DOI:
10.1049/el.2016.1619

Document Version
Peer reviewed version

The Changing Availability of TV White Space in the UK

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The UK regulator Ofcom has held a Pilot of TV white space (TVWS) technology in the UK. Based on the results of this Pilot, Ofcom has varied its calculations of allowed white space device EIRPs. Further, WRC 2015 has assigned 694-790 MHz to mobile broadband on a co-primary basis, in ITU Region 1 (which includes the UK/EU). We provide fundamental observations on the effects of these changes on TVWS availability in the UK.

Introduction: The UK regulator Ofcom's TV White Spaces (TVWS) Pilot [1] was a pioneering effort in the field of white space access. The UK TVWS rules, which have been taken to a harmonised standard at the European (EU) level [2], are very different from other rules internationally. The UK/EU rules allow variable power limits for White Space Devices (WSDs) and different classes of WSD RF performances (spectrum masks). This leads to considerably more white space being available under the UK/EU rules than under other rules internationally.

We led a large trial within the Ofcom Pilot [3]. We previously presented observations on TVWS availability/capacity in London, UK [4]. However, Ofcom has since changed to its EIRP calculations in finalising its framework [5], significantly affecting TVWS availability, and WRC 2015 has also, in November 2015, decided to make the upper end of the TV band (694-790 MHz) co-primary with mobile broadband in ITU Region 1, which encompasses the UK and wider EU.

In this paper, we highlight the differences in TVWS availability that these changes lead to. No other work in the literature has done this analysis, where it is noted that our insights present extremely important material for potential implementers/users of TVWS technologies in the UK, as well as in other countries of the EU through comparison, by virtue of ETSI EN 301 598 being a harmonised European standard [2].

Methodology: We have implemented a WSD as one aspect of our work within the Ofcom TVWS Pilot. We use that implementation to methodically query databases and post process results to assess white

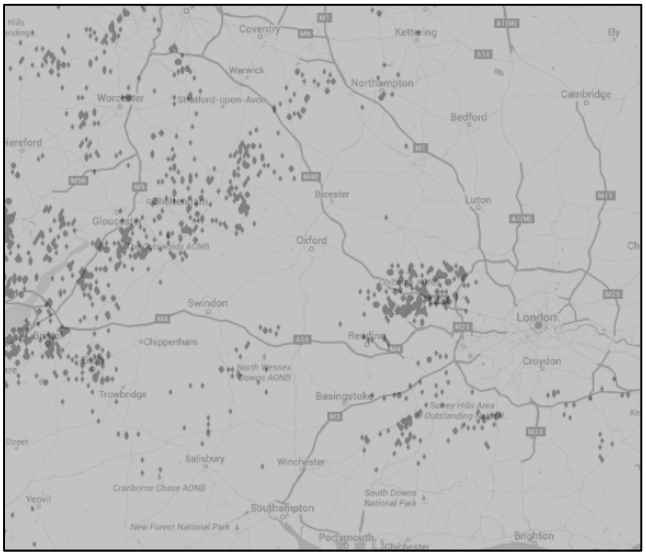
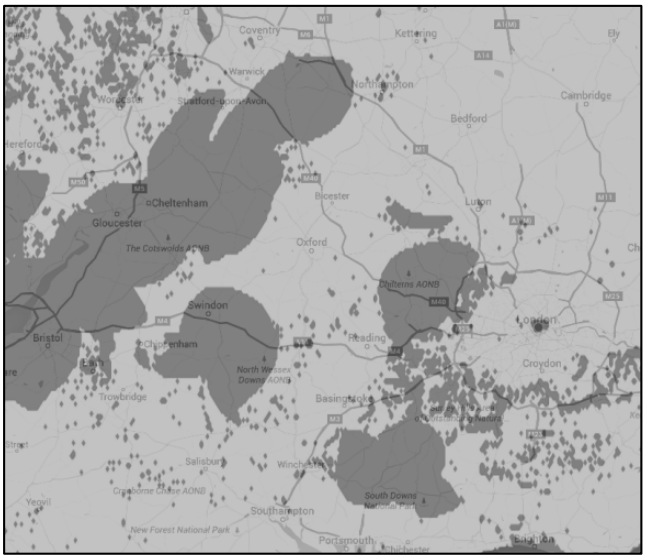


Fig. 1 *Locations for a large area of England in which at least one TV channel is available using the trial Ofcom TV white space databases for the MBD scenario. Dark areas indicate no availability. Note, under the IBP/MBU scenario at least 1 channel is available in all locations.*

Table 1: Assumed parameters for investigated scenarios.

Scenario	Transmitter Height (m)	Required EIRP (dBm)
MBD	30	At least 30
IBP/MBU	1	At least 20



a

b

Fig. 2 *Locations for a large area of England in which at least one TV channel is available under commercially operated Ofcom TV white space databases. Dark areas indicate no availability.*
a MBD scenario
b IBP/MBU scenario

Table 2: Statistics on TVWS availability under past, present and future rules, for various scenarios and locations (Class 3).

