

IEEE P802.22 Wireless RANs

UHF Spectrum Release in the UK				
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Abstract

This document gives an overview of the UKs plans for spectrum release in the band 470-870 MHz as of Sept. 2008.

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The Digital Dividend

Presentation to IEEE802.22
(8th September 2008)



Who are we?

- Ofcom is the telecommunications regulator in UK that covers;
 - Telecommunications;
 - Broadcasting licensing and content, and
 - Spectrum

Who am I?

- Stephen Talbot;
 - stephen.talbot@ofcom.org.uk
 - (some of you may know my colleagues; Andrew Gowans and Mark Austin)

The release of the digital dividend

- Digital switchover will complete in 2012 delivering three big benefits
 - Universal access to digital terrestrial TV
 - Allows upgrade of digital terrestrial TV for new services like HD
 - The release of the digital dividend
- The digital dividend is prime spectrum
 - 128 MHz of cleared spectrum
 - Signals cover large geographical areas and penetrate buildings well
 - Largest amount of most valuable spectrum released for 20 years



DDR statement, December 2007

- **Market-led approach to releasing the digital dividend**
 - One exception – programme-making and special events – award of a package of most interleaved (and other) spectrum by beauty contest
- **Cleared award (inc. channels 36 and 38 and interleaved channels 61 and 62)**
 - Technology- and service-neutral award
 - Packaged in a way that enables the widest possible range of uses
 - Award by auction
- **Geographic-interleaved awards**
 - Packaged in a way suitable but not reserved for local television
 - Risk of market failure if UK-wide packages
 - One or two single-channel packages in each of around 25 locations
 - Award of packages first in the earliest regions where switchover will take place
 - Award by auction

Aims and objectives for the planned awards

- Overall objective of maximising the total value to society generated by use of the digital dividend over time
- Create opportunities for new entry, new services and new technologies
- Best way to do this is to via service and technology neutrality
 - Reflect demand from consumers and citizens
 - Make licences tradable, so able to change use to reflect changes in technology and demand
 - Allow all potential uses to take part in the auctions

The available spectrum 'Cleared Award'





The available spectrum (from 2012)

Lower UK channel no.
Frequency (MHz)

30 542-550	31 550-558	32 558-566	33 566-574	34 574-582	35 582-590	36 590-598	37 598-606	38 606-614	39 614-622	40 622-630	41 630-638
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Upper UK channel no.
Frequency (MHz)

60 782-790	61 790-798	62 798-806	63 806-814	64 814-822	65 822-830	66 830-838	67 838-846	68 846-854	69 854-862	70 862-870
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-  Aeronautic radar: nationally cleared from April 2009
-  Nationally cleared from 2012
-  Radioastronomy: nationally cleared from 2012
-  Interleaved capacity included in the cleared award
-  Not in award: PMSE and other uses
-  Not in award: DTT and interleaved uses




Cleared Spectrum - The available spectrum (cont'd)

- 128 MHz of cleared spectrum and 16 MHz of interleaved spectrum
- Cleared channels 112 MHz as a result of digital switchover plus:
 - 8 MHz cleared of existing use of aeronautic radar in April 2009
 - 8 MHz cleared of existing use by radioastronomy in 2012
 - 16 MHz of interleaved spectrum (channels 61 and 62)
- Channel 69 – propose to discuss with PMSE users whether other spectrum, comparable in quality and quantity, could offer a superior long-term solution for PMSE needs
- London Olympics – assessing impact of meeting Government spectrum guarantees
- Continued PMSE access to cleared spectrum – longer notice period? upper and lower sub-bands?

