

TV White Spaces: Approach to Coexistence

About Google

Consistent with our mission of organizing the world's information and making it universally accessible and useful, the products and services of Google Inc. (a U.S. company) span the entire wireless economy, including mobile operating systems, mobile applications, phones, and tablets. Google's business depends on users having access to robust licensed and licence-exempt spectrum resources.

General Response

As demand for wireless data increases, regulators will need to employ creative strategies to ensure sufficient spectrum to support a robust ecosystem of wireless services, applications, and products. Enabling sharing of vacant channels in the broadcast bands is an important aspect of that overall effort. Google urges an approach to coexistence that protects incumbent users in the broadcast bands while maximizing the utility of unused spectrum. To that end, we have the following suggestions.

General Recommendations Regarding Ofcom's Overall Approach to Coexistence

1. Ofcom should provide stakeholders with access to raw data so that they can independently verify conclusions and more accurately comment on the sharing framework. For example, an update of the coverage map provided by Ofcom that overlays the locations of television receivers would be extremely helpful to database developers. Access should be subject to reasonable confidentiality protections for personal or commercial data.
2. Ofcom should use data and learnings from the television white space pilots to adjust and improve its recommendations. The trial will provide important information regarding coexistence, and the trial experience may indicate where Ofcom could free up more spectrum for license-exempt use.
3. Ofcom should not wait for the 700 MHz auction to be completed in 2018 before finalizing operating parameters for television white spaces. The auction may impact the amount of white space available for licence-exempt use, but not the principles that will govern use of the bands. Until auction results are known and new systems are deployed, broadcast band channels should continue to be shared.

Specific Recommendations on Managing Coexistence

Google supports using databases, among other tools, to manage coexistence. Ofcom should consider the following principles in adopting a database approach for incumbent protection.

1. In order to facilitate innovation and enable users to take advantage of the latest technological advances, Ofcom should set interference protection criteria and let databases calculate available white space. Requiring a particular set of algorithms, as proposed in section 2.6 of the Consultation, may limit innovation in database development and will not account for improvements in white space device characteristics. Ofcom can ensure interference protection through the database certification process and through enforcement; it need not prescribe “a specific set of algorithms” in order to protect incumbents.

2. At a minimum, Ofcom should shift away from an approach that focuses on the presence or absence of television receivers (called victim pixels in the technical report). An approach that draws on the propagation characteristics of television transmitters—rather than receivers—has several advantages.

- First, Ofcom's method relies on a proprietary dataset and will require much more frequent updating. While the locations of television transmitters do not vary significantly over time, the locations of receivers (i.e., individual televisions receiving over-the-air broadcast signals) change constantly.
- Second, Ofcom's method will not scale well to the rest of Europe because, in other jurisdictions, similar datasets may not be available or may have very different characteristics.
- Third, reliance on a non-transparent, proprietary dataset limits innovation on the part of database developers: If developers lack access to the raw data, they cannot effectively suggest improvements to the current model.
- Fourth, a transmitter-focused approach is more predictable. Calculating white space availability based on proximity to the nearest receiver can result in unpredictable highs and lows in the amount of white space available. Available white space can also change quickly under this method even though TV transmissions are relatively static, creating unnecessary uncertainty for white spaces users.

3. Ofcom should also consider using a terrain-based model for signal propagation. Terrain-based models more accurately capture the propagation of signals over hills and valleys, allowing better protection of incumbent operations and more accurate determinations of available channels. Google's TV white space trial in Cape Town, South Africa, relied on a terrain-based propagation model, and no interference was

observed or reported, even though fixed, higher power (4 watts EIRP) operations were permitted on channels immediately adjacent to television broadcast operations. The trial was able to achieve data rates of 2-12 Mbps over ranges of 2-6 km.

4. Finally, Ofcom should reconsider the hard power cap of 36 dBm/8 MHz set forth in section 3.16 of the consultation. In rural areas where there are fewer broadcasters, broadband providers may be able to reach more end users if they are able to increase the power of their operations.

Responses to Numbered Questions

Q1: Do you have any comments on our proposed approach to ensuring a low probability of harmful interference to DTT services? Please state your reasons for your comments.

