

The Role of the Innovator in Fostering Innovation

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3rd August 2005

Presentation overview:

- **Ofcom's spectrum management goals**
- **Review of possible methods of fostering innovation**
- **Spectrum usage rights and spectrum quality benchmarks**
- **A propagation modelling tool for use in a liberalised environment**
- **Accommodating innovative technologies**

Ofcom is required to:

- **Deliver optimum use of the spectrum**

Associated with this Ofcom has identified a major theme:

- **Fostering innovation**

Possible methods of fostering innovation

- Free spectrum for innovators
- Increase in licence-exempt spectrum/relaxation of rules for licence exempt transmitters
- Ensure that the regulator does not obstruct innovation

Free spectrum for innovators?

- **Not an idea that is warmly received**
- **Spectrum should not be free of charge any more than accommodation or equipment**
- **Spectrum must be valued from “day one”**
- **Making spectrum free is unlikely to lead to securing its optimum use**

Increase licence-exempt spectrum/relax rules?

- An idea that is being explored (e.g. can transmit power be increased in rural areas?) but....
 - Existing users of the spectrum (including “innovators”) are very concerned about possible rises in interference levels as a result of liberalisation
 - Even innovative technologies require a certain quality of spectrum – this cannot be provisioned in licence-exempt spectrum

Ensure that the innovator does not obstruct innovation?

- **Current assignments and licences are, perhaps, over-prescriptive**
 - **Technology to be used is dictated**
 - **Limits to number of licenses using a particular technology**
 - **Requirements for public wireless networks to provide a certain percentage coverage**

Ensure that the innovator does not obstruct innovation?

- **Spectrum management is the process by which optimum use of the spectrum can be delivered.**
- **Licensing and assignment is a vital element in the process of spectrum management.**
- **Can rights granted to licensees be modified to allow changes to the technology and/or use of spectrum whilst still facilitating the function of spectrum management?**

Ensure that the innovator does not obstruct innovation?

Ofcom's vision for spectrum is expressed in the Spectrum Framework Review

- Spectrum should be free of technology and usage constraints as far as possible. Policy constraints should only be used where they are justified.
- It should be simple and transparent for licence holders to change the ownership and use of spectrum.
- Rights of spectrum users should be clearly defined and users should feel comfortable that they will not be changed without good cause.
- For the full document, visit www.ofcom.org.uk

Implications:

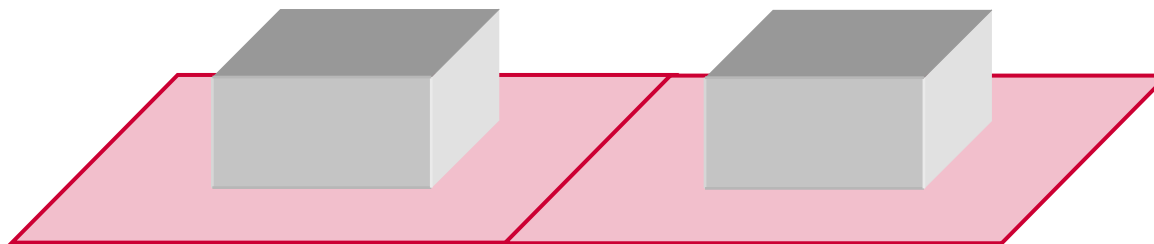
- Need to check Change of Use (CoU) applications
- Must be transparent, timely, evidence based, flexible, technology neutral...

Spectrum Usage Rights and Spectrum Quality Benchmarks

- Licensees rights and obligations should be summarised in a straightforward, technology-neutral manner.
- The process of spectrum management can be viewed as placing as few restrictions as possible whilst ensuring that spectrum usage rights granted to one user do not infringe on the spectrum quality of another.

Spectrum usage rights

- Often referred to as “property rights”.