The available spectrum 'Interleaved Award'

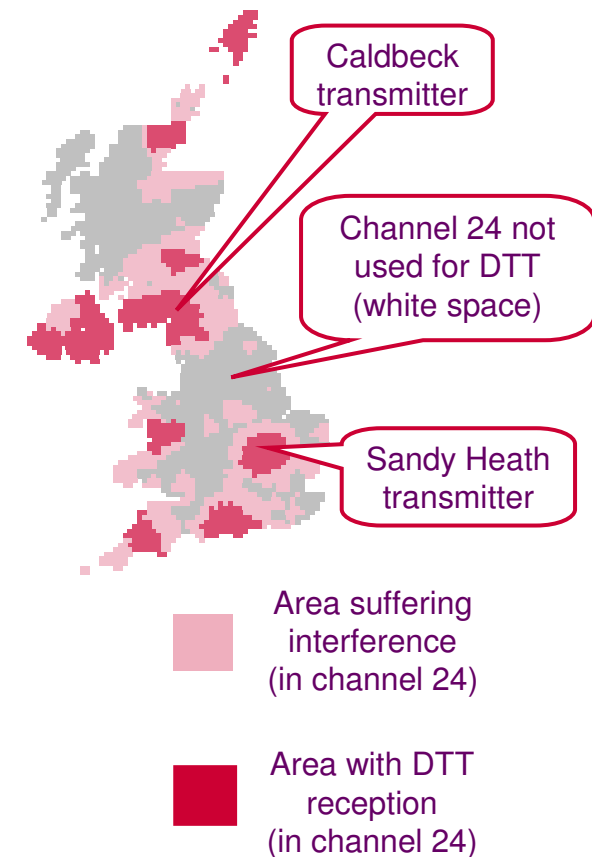
Available Spectrum

UK channel no. Frequency (MHz)	21 470-478	22 478-486	23 486-494	24 494-502	25 502-510	26 510-518			
	27 518-526	28 526-534	29 534-542	30 542-550	31 550-558				
UK channel no. Frequency (MHz)	40 622-630	41 630-638	42 638-646	43 646-654	44 654-662	45 662-670	46 670-678	47 678-686	48 686-694
		49 694-702	50 702-710	51 710-718	52 718-726	53 726-734	54 734-742	55 742-750	56 750-758
		57 758-766	58 766-774	59 774-782	60 782-790	61 790-798			

-  Interleaved Award and DTT uses
-  Not in interleaved award (Nationally cleared from 2012)
-  Interleaved capacity included in the cleared award

The Interleaved Spectrum - The available spectrum (cont'd)

- There are six existing DTT multiplexes which use a very large amount of spectrum: $32 \times 8 \text{ MHz channels} = 256 \text{ MHz}$
- In any one location, only six channels directly serve viewers
- The figure shows use of channel 24, which is not used between Caldbeck and Sandy Heath because of interference constraints
- So each and every one of the 32 channels is available as unused “white space” somewhere in the UK
- The aggregate of this white space is the ‘Interleaved Spectrum’



Non-technical licence conditions

Non-technical licence conditions – Cleared Spectrum

- DTT multiplex issues
 - ownership restrictions broadly equivalent to those under the Broadcasting Act
 - facilitate interoperability
- All licences in the cleared award to be tradable – with all types of trade permitted
- Licences to have an indefinite term
 - initial term ending in 2026
 - five years' notice to revoke on spectrum management grounds
 - expect additional AIP-based licence fees to be payable after the initial term
- Provisions requiring licensees to provide us with information about spectrum use
- No rollout or use-it-or-lose-it obligations

Geographic packages – through the interleaved awards

- Suitable but not reserved for local television
 - One or two single-channel lots in each location
 - Each lot able to support a multiplex carrying two to 10 video streams
 - Award by auction
 - Licences to be tradable
- Small lots available from the band manager (separate consultation soon)
- Spectrum not reserved for local television for three reasons
 - Would impose a significant cost by precluding other potential uses
 - Would reduce incentives to use spectrum efficiently and risk distorting organisations' decisions about how to distribute local content
 - Would not resolve other issues fundamental to the business model for economically sustainable local television

Technical licence conditions

Suitability of Spectrum Usage Rights (SUR) for spectrum under the Cleared Awards

- Transmit mask approach
 - restricts the in-band and out-of-band emissions of transmitters but this does not account for transmitter density.
 - not so much of a problem if neighbouring licensees have similar deployments and are not likely to change use
- SUR approach
 - controls the aggregate interference experienced by a neighbouring licensee's receivers.
 - licensee has to manage the transmitter power and density
 - SUR represents a more direct control on interference caused to neighbours
- SUR is more appropriate for the cleared award
 - stakeholder and market research show many possible uses for the cleared spectrum
 - unclear which technologies/services will be deployed during the expected life of licences and whether they will change in the future
 - SUR likely to provide greater certainty over expected interference levels
- Ofcom has not made a final decision on the TLC type(s) selected for this award and will assess feedback from stakeholders