As noted above, Google supports using databases to manage coexistence between digital television and white space devices. Ofcom should adopt a coexistence framework that allows database developers to innovate: It should set interference protection thresholds and recommend propagation models, but it should not lay out algorithms in chapter and verse.

Google also suggests moving away from a protection model that requires knowing the locations of television receivers. Currently, Ofcom's protection model depends on data regarding receivers, rather than the overall characteristics of the transmitter. This method relies on a proprietary dataset and will require much more frequent updating. In addition, it will not scale well to the rest of Europe because, in other jurisdictions, similar datasets may not be available or may have very different characteristics. Moreover, reliance on a non-transparent, proprietary dataset limits innovation on the part of database developers—if they lack access to the raw data, they cannot effectively suggest improvements to the current model. Finally, calculating white space based on the presence of receivers creates unpredictability: Available white space can change quickly when based on the presence or absence of receivers, even though TV transmissions are relatively static. As a result, relying on receiver data creates unnecessary uncertainty for white spaces users.

Q2: Do you have any comments on our proposed approach to ensuring a low probability of harmful interference to PMSE services? Please state your reasons for your comments.

Ofcom proposes that white space devices (WSDs) ping the database every fifteen minutes to receive up-to-date channel availability information. This requirement is driven primarily by a concern for protecting PMSE use that may be introduced on

relatively short notice. However, the need to ping the database frequently increases the cost of service because the database needs to serve a much higher volume of queries at any given time. We suggest a more efficient approach: Channel 38 should be set aside for PMSE in urban areas where there is high PMSE utilization. A second channel should be made available on a priority basis for PMSE. If a WSD seeks to use those channels, it should be required to check in every hour. If a white space device refrains from using those channels, it need not check in with the database as frequently.

Additionally, nationwide restrictions in channels adjacent to 38 should be tested during the pilots to determine whether they can be eased to reflect a lower risk of interference, for example, in certain rural areas where the population density is much lower. As above, restrictions can then be relaxed to the extent that they are found to be unnecessary.

Ofcom should base its protection criteria on the performance of professional, state-of-the-art PMSE equipment. If necessary, Ofcom can allow for a transition period to account for the fact that some older equipment will still be in regular use. Ofcom should also step up its efforts to identify and eliminate un-licensed use of PMSE equipment and seek ways to encourage PMSE users to update their equipment. It is important that PMSE manufacturers and regulators help to solve the interference and deployment issues with improved processes and technology.

Ofcom should take steps to encourage efficient use of spectrum by PMSE to help address the issue of limited spectrum availability in areas where there is both high demand and limited availability. The band manager for PMSE spectrum allocations (currently JFMG, an Arqiva company) should be required to make the allocation of reservation information (spectrum, location and date/time required) that will be entered into the WSD database available for review and should also be required to provide periodic, verifiable reports on actual usage of the allocated spectrum in order to ensure that the spectrum is being used efficiently. In addition, it will be beneficial if the WSD database in turn makes the PMSE information publicly available.

We agree that using wanted power rather than sensitivity for calculating the protection ratio is a realistic assumption. However, assuming that the PMSE device is always at the edge of the frequency band and not taking into account the mitigating effects of directional antennas may result in WSD emission limits that are overly cautious and unnecessarily restrictive.

The pilots offer the opportunity to test whether a database can be used to provide calculated power allowances rather than completely prohibiting operation in white spaces around venue boundaries. This prohibition can then be relaxed to the extent that it is found to be unnecessary, by fine-tuning the calculations.

Q3: Do you have any comments on our proposed approach to ensuring a low probability of harmful interference to 4G services above the UHF TV band? Please state your reasons for your comments.

Google suggests that portable WSDs should be allowed to operate on channel 60. Any necessary protection could be achieved by restricting power. That is, rather than employing a total ban, Ofcom should prescribe the out-of-band emission limit for devices in channel 60 and leave it to device manufacturers to determine how those requirements can best be met. Specifically, Ofcom should create a receiver profile for a nominal protected user in channel 61—just as it has done for broadcast receivers and PMSE users—and then calculate adjacent channel limits for white space devices based on those characteristics.