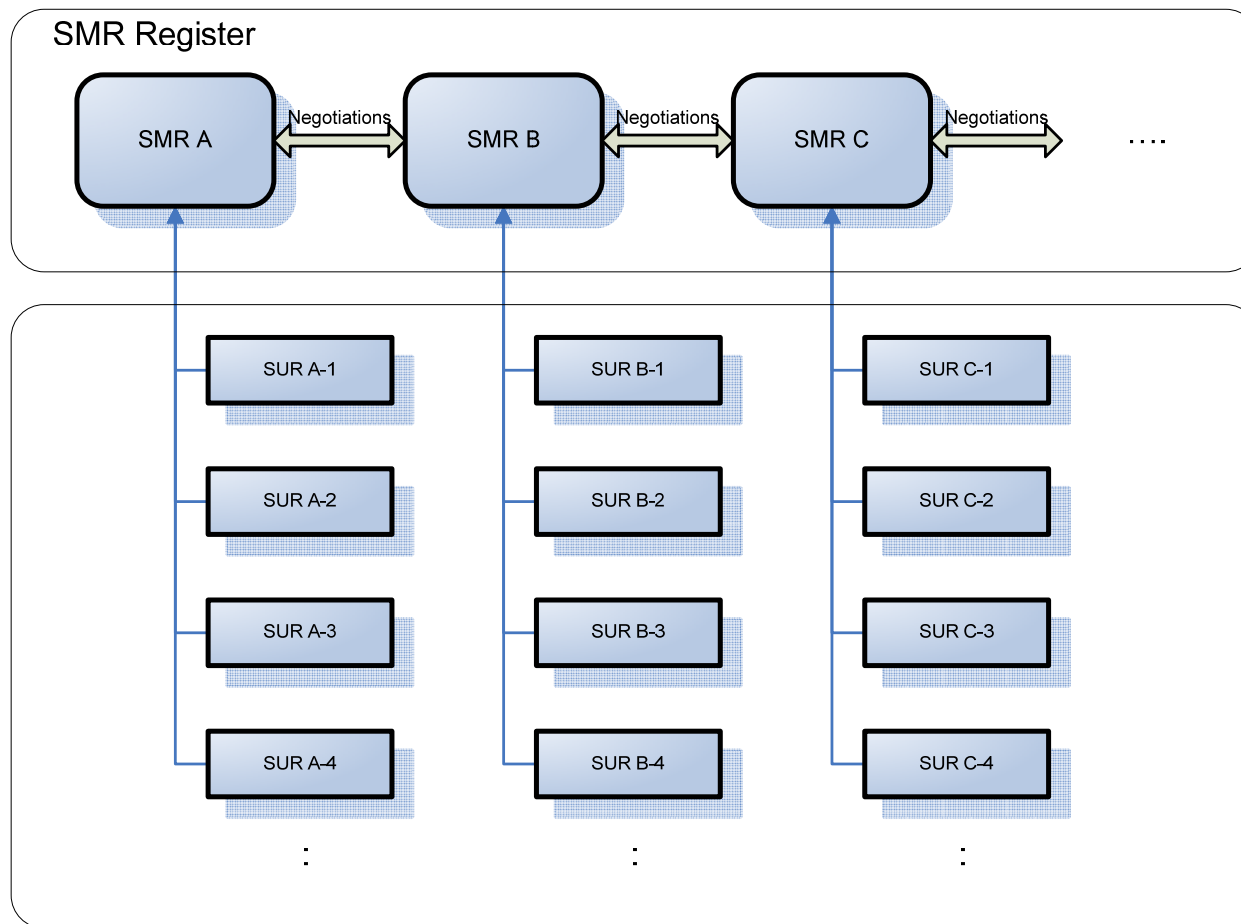
- Space
- Shelter
- Freedom

- Peace
- Light
- Air

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Spectrum Usage Rights and Spectrum Quality Benchmarks

