

Licence-Exemption Framework Review

**A consultation on the framework for managing spectrum
used by licence-exempt (LE) devices**

May 2007

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- Previous work on licence-exemption
- The current situation with licence-exemption
- Aims and objectives of licence-exemption
- Our key proposals
 - Spectrum commons
 - Light licensing
 - Exemption at high frequencies
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- Our vision for licence-exempt use of spectrum

In the SFR we said that there are three possible ways to manage spectrum

Command & Control Regime

Ofcom manages it

Approach that is currently adopted for about 94%+ of the spectrum

Market Forces Regime

Companies manage it

Approach advocated by Cave and implemented by trading and liberalisation

Licence-exempt (LE) Regime

Nobody manages it

Approach currently adopted for 6%+ of spectrum, some argue for radical increase

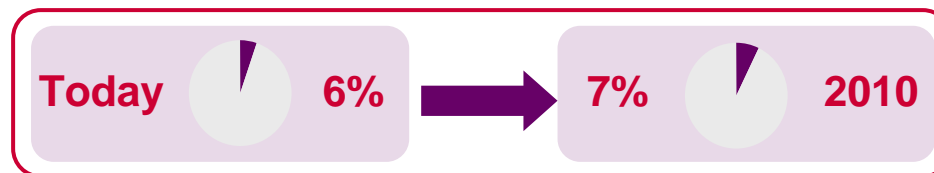
- We need to decide the right balance between the regimes.
- Regimes are currently demarcated by frequency. However, there are also dimensions of power and time.

+ The spectrum percentages correspond to frequencies up to 60 GHz, exclude spectrum used by the MoD, and represent percentages of amounts of spectrum bandwidth relative to the band centre frequency, rather than absolute amounts.

The SFR discussion of licence-exemption (LE)

- Key area for innovation but we do not need much more spectrum for this.
- Focus on removing restrictions, e.g. higher power in rural areas.

- Increasing LE allocation to 7%+ of total spectrum allows enough for everyone to install equipment capable of delivering 100 Mbits/s data services in homes or offices.



+ The spectrum percentages correspond to frequencies up to 60 GHz, exclude spectrum used by the MoD, and represent percentages of amounts of spectrum bandwidth relative to the band centre frequency, rather than absolute amounts.

Higher power LE usage in rural areas

- We studied the technical and economic issues associated with higher power LE usage in rural areas.
- The business case was marginal because there were few homes and businesses that were unable to obtain broadband access.
- Interference concerns were significant
 - In rural areas there might be interference to areas such as airports and motorways.
 - There was a risk that rural devices would be used in urban areas.
- As a result, we concluded that there was insufficient benefit to outweigh the risks of increasing the power in rural areas.