Q4: Do you have any comments on our proposed approach to ensuring a low probability of harmful interference to services below the UHF TV band? Please state your reasons for your comments.

Google agrees with Ofcom's proposed approach.

Question T1: Do you have any comments on our proposal to cap the maximum in-block EIRP of all WSDs at 36 dBm/(8 MHz)?

As noted above, Ofcom should reconsider the power cap of 36 dBm/8 MHz. In rural areas where there are fewer broadcasters, broadband providers may be able to reach more end users if they are able to increase the power of their operations. Ofcom should consider increasing the power cap to 40 dBm/8 MHz, and remain flexible going forward based on actual experience,

Question T2: Do you have any comments on our proposed approach for calculating WSD emission limits, as expressed in Equation (4.3), in relation to DTT coexistence calculations?

Google supports Ofcom's proposed approach.

Question T3: Do you have any comments on our proposed approach for dealing with the uncertainty in the locations of DTT receivers in relation to DTT calculations?

Google recommends that Ofcom move away from a receiver-centric framework, which often would result in overprotection. For example, in a given 300 meter x 300 meter square, Ofcom's calculations assume that the device and the receiver are within 5, 10, or 20 meters of each other. However, in such a scenario, the device and the receiver could be *significantly* farther apart. Because the receiver-centric framework requires the

use of such hypotheticals and places Ofcom in the position of having to make such hypothetical estimates, whereas a transmitter-centric approach would not, the former approach unnecessarily decreases available white space.

Question T4: Do you have any comments on our proposed target of a 10% likelihood of a 1 dB rise in the noise-plus-interference floor at the edge of DTT coverage?

Google supports this approach. However, Google remains optimistic that the pilots will demonstrate that it is feasible to adjust the resulting parameters to allow for more white space usage, thereby allowing Ofcom to reconsider the target.

Google also agrees that the proposed target reduction should depend on the sensitivity of the receiver and the strength of the DTT signal. This approach allows for increased degradation tolerance in areas where the DTT signal is strong and limits degradation where the DTT signal is weak.

Question T5: Do you have any comments on our proposed approach for calculating coupling gains in relation to DTT calculations?

Google believes that Ofcom's approach to coupling gains for portable devices should be modified. Ofcom proposes that if a Type B portable device reports its height as greater than 2 meters, then the device will be considered indoors and an extra 7 dB of attenuation will be applied. However, for most structures, the exterior wall of a building causes signal loss in the range of 10 to 15 dB on average. Ofcom should raise the 7 dB parameter accordingly.

Question T6: Do you have any comments on our proposed protection ratios in relation to DTT calculations?

In addition to the protection ratios Ofcom has already developed, Ofcom should also develop protection ratios for 802.11af, which is a likely candidate for the band.

Question T7: Do you have any comments on our proposed approach for dealing with the uncertainty in the locations of WSDs in relation to DTT calculations?

Google is concerned that Ofcom's proposed approach does not maximize spectrum utilization. More specifically, Ofcom's prescription of absolute limits on the power levels for non-geolocated slave devices could result in significant overprotection, diminished use of available spectrum, and unnecessary limits on the use of non-geolocated slave devices.

For example, if there is a master device transmitting at 36 dBm with an antenna height of 30 meters in a pixel classified as open, the resulting radius will be over 20 kilometers. A circle with that radius will cover over 125,000 100x100 meter pixels. Based on the proposed method, if even a single one of those 125,000 pixels is affected by the use of a channel, then that channel cannot be used by any of the 125,000 pixels. With such a large area covered, the odds of one pixel completely blocking the channel increase, while the odds of the slave device residing in that particular pixel decrease dramatically. In any given pixel, though, there may or may not be a device, and there may or may not be a television receiver. By precluding TV white space operations where there is a mere possibility of interference to a receiver, Ofcom has proposed an overprotective approach that limits the utilization of white space, even when there may be no interference.