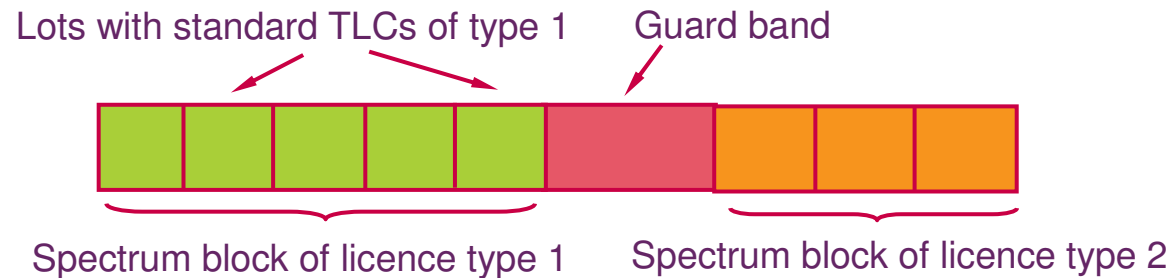
Managing interference between new licensees of the same licence type

- TLC based around five generic types of transmission networks:
 - Broadcast – DVB-T or similar
 - Mobile multimedia services
 - FDD downlink (DL)
 - FDD uplink (UL)
 - TDD
- TLC (standard TLC) for lots within spectrum block of the same licence type manages interference between licensees of same licence type
- Additional restrictions to avoid base station to base station interference between TDD licensees

	In-band PFD* (dBW/m ² /MHz)		Out-of-band PFD* (dBW/m ² /MHz)	
	1.5 m	10 m	1.5 m	10 m
DVB-T	-81	-65	-141	-125
MMS	-54	-38	-114	-98
FDD-DL	-60	-42	-106	-88
FDD-UL	-81	-63	-112	-94
TDD	-59	-41	-102	-84

(*): The power flux density (PFD) limits should not be exceeded at more than 95% of locations in a test area

Managing interference between new licensees of different licence types



- A lot at the edge of spectrum block of the same licence type has a standard TLC just as a lot in the middle of the block
- Guard bands are used to manage interference between spectrum blocks of different licence types
- Additional restriction to avoid base station to base station interference between TDD and FDD licensees

	DVB-T	MMS	FDD-DL	FDD-UL
DVB-T				
MMS	5			
FDD-DL	5	5		
FDD-UL	16	19	10	
TDD	16	19	5	5

Protecting existing DTT services from interference from new services

- Protection required for existing DTT services given coverage obligation. Ofcom needs to balance protection with its duty to secure optimal use of spectrum
- DTT receivers currently in use are susceptible to interference from immediately adjacent channels as well as the image channel (n+9).
- Potential options include:
 - geographic exclusion zones
 - likely to cover significant areas of the country.
 - conservative assumptions in the absence of detailed knowledge on network rollout
 - guard bands
 - image channel problem remains
 - protection clause
 - obligation on all licensees to plan their networks to avoid harmful interference to reception of existing DTT services
 - protection clause supplemented by a guard band of 16 MHz in FDD UL/TDD licence types to protect existing DTT services from mobile transmissions

Practicalities of implementing the protection clause

- **Aim:**
 - to prevent undue interference being caused to reception of existing DTT services and enable Public Service Broadcasters to meet the coverage requirements specified in their licences (and commercial broadcasters to meet coverage levels envisaged in the current switchover plan)

- **Proposed approach:**
 - working together with stakeholders to agree upon a solution that is acceptable to both existing and new licensees

- **Remaining issues:**
 - access to planning information for new licensees
 - defining protected coverage areas
 - protecting indoor/set-top antennas
 - design of an appropriate interference investigation and resolution process