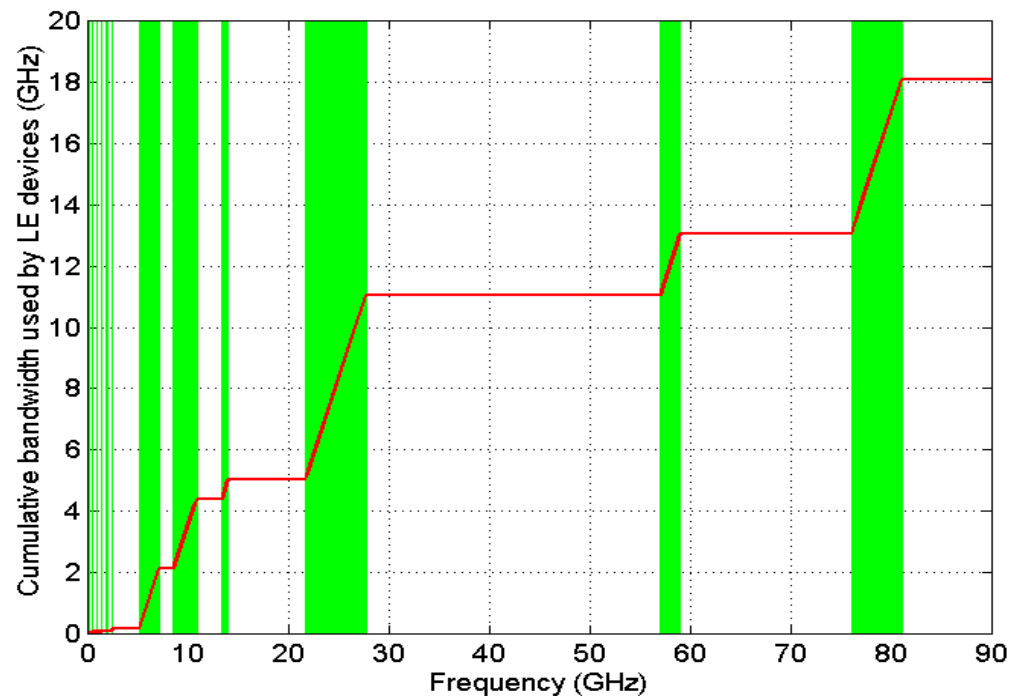
*Unserved households
in the UK*

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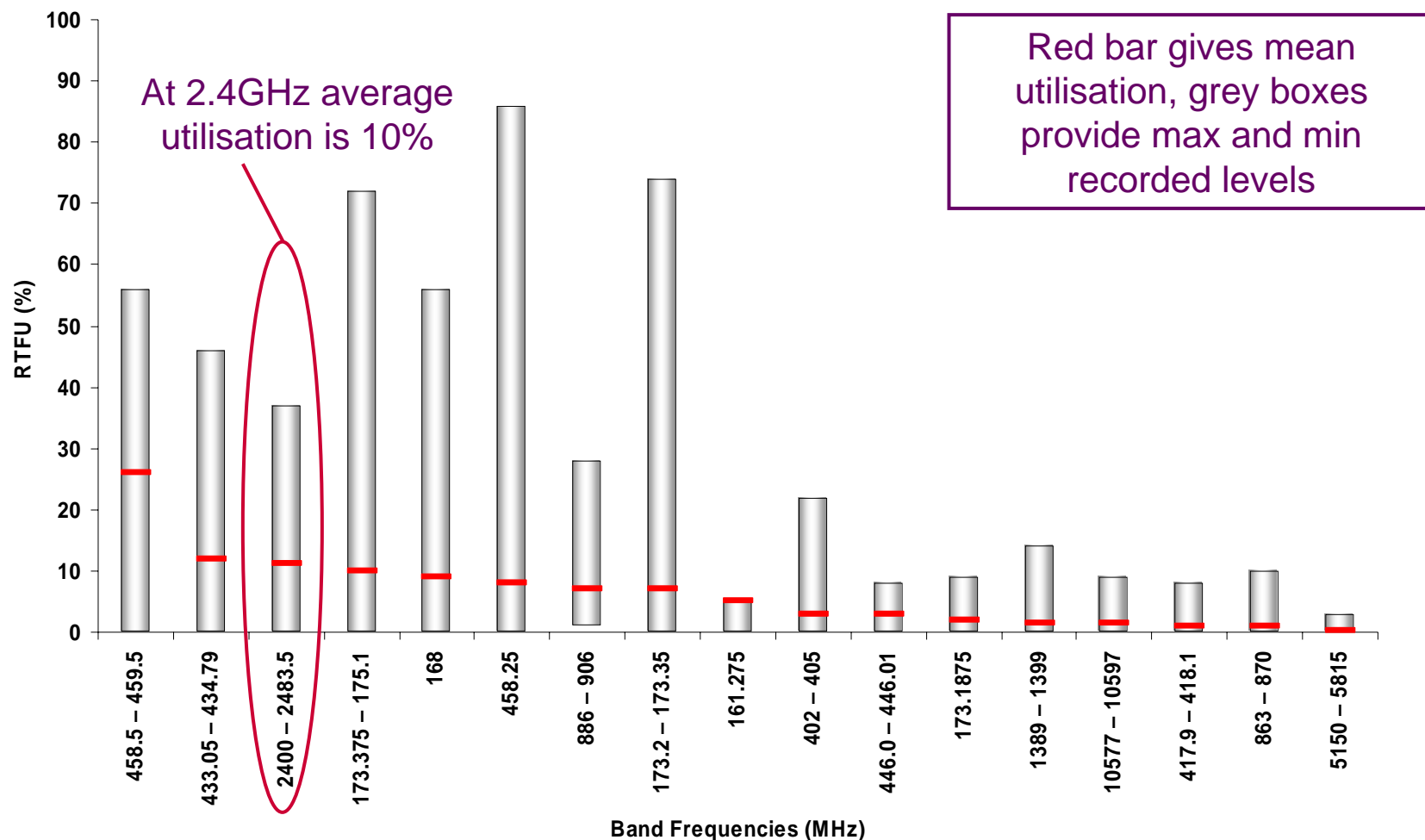
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Spectrum used by LE devices