To improve spectrum utilization, Google suggests computing the maximum allowable power level for the slave device in a probabilistic way and allow TV white space operations where the likelihood of interference is below a threshold level. Google suggests that threshold be set at 5%. This assessment will better capture the random placement of the slave devices in the master device's service area. With this small change to the interference criteria, the resulting impact on DTT will be negligible and the usability of non-geolocated slave devices will greatly increase.

Question T8: Do you have any comments on our proposed approach for calculating WSD emission limits, as expressed in Equation (5.2), in relation to PMSE coexistence calculations?

Google agrees with Ofcom's proposal to use a value of -65 dBm for the proposed wanted signal power of wireless mics. This approach makes sense because this value is based on operating power levels for microphones that are currently in use.

Question T9: Do you have any comments on the PMSE wanted signal power levels that we propose in relation to coexistence calculations?

Google agrees with Ofcom's proposed approach.

Question T10: Do you have any comments on our proposed approach for calculating coupling gains in relation to PMSE calculations?

Google has no comment on this question.

Question T11: Do you have any comments on our proposed approach for dealing with the uncertainty in the locations of WSDs in relation to PMSE calculations?

Google believes that Ofcom's proposed approach is reasonable.

Question T12: Do you have any comments on our proposed approach for dealing with the uncertainty in the locations of PMSE receivers in relation to PMSE calculations?

Google believes that Ofcom's proposed approach is reasonable.

Question T13: Do you have any comments on our proposed approach for the derivation of WSD-PMSE coupling gains for non-geolocated slaves in relation to PMSE calculations?

Google's concerns regarding the treatment of non-geolocated slaves—as set forth in the response to question T7—also apply to the derivation of WSD-PMSE coupling gains. Therefore, Google proposes that the same type of calculation discussed in our response to T7 be used in this context as well.

Question T14: Do you have any comments on our proposed protection ratios in relation to PMSE calculations?

Google agrees that the current protection ratios are adequate based on the assumptions used. However, Ofcom's analysis to date has assumed that all white space signals look similar to those emitted by Weightless devices. Ofcom may need to adjust protection ratios in the future as it collects more information regarding the characteristics of other WSDs.

Question T15: Do you have any comments on our assessment that a margin for uncertainties in radio propagation is not necessary given the proposed parameters for derivation of coupling gains in relation to PMSE coexistence calculations?

Google has no comment on this question.

Question T16: Do you have any comments on our proposed WSD emission limits in relation to PMSE use in channel 38?

Google does not have comments on the proposed WSD emissions limits, but suggests that the channel 38 noise restriction value used to calculate the values for table 5.8 be published. Even if WSDs may not operate in channel 38, it would be helpful to know the interference thresholds so that devices can more accurately calculate their nominal in-band power in relation to their out-of-band emissions mask. If the rules pertaining to channel 38 change in the future, having this information available will enhance the adaptability of legacy devices to the new rules.

Question T17: Do you have any comments on our proposal not to permit WSDs to operate in channel 60?

Google suggests that portable WSDs should be allowed to operate on channel 60. Any necessary protection could be achieved by restricting power. As set forth in greater detail above in Google's response to Question 3, Ofcom should prescribe the out-of-band emission limit with which devices in channel 60 must comply and leave it to device manufacturers to determine whether those requirements can be met.

Question T18: Do you have any comments on our proposal that, if the unwanted emissions limit (over 230-470 MHz) in the draft ETSI standard (EN 301 598) is tightened by 8 dB, there should be no further restrictions on the operation of WSDs in relation to services below the UHF TV band?

Google agrees that Ofcom need not impose further restrictions on the operation of WSDs if ETSI's standard is tightened. However, Ofcom's process and ETSI's process are on parallel tracks, and they need not depend on each other. Google and other database providers can build databases that are both ETSI-compliant and Ofcom-compliant even if Ofcom sets its own rules for channel 21-23.

Question T19: Do you have any comments on our proposal that, if unwanted emissions limit (over 230-470 MHz) in the draft ETSI standard (EN 301 598) is not changed, there should be restrictions on the in-block powers of WSDs in channels 21 to 23?

Google has no comment on this question.