Scen-ario	Data-base calc.	Locat-ion	Ave. no. chan.	Std. no. chan.	CoV no. chan.	% loc. >= 1 chan.	% loc. >= 3 chan.
MBD	Past	Wide area	8.6	7.2	0.83	98.0	81.6
		London M25	15.2	8.5	0.56	99.5	97.1
	Present	Wide area	4.0	4.9	1.21	74.1	43.1
		London M25	4.7	3.5	0.76	90.8	63.1
	Future (WRC)	London M25	1.6	1.4	0.88	82.5	21.0
IBP/ MBU	Past	Wide area	26.5	6.1	0.23	100.0	100.0
		London M25	25.5	3.6	0.14	100.0	99.9
	Present	Wide area	23.5	7.1	0.30	99.9	99.7
		London M25	24.8	4.7	0.19	100.0	99.9
	Future (WRC)	London M25	14.4	3.6	0.25	99.5	99.0

a

b

Fig. 3 *Locations for only the London "M25" area in which at least one TV channel is available under commercially operated Ofcom TV white space databases for the MBD scenario. Dark areas indicate no availability.*
a Before implementation of the WRC 2015 decision
b After implementation of the WRC 2015 decision

space availability. Using that implementation, we have sampled availability over a large area of England (~42,300 km^2—see Figures 1, 2), at a resolution of 0.01 degrees equally in latitude and longitude. This equates to 54,400 locations being sampled across this area. Results are for a Class 3 WSD operating with specific operational parameters.

We assess the number of channels that are available under various criteria. We consider similar scenarios to [3], [4]: mobile broadband downlink (MBD) in TVWS, and indoor broadband provisioning or mobile broadband uplink (IBP/MBU) in TVWS. However, we also vary the parameters in order to consider, e.g., the benefits of reducing antenna height. Due to space limitations, our main interest here is TVWS availability. Table 1 presents parameters used for our scenarios.

Results: Results are presented in Table 2 and Figures 1 to 3. For the MBD scenario, there is a significant reduction in TVWS availability under the commercial database, with large areas of the investigated area of England having zero availability. The average number of available channels is reduced from 8.6 to 4.0. Results are more striking when narrowing down to the London area, which still has good availability for the most part, although reduced from 15.7 to around 4.7 channels being available on average. Uncertainty in the availability for both cases is also significantly increased.

The IBP/MBU scenario is far less affected, still with excellent availability for the commercial databases. Uncertainty in availability is also only marginally increased under the commercial databases.

Investigation of the effects of the WRC decision is done only for the London M25 area, as this area is dominated by the Crystal Palace TV transmitter operating on channels below 49, with relays and transmissions from other areas only minimally operating on channel 49 or above. Hence, the effects of re-planning the higher-frequency DTT transmitters due to mobile broadband taking 694-790 MHz can be largely neglected for the London M25 area. Results for both scenarios show a significant reduction in availability due to the WRC decision, although the IBP/MBU availability remains excellent with over 14 channels being available with a low variability.

Finally, we note that many of the observations in [3], [4] regarding the effects of spectrum mask classes still apply, with Class 1-3 achieving relatively similar availability, but classes 4 and 5 having significantly reduced availability. Moreover, we note that lowering the transmitter height for the MBD scenario can significantly increase availability; as an extreme example, lowering the antenna to 1m height above ground level leads to the average channel availability in the London M25 Future case (even while taking into account the WRC decision) increasing from 1.6 to 9.5, the CoV decreasing from 0.88 to 0.40, and the percentage of locations in which 1 and 3 channels can be used respectively increasing from 82.5% to 96.3%, and 21.0% to 94.0%. Ofcom uses different height ranges for DTT protection calculations, such that similarly exceptional results hold up to 3.2m height above ground level, and reductions in this availability occur if the height is raised above 3.2m, then above 7.4m, and then again above 12.4m. At 7.4m and 12.4m, the average number of channels available is 5.6 and 3.6 respectively, the CoV is 0.71 and 0.86 respectively, at least 1 channel is available in 78.7% and 78.2% of locations respectively, and 3 channels are available in 72.5% and 56.8% of locations respectively. Hence, even with such modest reductions in height, a lot of usable TVWS becomes available for the MBD scenario.

Conclusion: We have presented the first assessment of TVWS availability in the UK considering changes in EIRP calculations by Ofcom in the final approval of commercial operation of the technology, and the effects of the WRC 2015 decision to make mobile broadband co-primary with broadcasting at 694-790 MHz for ITU Region 1.

Acknowledgments: This work has been supported by the "Spectrum Overlay through Aggregation of Heterogeneous Dispersed Bands" project, ICT-SOLDER, www.ict-solder.eu.

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