- A wide range of bands are used by LE devices.
- At frequencies below 1 GHz these tend to be narrow and fragmented, primarily supporting low-rate (e.g. telemetry) services.
- By far the highest value is delivered within the 2.4 GHz band.



Current LE bands are lightly used



Delivering on the vision of the SFR

- In the SFR we suggested an increase in LE spectrum of 1%, relating perhaps to an additional 200MHz at 5GHz.
- Our recent measurements suggest a low level of LE utilisation, especially in the existing 5 GHz bands.
- Hence, there seems little reason at this stage to extend the LE allocation in these bands.
- We will keep this under review but at present do not expect to provide additional spectrum for LE at 5 GHz by 2010 .

Questions not addressed by the SFR

- a) Should spectrum be reserved for exclusive LE use by a single wireless application (i.e. **application-specific** spectrum)? Or should multiple applications be allowed to share the spectrum (i.e. **spectrum commons**)?
- b) What type of **rules**, if any, should be used to manage LE use of spectrum (e.g. rules of entry and operation within a spectrum commons)?
- c) What is the relationship between **light-licensing** and licence-exemption? What are the circumstances under which one regime is preferable over the other?
- d) Is there a **frequency limit** above which all spectrum use can be made exempt from licensing? If so, what is the value of this limit?
- e) Is there a **transmission power limit** below which all emissions can be made exempt from licensing? If so, what is the value of this limit and how should it vary as a function of frequency?
- f) What should our **international stance** towards licence-exemption be?
- g) Should there be any degree of **protection** towards LE users of spectrum beyond our current legal obligations?

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When is licence exemption appropriate?

- Ofcom's main objective is to maximise the efficient use of the spectrum – measured in terms of economic efficiency.
- There are two reasons why licence-exempt use might achieve this:

1) Higher economic value

Making a band available for LE use might result in more economic value than licensing it. To test this we need to make a forward prediction of use under licensed and LE usage.



2) Supply exceeds demand

In some bands, particularly at very high frequencies, there is more supply than demand and hence licensing imposes an unnecessary bureaucratic burden.



Understanding relative economic efficiency

- Forward predictions of value are subject to a high level of uncertainty but can provide some guidance.
- For example, the value of spectrum which can be effectively used for cellular appears higher than that for public access Wi-Fi.
- However as more spectrum is assigned to cellular its value/MHz can be expected to fall.

		NPV (£bn) over 20 years for given risk of substitution	Bandwidth required (MHz)	£bn/MHz
Cellular (2008-2028)	High	110	340	0.32
	Low	405		1.19
Public access Wi-Fi (2006-2026)	High	65	233	0.28
	Low	105		0.45

A preference for international coordination

- In general, we prefer the market to achieve coordination and harmonisation through trading and change of use of spectrum in multiple countries.
- However, LE use of spectrum requires regulatory intervention to
 - identify the spectrum, and
 - establish rules for its management,giving little opportunity for market forces to modify parameters.
- It would generally be preferable for regulators to coordinate internationally as far as possible in order to achieve harmonised strategies and allocations.
- We will work with CEPT, EC and ITU to aim for a harmonised approach to LE spectrum as far as possible although equally we will not unduly delay our initiatives if harmonisation appears difficult to achieve.

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Our proposals fall into four key areas

Better LE use of spectrum

Bands shared by a range of LE applications, with interference managed through power limits and polite protocols.

Role of light licensing

Light licensing will evolve towards LE in time, but will maintain its role for the foreseeable future.

Exemption at high frequencies

Much of the spectrum above 40 GHz can be released for LE use.

Exemption of low-power tx

All spectrum use can be made exempt for transmission power levels similar to the UWB limits.