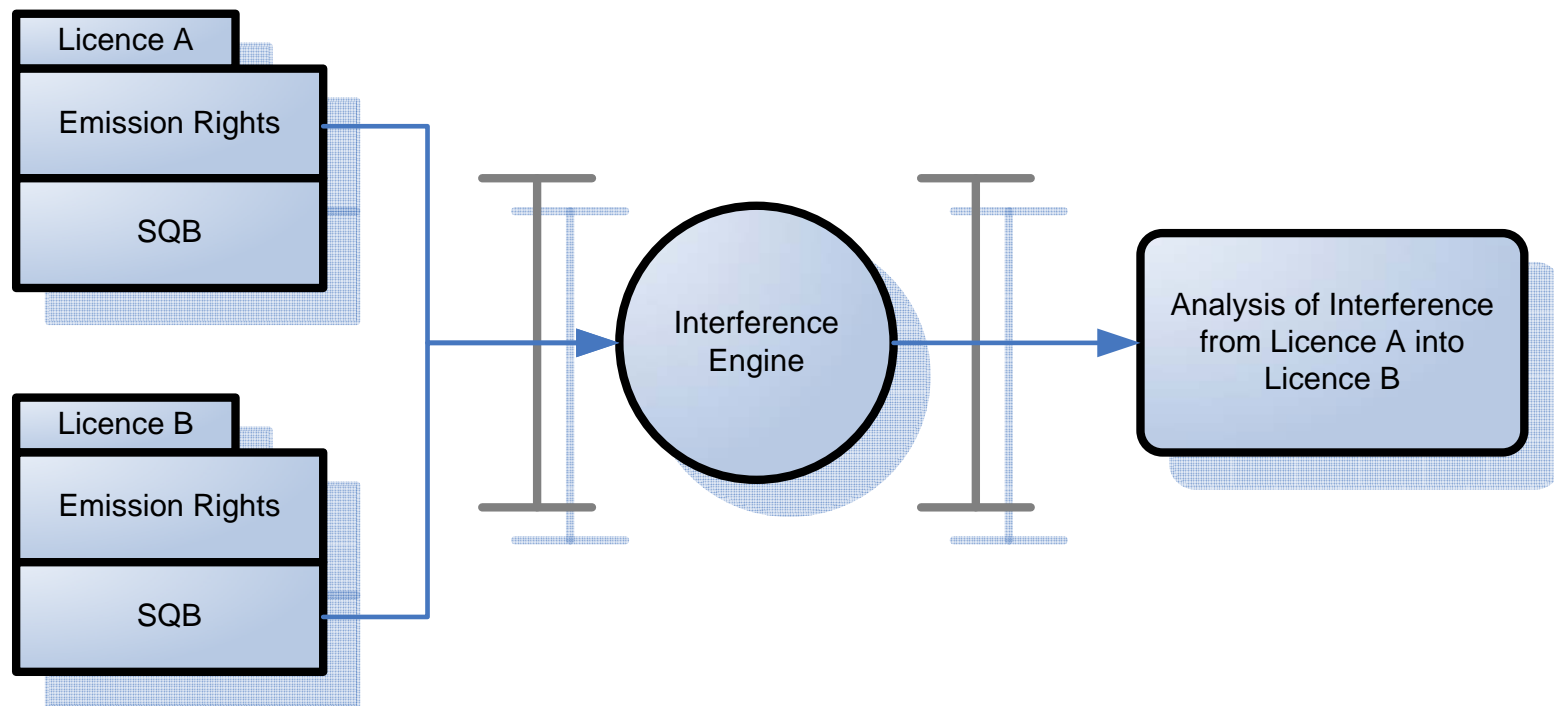


A Possible Spectrum Quality Benchmark (SQB)

- *Interference at the receiver should not exceed X dBW for more than Y % of the time [at more than Z % of locations]*
- Change of use (or a new assignment) should not violate this benchmark
- What tools can be used to assess this?

Assuring Spectrum Quality Benchmarks

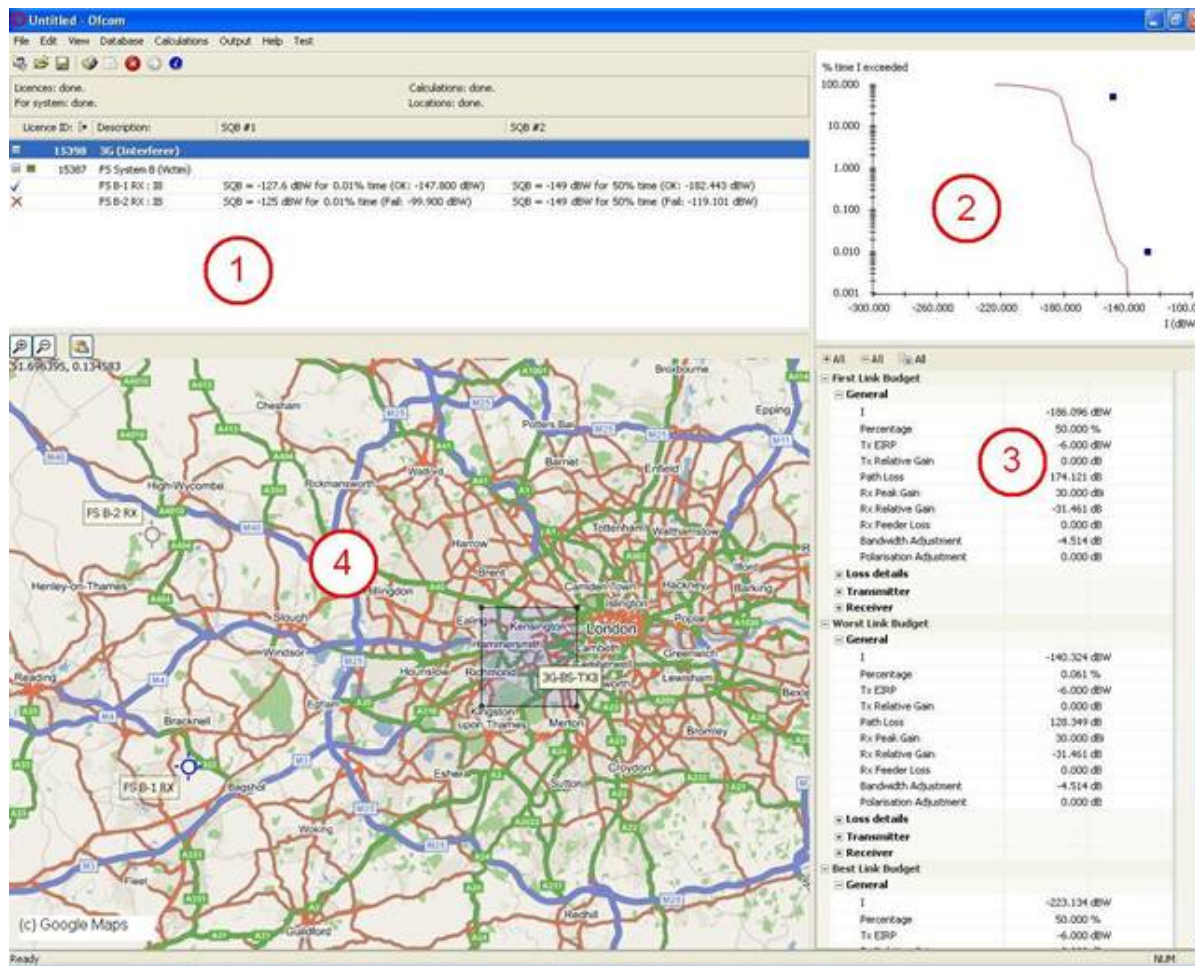
- A research project is being undertaken to provide a “Generic Radio Modelling Tool”.