- **Suggested next steps:**
 - stakeholder workshops to be held following the deadline for receipt of responses to the consultation

Protecting other existing services from interference from new services

- Transitional arrangements to protect analogue TV
 - for channel 36 licence, protection clause is extended to protect analogue services in channels 35 and 37
- Protection to radioastronomy from interference due to new services in channels 37 to 39
 - licences in channels 37 to 39 have an additional requirement to protect UK radioastronomy until the end of switchover in 2012 and to protect international radioastronomy on an ongoing basis
 - protection levels are specified in ITU-R RA. 769-2 with a 12 dB relaxation for UK sites
- Protection to PMSE in channel 69
 - relevant standard TLCs in licences in the upper sub-band apply

Technical restrictions – for Interleaved Spectrum

- We propose licence conditions suitable for **DTT services** – this reflects main stakeholder interest in using the geographic interleaved spectrum.
- Technical conditions for a given transmission site will cover:
 - maximum radiated power;
 - transmit antenna template;
 - polarisation (horizontal or vertical); and
 - height of transmit antenna on the mast.
- There will also be a block edge mask, specifying allowable out of band emissions. This will be based on the mask in Ofcom's Interface Requirement 2022.
- **Non-DTT services** are more likely to deploy multiple transmitters for their networks. In this case the spectrum usage rights (SUR) approach would be more suitable.
- Where a licensee wishes to provide a non-DTT service it may ask Ofcom to vary the TLCs in its licence to allow for the new service.

International coordination

- Cleared spectrum coordinated under Geneva 2006 (GE-06) plan and bilateral agreements for DTT use at designated sites
- Other types of service and other sites can be used provided the exported interference does not exceed the coordinated levels
- For protection under the GE-06 plan any changes would need to be coordinated and agreed with affected Administrations
- Different channels have different levels of allowable exported and imported interference. Maps for each channel have been published by Ofcom in the annexes to the DDR statement
- Channel 36 has no coordinated transmission rights in the UK due to the current protection afforded to radar use
- Bilateral discussions with relevant national administrations to agree suitable usage rights for channel 36 are ongoing.
- Possibility of post-award coordination for remaining cleared spectrum

Packaging

Frequency size of lots

What is the minimum contiguous usable frequency users will need to acquire?

- DVB-T**
- 8 MHz channels proposed (aligns to DTT post-DSO)
- MMS**
- Can use <8 MHz or 8 MHz
 - propose 8 MHz (facilitates national broadcasting footprints etc)
- FDD/TDD**
- Existing 5 MHz technology/CEPT planning
 - could move to >5 MHz (e.g. LTE technology)
 - but alternatives to UMTS etc uncertain: propose 5 MHz

KEY POINTS:

- Reflects consumer and stakeholder research in 2006 & 2007/8
- We propose both lot sizes across both sub-bands.
- Accommodate all likely uses of this spectrum

Frequency – specificity of lots – general considerations

Advantages of frequency specific lots	Advantages of frequency generic lots
<ul style="list-style-type: none"> • Reflect value differences more accurately: <ul style="list-style-type: none"> – reduced substitution/aggregation risks and reduced need for bid shading 	<ul style="list-style-type: none"> • Flexible assignment of capacity to optimise spectrum utilisation
<ul style="list-style-type: none"> • Enables secondary market accurately to signal ongoing constraints by frequency 	<ul style="list-style-type: none"> • Potentially provides a more homogenised basis for spectrum trading
<ul style="list-style-type: none"> • Reduces need for, or importance of, frequency assignment bidding rounds 	<ul style="list-style-type: none"> • Can enable a less complex auction design in principal with fewer outcome permutations
<ul style="list-style-type: none"> • Potentially a more level playing field between types of bidders 	<ul style="list-style-type: none"> • Maximises opportunity for auction to reduce common value uncertainty
<ul style="list-style-type: none"> • Potentially more efficient competition for each frequency 	<ul style="list-style-type: none"> • Limits scope for strategic bidding behaviour

Geographic coverage of lots

We propose to make all licences in the award UK-wide

- subject to geographic technical restrictions (including interleaved channels 61 and 62, and respecting GE-06 constraints)
- including Northern Ireland, excluding Isle of Man
- possibly including Guernsey and/or Jersey, subject to stakeholder views and consideration from the respective Crown Dependencies.