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Spectrum commons

- **Application-specific** spectrum reduces the probability of interference, but it also results in regulator-imposed **fragmentation** and non-uniform use of spectrum.
- Generally, the best way to **promote innovation** and generate value is **not to restrict** the range of applications and technologies that are allowed to use the spectrum, and allow the **market** (rather than the regulator) to decide best use.
- For LE devices this can be achieved by a **spectrum commons**, where a segment of spectrum can be used by a **range** of different applications in a co-channel manner.
- Spectrum commons is our preferred model.

Interference management in spectrum commons

- Two components:

Politeness Rules

Limits on radiated power
as a function of
frequency, time and space

Specified by regulator

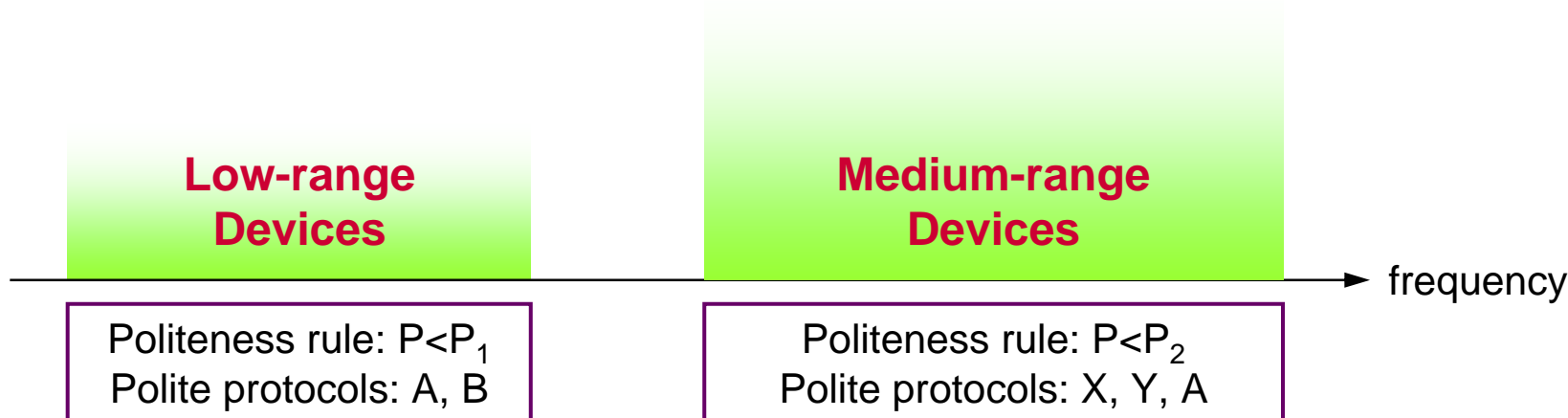
Polite protocols

e.g. “listen-before-talk” to ensure users get a fair
share of radio resource, and different technologies
do not drown each other out.

Defined by standards bodies
Authorized by regulator

Diverse applications and spectrum commons

- Co-existence issues may arise if **very different** applications **share** a commons; e.g. a high-power application may drown out a low-power application.
- Divide spectrum into multiple **classes** of spectrum commons. Within each class, politeness rules restrict the range of applications.
- Example:



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What is light licensing?

- Light licensing is an approach where users of the spectrum have to **register** their details in a database.
- Varying degrees of light licensing might require users to **resolve interference** issues if it is their fault.
- Benefits include:
 - Ability to **coordinate** with **incumbents** (e.g. satellite operators) to operate in particular geographical areas.
 - Reduce risk of interference by requiring **explicit co-ordination** among light-licensed operators.

Evolution of light licensing

- We believe that the distinction between light-licensing and licence-exemption will be increasingly **blurred** in the future.
- Devices will increasingly be able to deliver the same low risk of interference through **autonomous self-coordination**, with little or no human intervention.
- We accept that this is not the case yet and that light licensing will still have a role to play in the short to medium term.
- However, we expect to make **decreasing use** of light-licensing over time.