Accommodating time-varying phenomena

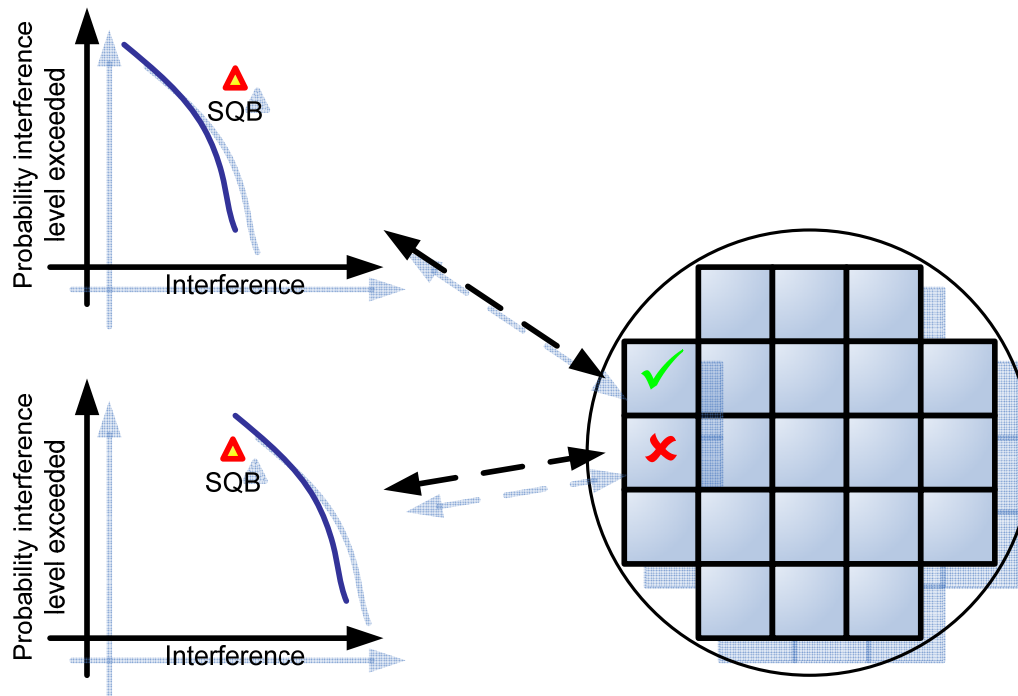
- **SQB assures interference limits for a percentage of time.**
- **Time-varying factors:**
 - **Propagation Loss**
 - **ERP**
 - **Frequency Hopping**
 - **Transmitter Location**
 - **Antenna Direction**
 - **Activity Factor**
- **Monte Carlo simulation can accommodate the above variations**

Assuring Spectrum Quality Benchmarks



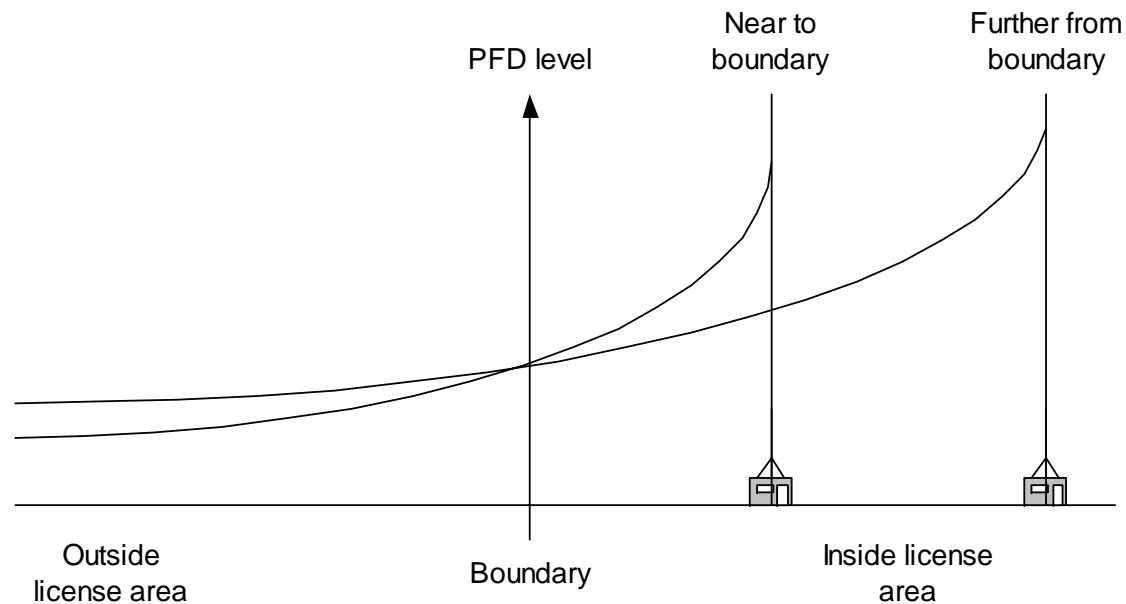
Spectrum Quality Benchmarks for Area Licences

- *Interference at the receiver should not exceed X dBW for more than Y % of the time [at more than Z % of locations]*



