treated the same way as they are now but we have suggested that lawful interference disputes may require a new approach. We have recommended that a means of resolving disputes through arbitration should be established, involving an ad hoc independent arbitration body and setting down criteria that would govern its decisions.

## 5 CONCLUSIONS

In a liberalised regime, the only constraint on spectrum use should be the controls necessary to avoid harmful interference and the study team has therefore sought to determine a set of controls that offer flexibility in spectrum use while not increasing the level of harmful interference. In doing this we have developed a framework that accommodates:

- Existing licensed systems (operating in much the same way as present)
- System planning within each piece of spectrum for single / multiple users and systems types
- Different organisations and types of organisation undertaking the system planning
- Different degrees of flexibility, risk of interference and quality of service
- The ability to change the usage of a piece of spectrum

We reiterate that the proposals we have developed do not take account of constraints imposed by UK and EC legislation.

### **Framework and definition of rights**

It is proposed that every piece of spectrum can be defined by Ofcom in terms of Spectrum Management Rights (SMR) with Spectrum Usage Rights (SUR) falling within the Spectrum Management Rights. The owner of Spectrum Management Rights is responsible for exploiting use of that piece of spectrum and managing the use of the band including in the first instance interference within the band. The owner may issue Spectrum Usage Rights as they see fit so long as the conditions of the Spectrum Management Rights are met. Otherwise it would be necessary for the Spectrum Management Rights owner to negotiate a change of its SMR parameters with any affected neighbours. It is proposed that use of spectrum by an SMR holder should be registered through issuing itself with SURs, so as to reduce transaction costs and improve spectrum efficiency.

The specific parameters used to define rights are summarised in sections 2.4 and presented in more detail in Chapter 4 of the main report. We have given a number of options for dealing with out of band emissions and intermodulation and overload. In both cases choices depend on judgements concerning the trade-offs between the impact on the increased risk of interference versus the flexibility offered to rights

holders. The views from consultation responses could assist in determining the option to adopt.

The case studies we have undertaken have shown that the use of two levels of rights, namely SMRs and SURs, proved an effective way of capturing the rights of existing and future spectrum stakeholders. Interference issues were found to arise from the introduction or modification of SURs rather than anything inherent in SMRs. The process by which SURs can be introduced or modified becomes a key tool in the management of interference, however, no single technical solution for the process of how SURs can be introduced or modified was found to be optimal in all circumstances. This means that each SMR should clearly specify the process by which its SURs can be introduced or modified and the regulatory framework should clearly specify how SMR owners could change the process by which SURs can be introduced or modified.

### **Process for making a change of use**

To make a CoU a licensee will need information concerning the spectrum rights of all potentially affected users, including licensed users, licence exempt users, government users, future users and international users. As much of this information as possible should be publicly available on a licence register. This information together with models for assessing the impact of a CoU (e.g. ITU/CEPT models and possibly also industry agreed models) will be used to assess impacts and will form the basis of negotiation between users.

The CoU process proposed in this document involves notification of the details of the change to Ofcom, so that constraints imposed by Crown users and international agreements can be addressed and to initiate site clearance procedures where these are necessary. We have suggested that Ofcom should provide an interface for dealings with Crown users. It is anticipated that it will not be possible to make changes to interference parameters for bands managed by Ofcom, given Ofcom's statutory obligations mean it cannot negotiate such changes. In the longer term this problem could be avoided by transferring Ofcom's band management functions to the private sector.

If interference disputes and disputes about whether a CoU that has been implemented violates a third parties' rights cannot be resolved through negotiation or voluntary mediation, then users would have the right to apply for compulsory arbitration. They would also have the option of taking complaints to the courts.