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Exemption at high frequencies

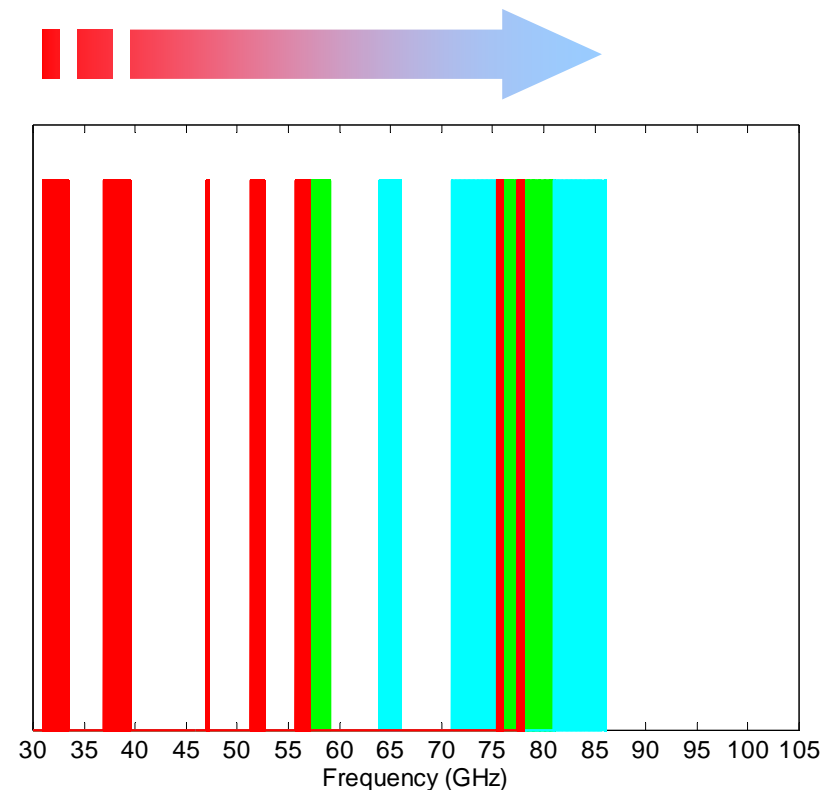
- Probability of radio **congestion** reduces at higher frequencies:

- Limited **range** due to poor propagation (especially above 40 GHz).
- **Directional** antennas used to improve link budgets.
- Large **amounts** of available frequency.

- Supply of spectrum exceeds demand, hence licensing is increasingly unnecessary at higher frequencies.

- Today's mix of licensing regimes⁺ above 40 GHz confirms this...

- Licensed.
- Light licensed.
- Licence-exempt.



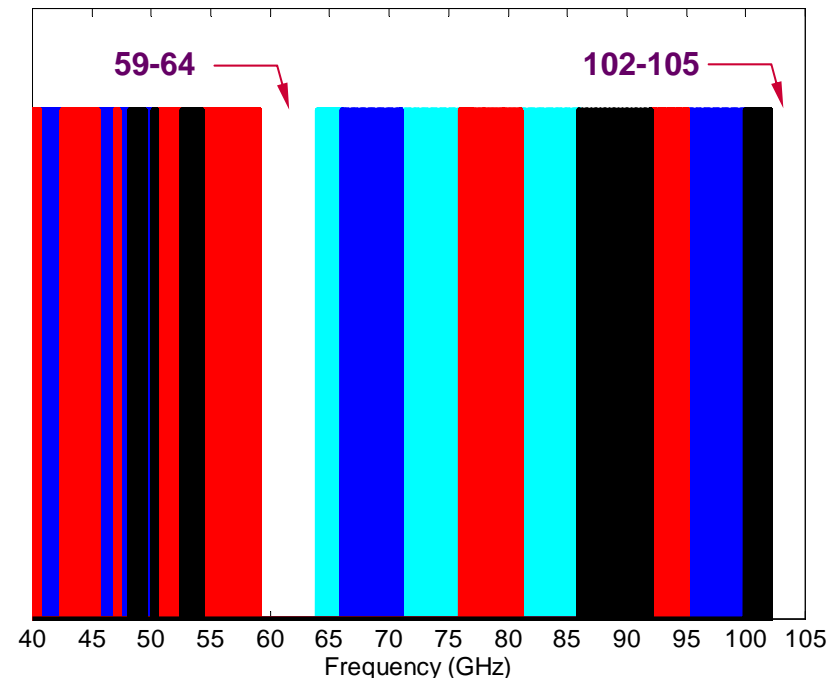
⁺ White areas are either used by the MoD, are protected for passive services, or are unused.