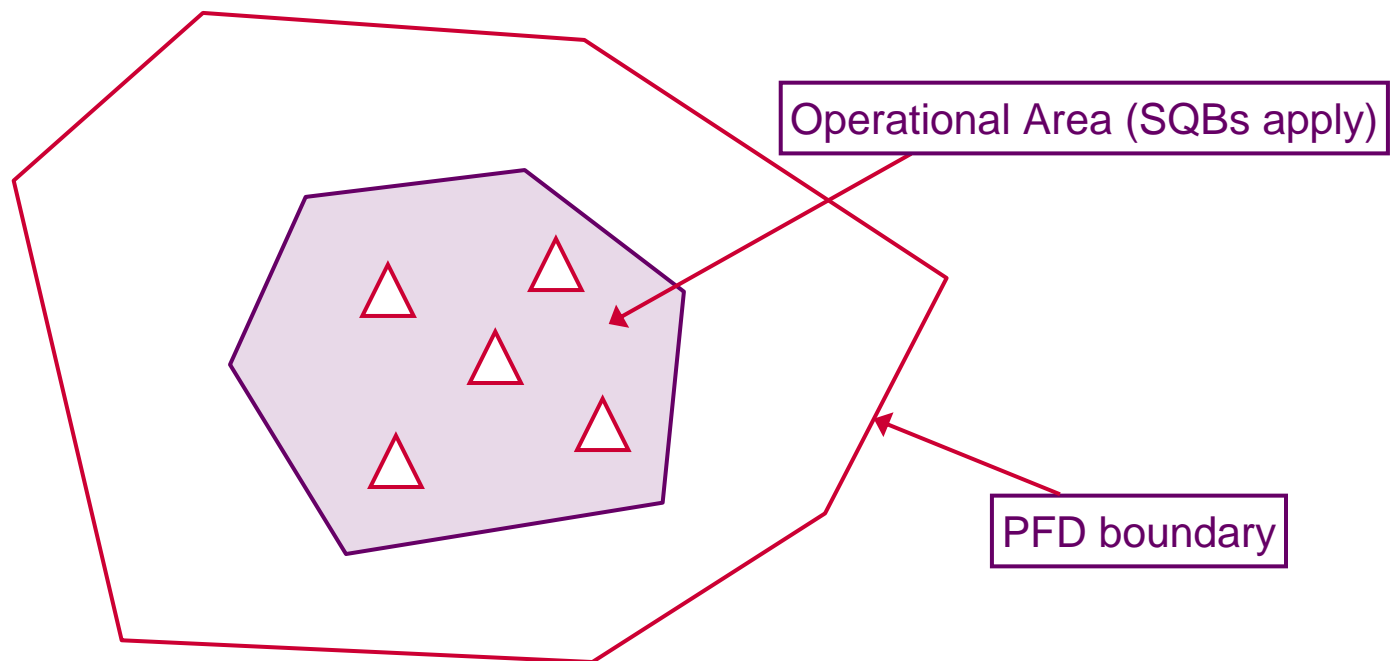
Spectrum Emissions Rights

- Rights to transmit in a particular area provided that you do not cause interference outside that area.
- Power Flux Density (PFD) on boundary is a possible significant parameter.



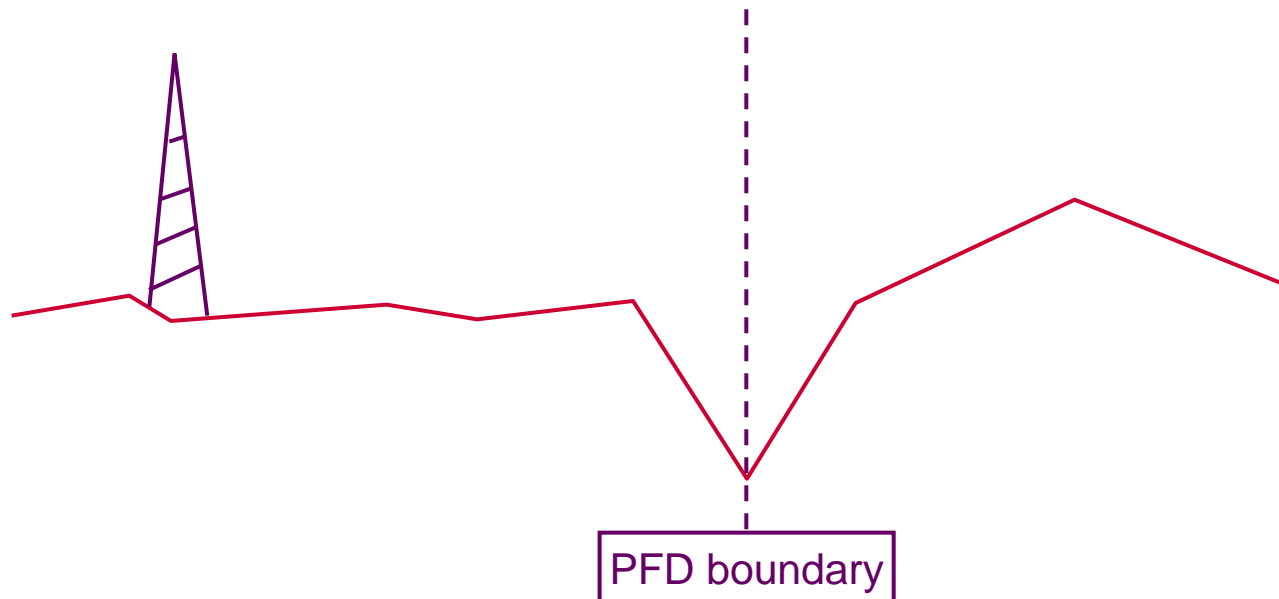
Spectrum Emissions Rights: dual-boundary approach

- Area in which right to transmit is conferred and SQBs apply is not the same as that enclosed by PFD boundary.