UK-wide lots permit:

- rollout of services for UK-wide markets after switchover
- subsequent geographic fine-tuning post-award
- potential changes to international coordination post-award

Auction design

Auction design – key considerations

Design	Proposal	Rationale
Simultaneous or sequential	Simultaneous	Significant levels of complementarity and substitutability between different lots, e.g. <ul style="list-style-type: none"> - Multiple channels needed for national MFN - Contiguous frequency desirable for LTE
Single or multiple rounds	Multiple rounds	Reduces common value uncertainty, likely to be high for post-2012 use. Maximise opportunity to substitute within auction, based on relative prices that emerge
Generic or specific lots	Mixture of generic and specific lots, but with frequency assignment round	More significant common value differences for some frequencies/applications (e.g. channel 36 for MMS) than others. Significant private value differences for some bidders (e.g. for multiplex proposals)
Multiple or package bids	Package bidding with supplementary bids round	Very large number of multiple bids otherwise needed, given number of lot categories proposed.

Key point: Implies a combinatorial clock auction format with primary, supplementary and assignment bidding rounds – distinguishes between spectrum auctions held in other countries

Other key features proposed for this award

Standard issues

- Standard rules on bidder association
- Initial deposit required (before auction starts): £50,000-£100,000
- Reserve price: consistent with deposit and other awards
- Deposit top-ups required during auction
- Limited bid submission extension rights to manage technical failure risk

Getting to the start of an Ofcom Auction



The key stages of a typical Ofcom Auction



Proposed timing of the Cleared Award

Date	Activity
6 June 2008	First consultation on detailed award design
15 August 2008	First consultation closes
Late autumn 2008	Second consultation on detailed award design
Winter 2008	Second consultation closes
Autumn 2010	Deadline for expressions of interest in sites for phased awards in 2011
Early 2011	Subsequent phased awards

- Planning to award the spectrum as soon as possible – could begin by summer 2009
- Allow spectrum to be used as soon as it becomes available
- Consistent with an orderly process
- Prudent to plan for 2nd consultation on outstanding technical issues

Proposed timing of the Interleaved Awards

Date	Activity
Summer/autumn 2008	Stakeholder events (London, Carlisle, Manchester, Cardiff + other locations)
21 August 2008	First consultation closes
Early autumn 2008	Information Memorandum and draft regulations for the first phased awards for Carlisle, Cardiff and Manchester
Late autumn 2008	Second consultation on detailed award design for combined award
Late 2008/early 2009	First phased awards
Late 2008/early 2009	Second consultation on subsequent phased awards
Spring 2009	Deadline for expressions of interest for additional sites for the combined award
Late spring 2009	Information Memorandum and draft regulations for combined award.
Autumn 2009	Combined award
Autumn 2009	Deadline for expressions of interest in sites for phased awards in 2010
Early 2010	Subsequent phased awards
Autumn 2010	Deadline for expressions of interest in sites for phased awards in 2011
Early 2011	Subsequent phased awards

Cognitive Devices in the Interleaved Spectrum

- Ofcom is aware that the device being standardised by the 802.22 group, is one that will co-exist with existing systems in the same UHF spectrum.
- This has been driven by the specific nature of the FCC proposals in the UHF ‘white space’.
- Ofcom does recognise the potential value these devices can offer in making better use of spectrum.
- In our Interleaved Consultation Document we said;

We proposed to allow licence-exempt cognitive devices access to the interleaved spectrum but decided not to set aside any of the digital dividend exclusively for licence-exempt use or as an innovation reserve.

- Ofcom will be consulting more widely on cognitive devices before the end of this year.

Developments in Europe

- Commission Communication on Digital Dividend
- CEPT – TG4 Band Plan - channels 61 to 69
- Developments in other Member States
 - Sweden
 - France
- Implications for UK