Exemption: 40 - 105 GHz

- Our studies indicate that spectrum used in the UK today for **light-licensed** applications is broadly **sufficient** to satisfy demand for next 20 years.
- For **LE** use, we believe there will be demand in this band for **additional** spectrum.
- We have identified the 59–64 GHz⁺ and 102–105 GHz bands as potentially suitable for LE use.

- Potentially suitable for future **LE** use.
- Already **light licensed**.
- Allocated by ITU to various satellite services.
- Subject to Footnote 5.340.
- Already used by passive, licensed, LE, or MoD.

⁺ Managed by Ofcom+MoD. Already available for LE use in US and Japan, and is being studied by CEPT SE19 and SE24 for Multiple Gigabit wireless systems and intelligent transport systems.



Exemption: beyond 105 GHz

- Much of spectrum above 105 GHz is **unused**, because:

- Technology is **expensive**.
- Radio **propagation** is poor and line-of-sight.

- Two key application categories:

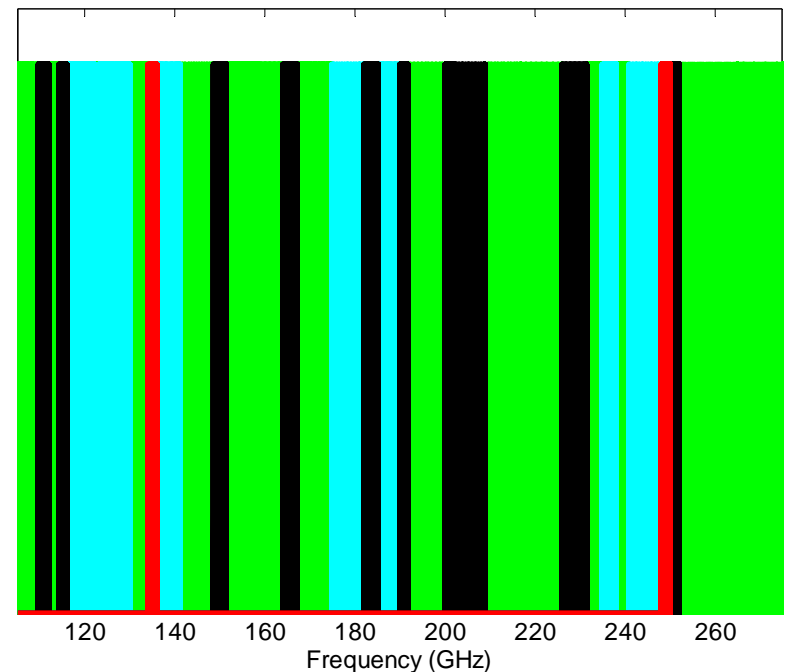
- Short-range consumer devices.
- Medium-range point-to-point fixed links.

- Each category will require 10-15 GHz over the next 20 years.
Unlikely to result in congestion.

- Not all spectrum above 105 GHz is suitable for exemption (see chart).

- All spectrum above 275 GHz is suitable for exemption.

- Potentially suitable for **LE use (94 GHz)**.
- Potentially suitable for **light-licensing (40 GHz)**.
- Allocated by ITU to amateur services.
- Subject to Footnote 5.340.