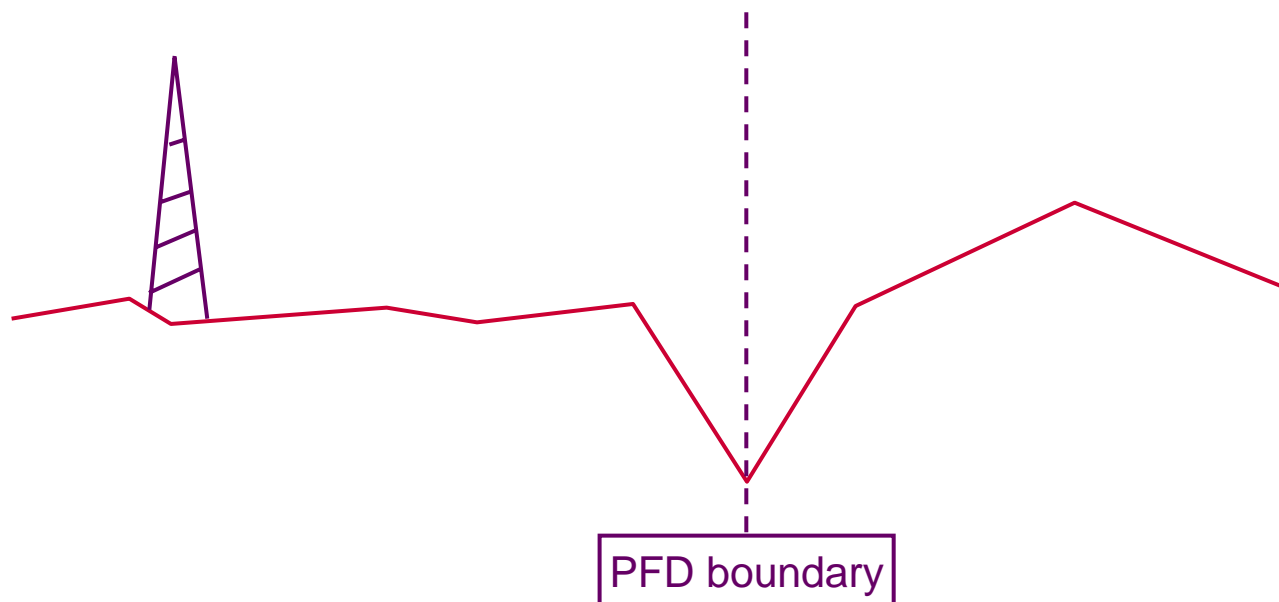
Spectrum Emissions Rights: definition

- Boundary PFD limit could be made comparable to allowable interference (SQB) of neighbouring licensees.
- Still possible issues with PFD being stronger beyond the boundary than at the boundary.



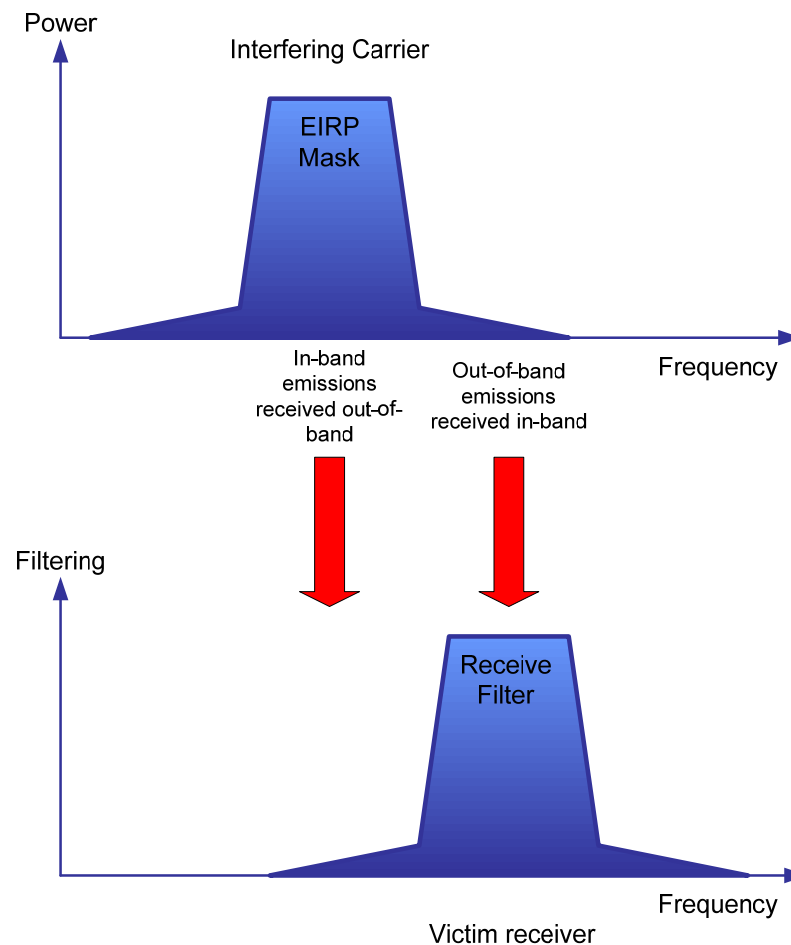
Possible definition of PFD limit

- *The aggregate transmitted PFD at or beyond [definition of boundary] should not exceed $X \text{ dBW/m}^2/[\text{Ref BW}] \text{ kHz}$ at any height up to $H \text{ m}$ for more than $P \%$ of the time;*