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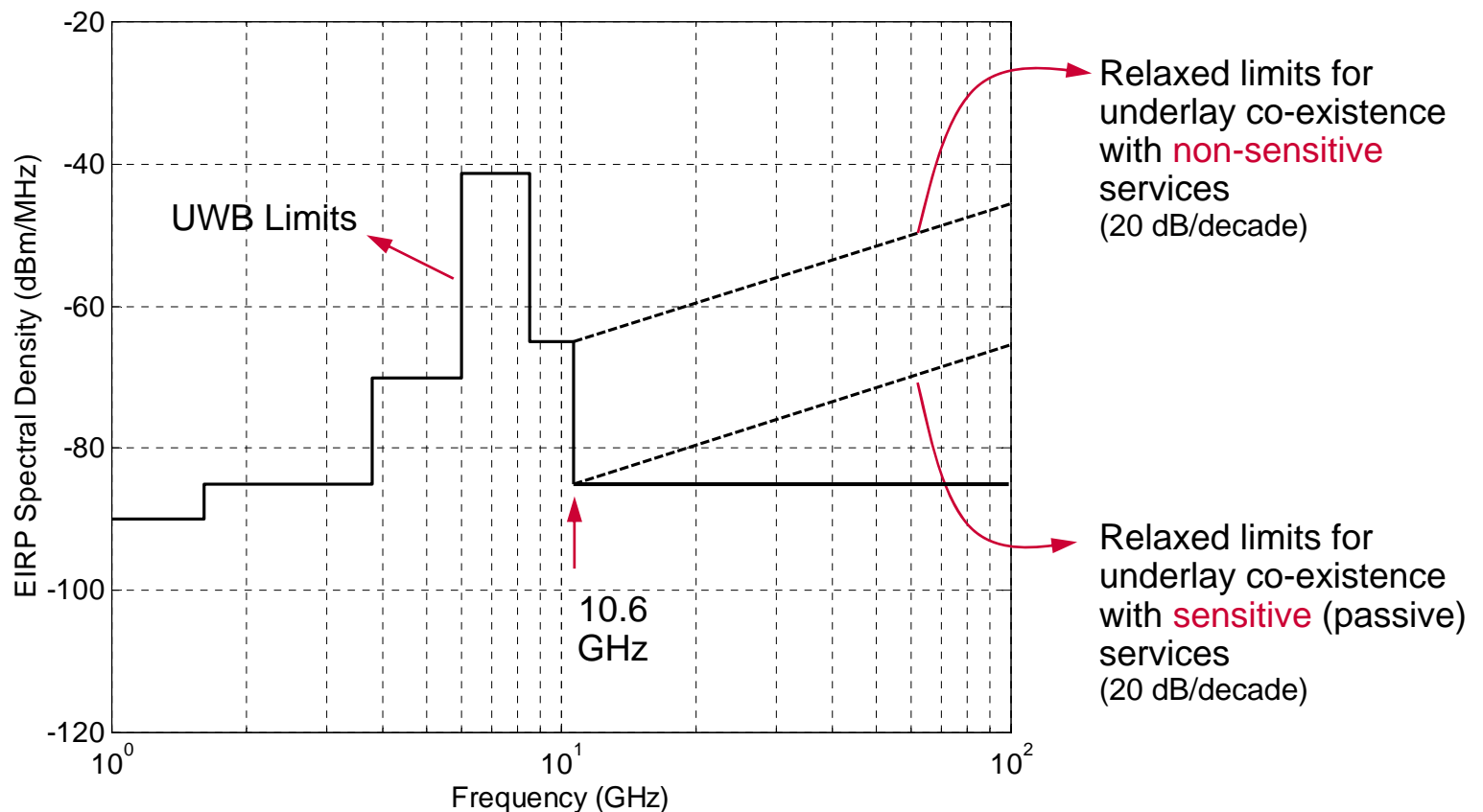
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Exemption of low-power transmitters

- Radio devices which transmit at sufficiently **low power** levels **do not** cause material **interference**. Such devices are candidates for licence-exemption.
 - Can we define **generic power limits** below which all transmitters are exempt from licensing?
 - The FCC has long had a **Part 15 limit** below which devices are allowed to operate without a licence.
 - The **UWB** legislation effectively sets such power limits in Europe (for transmitter bandwidths greater than 50 MHz).
 - We propose generic radiation power limits that are:
 - 1) based on **UWB** limits for frequencies < 10.6 GHz.
 - 2) based on a **relaxation** of **UWB** limits for frequencies > 10.6 GHz.
- and below which **all** transmitters are exempt from licensing.

Proposed masks

- Proposed generic radiation power limits (**guidelines**):



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Ofcom's vision for LE use of spectrum

- We will provide spectrum for licence-exempt use where it will enhance the efficiency of spectrum use.
- Our preference will be for spectrum to be used by a **range** of exempt applications, subject to regulator-defined **constraints** on radiated power characteristics, and authorised **polite protocols** defined by standardisation bodies.
- We support the licence-exempt usage of unused **high-frequency** bands, especially those above 100 GHz.
- We support the exemption from licensing of all **low-power** transmissions below the **UWB limits**, with a relaxation of those limits at frequencies above 10.6 GHz.

Ofcom's vision for LE use of spectrum

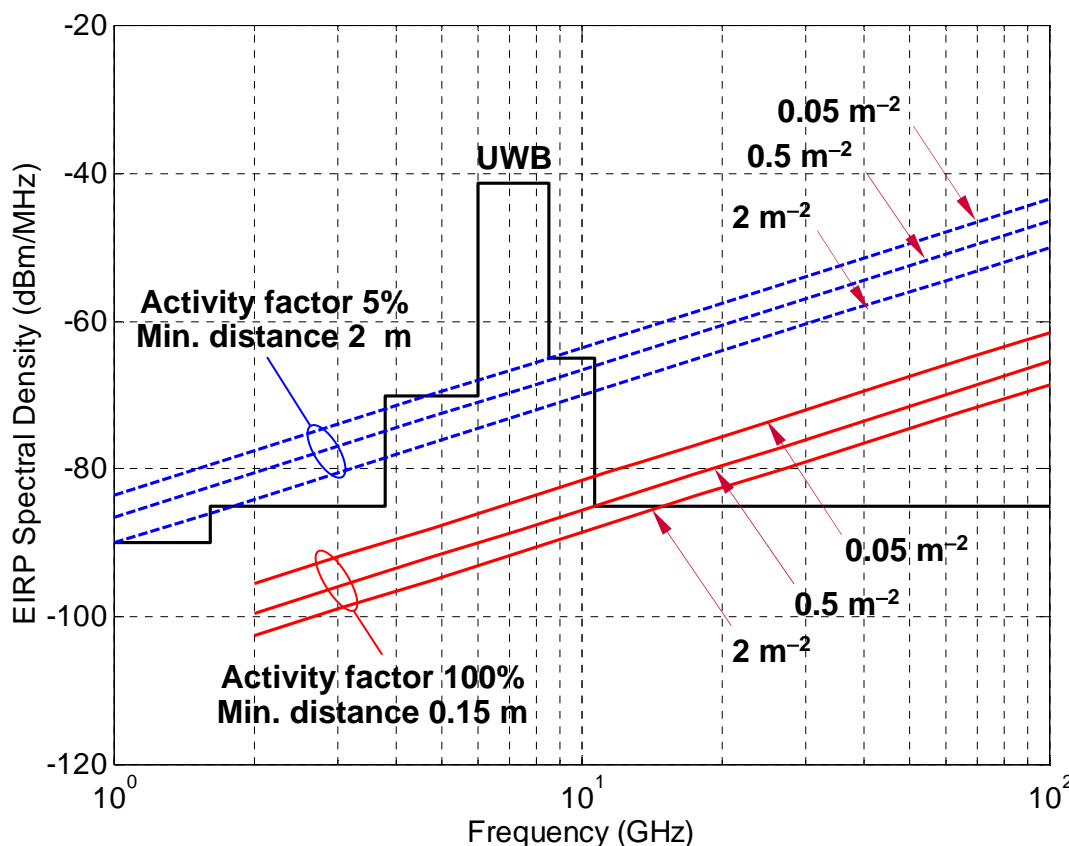
- We believe that **light-licensing** and **licence-exemption** serve different purposes in the short term, but will **converge** over the long term through advances in sensing and autonomous self-deployment technologies.
- Ofcom will develop its strategies within **harmonisation** frameworks at a European level (CEPT and EU) and at a global level (ITU), proceeding on a case-by-case basis, and supporting each harmonisation decision by an impact assessment.
- We believe that additional **regulatory instruments** are **not required** for the **protection** of licence-exempt equipment. Harmonised technical standards are expected to be sufficient for mitigating the impact of interference caused by compliant radio transmitters.

Q&A

Back-up Slides

Exemption of low-power transmitters

- Limits on mean EIRP spectral density, such that aggregate **interference** from transmitters **exceeds 5% of ambient noise** with a **probability of 0.1%**.



- Free-space **link-budget** deteriorates with the **square of frequency** for a specific receiver antenna gain.
- Increasing EIRPs can be tolerated at higher frequencies, with incumbent receivers experiencing the same marginal degradation in their performance.