Out-of-band issues

- *Interference at the receiver should not exceed X dBW for more than Y % of the time [at more than Z % of locations]*
- **Can such a statement be applied to in-area, out-of-band scenarios?**

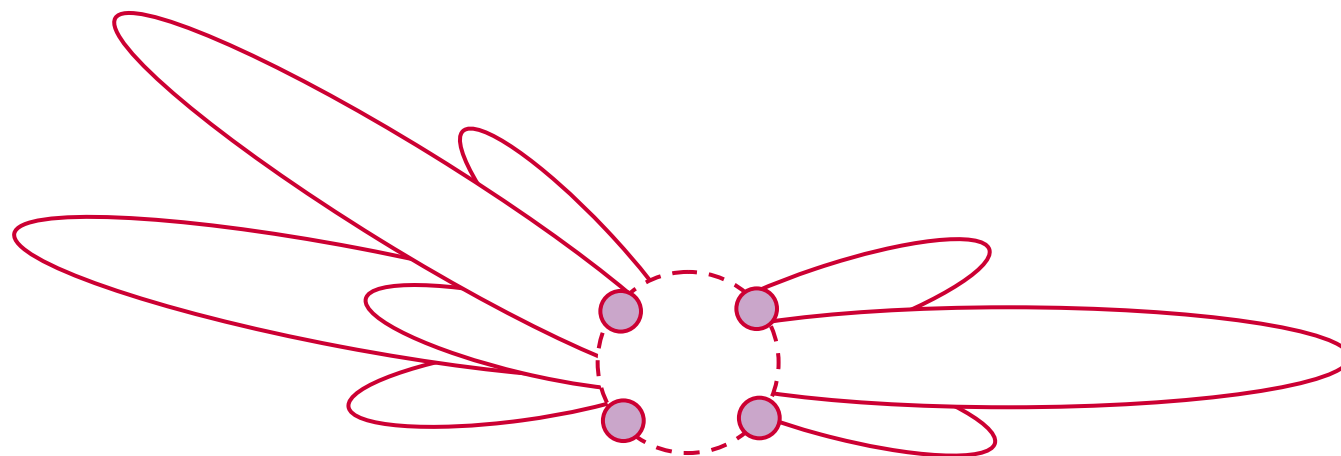


Accommodating innovative technologies

- Emissions rights and SQBs should be “technology neutral” and, yet, “technology aware”.
- Exploring how such an approach to spectrum management would cope with innovative technologies is informative.
 - Smart antennas
 - Cognitive radio

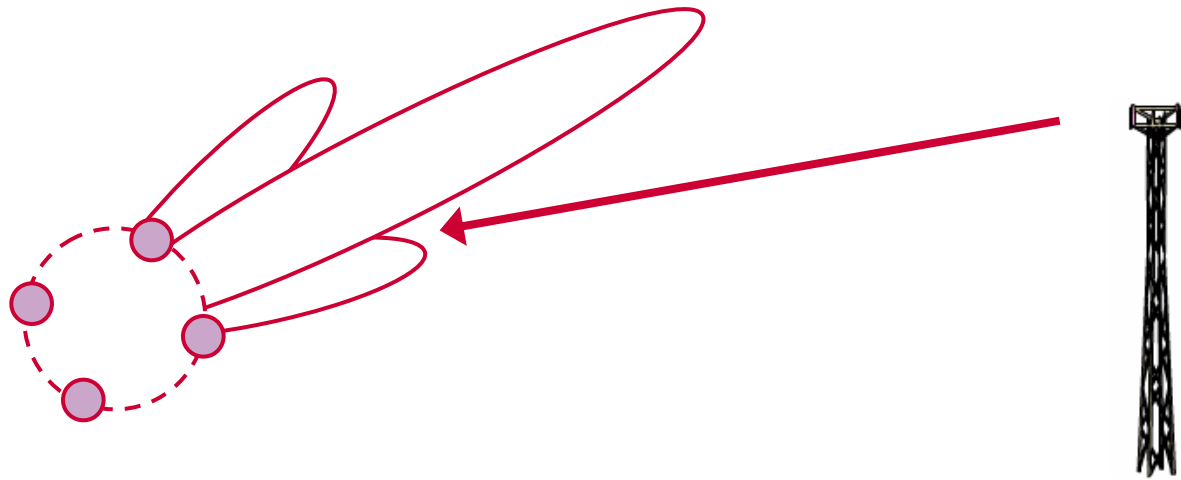
Accommodating Smart Antennas

- EIRP not a fixed value but can be defined by a probability density function.
 - Not dissimilar to an approach similar to that for scanning antennas



Accommodating Smart Antennas

- Ability to steer nulls permits operation with poorer SQB
 - Possible to incentivise operators to use Smart antennas
 - Identifiable route to improving spectrum efficiency

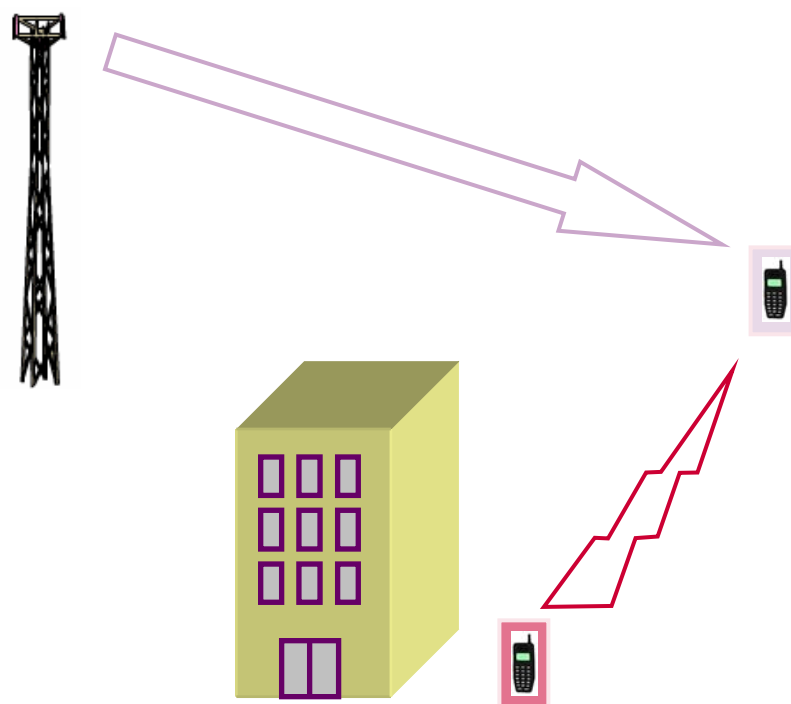


Accommodating Cognitive Radio

- A trickier problem
- Cognitive radios do not transmit in already-occupied spectrum
 - But the radios themselves define “already-occupied”
 - Detectable by their receiver with their antenna
 - The incumbent may have more sensitive receivers with higher gain antennas

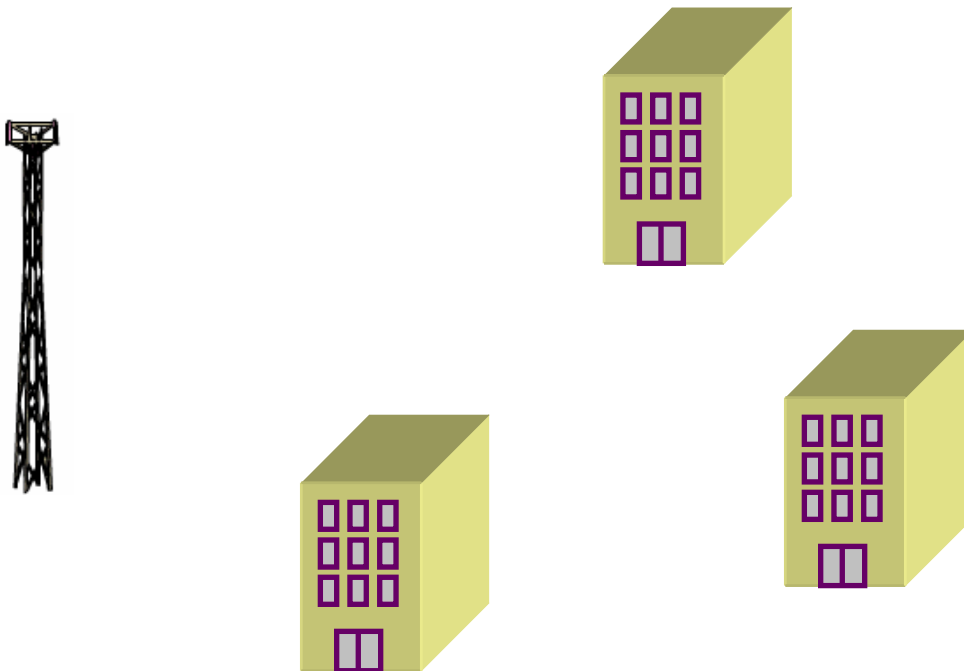
Accommodating Cognitive Radio

- The “hidden mobile” problem



Accommodating Cognitive Radio

- *Interference at the receiver should not exceed X dBW for more than Y % of the time [at more than Z % of locations].*



Conclusions:

- **Ofcom views fostering innovation as a key element in delivering the optimum use of the spectrum**
- **A “light touch”, technology-neutral approach is seen as necessary in fostering such innovations**
- **This approach could be based on the concept of spectrum usage rights and the assurance of spectrum quality benchmarks**
- **Current propagation modelling tools need further development in order to be useful in a liberalised environment. Such a tool is under development at Ofcom.**
- **This tool is likely to be useful in analysing the interference caused by modern technologies.**