



Vodafone Response to Ofcom Consultation: Review of spectrum fees For fixed links and satellite services



Executive Summary

Vodafone agrees the principle that spectrum users should be incentivized to act efficiently, and we accept that Administered Incentive Pricing (AIP) provides a regulatory mechanism to encourage this.

The application of AIP, however, should be restricted to where there is a suitable alternative usage for spectrum, with cost-based administration fees being used where there is no demonstrable excess demand for a given block of spectrum. Vodafone considers that although there are some bands where there is excess demand (including other potential licensees with the same application that would clash with the current licensee), in general no evidence has been provided to suggest that demand exceeds supply across the whole range of bands where AIP is applied.

We agree with Plum's analysis that the 3.6-3.8 GHz band has a suitable alternate usage, hence AIP fees should be applied based upon this usage: to this we would also add the 1.4 GHz band, dismissed by Plum in the accompanying document. We also concede that there are other bands, particularly below 20GHz, where demand for fixed links exceeds supply so AIP should be used. However, there are many bands above 20GHz, particularly e-band spectrum, where there is no evidence that supply is outstripped by demand, hence no case for the usage of AIP-based licence fees.

Vodafone has reviewed Plum's methodology. For the mechanism utilized, we have audited the input equipment costs and believe that they are broadly right. However, we disagree with the methodology used to calculate the "own use" opportunity cost, i.e. to assume that where an applicant is "blocked" from securing spectrum, they would instead get higher frequency spectrum and *de facto* deploy a repeater station to utilise two hops to achieve the same goal. Instead, in practical terms, where we are unable to secure spectrum in a given band, our approach would be to move up to the next available spectrum band, and deploy a larger antenna/dish to achieve broadly the same outcome with a single hop – i.e. the "cost" of not securing spectrum is a larger antenna/dish, and higher rents associated with that antenna/dish, rather than the costs associated with deploying an additional site. Taking this into account the opportunity costs of excess demand, which form the key part of the AIP calculation, will be considerably lower.

We agree that AIP should incorporate a measure of geography, but consider the current proposals are insufficiently granular. We agree to changes to the bandwidth factor and measures to reward the usage of high performance antennas. We are less convinced about incorporating measures to incentivize automatic power control, but are not fundamentally opposed if a practicable evidence-based approach could be found.



Answers to Questions

Question 1 Do you agree with Plum's view of the potential higher value alternative mobile use of the 3.6-3.8 GHz bands over the next seven to ten years?

Vodafone agrees with Plum's view of the higher value alternative use of the 3.6-3.8 GHz band for mobile, assuming identification goes ahead at WRC-15. We also agree that whilst the 3.8-4.2 GHz band is attractive for mobile usage, it is likely to be in the longer term given the low probability of an identification at WRC-15.

Satellite usage of C-band provides a useful counterpoint to the logic of AIP; although the purpose of AIP is to incentivise efficient usage of spectrum rather than as a revenue raising tool, in practice cognisance of the wider environment can have a similar effect. The usage of C-band has been diminishing, largely because satellite operators are aware that mobile usage is on the horizon, and when this happens unlike terrestrial applications it won't be possible to simply change out the radio equipment. As such, reflecting the long design lives of satellites, usage has been diminishing, restricted largely to where it is required for climatic propagation reasons. AIP has played little role in this transition and arguably imposing it simply imposes additional cost on those operators that are forced to use C-band for technical reasons.

We consider that Plum have been unduly conservative with respect to the 1.4 GHz band. We note that Plum refers to this band potentially not being brought into usage for mobile until 2028¹, but this is not for any want of demand on the part of the mobile industry, with broad support for identification of the band (i.e. equivalent to the status of 3.6-3.8 GHz) at WRC-15. Rather, any delay is because the incumbent fixed point-point links preclude the usage in the UK² – this is the very definition of there being an alternative use, and this should be taken into account for AIP purposes.

¹http://stakeholders.ofcom.org.uk/binaries/consultations/review-spectrum-fees-fixed-links-satellite/annexes/plum_report.pdf, section 2.2.1

² There may be a secondary issue of interference with MSS band above 1518 MHz, but Vodafone has presented material to IFPG Working Party D demonstrating that interference from mobile usage would be no more than from existing fixed links.



Question 2 Do you agree with Plum's analysis of current and future demand for spectrum for fixed links? Please give your reasoning.

Vodafone broadly agrees with the trends identified by Plum, albeit it is concerning that the future demand analysis is significantly based upon a four year old Aegis report which predates significant industry developments, such as mast sharing, that we consider below.

In general, the bulk of usage of fixed links is for mobile backhaul, with a certain amount of usage for Enterprise access (together with emerging usage for direct links in the finance industry). We are experiencing a huge growth in mobile data, which in turn places demand for higher bandwidths on backhaul. Wherever possible, Vodafone makes use of fibre, but where this isn't practicable we then use wireless fixed links, preferably utilising spectrum that has been exclusively licensed as a block (e.g. 28GHz), falling back to individually licensed spectrum where this isn't possible. Where we make use of individually licensed fixed links, our approach is to use as high a frequency as possible given the distance, because this will allow us to deploy the widest possible bandwidth. Rollout to meet the coverage obligations agreed with Government and (more importantly) demanded by our customers will lead to an increase in masts. As such, Plum's conclusion of a growth in demand for higher frequencies and a steady decline at lower frequencies is, all things equal, correct.

We would highlight, however, that all things aren't quite equal. Even absent current Merger and Acquisition activity, we are in the throes of an evolution from four national MNOs with their own mast networks, to two mast networks (CTIL and MBNL) used on a shared-basis. For CTIL, backhaul is provided by either Vodafone or Telefonica, according to location. As such, this will to some degree moderate the demands for links, because (compared to the counterfactual of no mast-sharing network) there will be fewer links, albeit of wider-bandwidth. At the very least this will lead to a reduction in the demand for the number of links, but also the higher per-link bandwidth requirements will inevitably benefit the business case for using fibre, thus further reducing the number of radio links. Additionally, other Ofcom initiatives such as the regulated provision of dark fibre by BT, will increase the relative attractiveness of fibre when compared to radio backhaul. Finally, we note that Government subsidies for Superfast Broadband deployment in rural areas are likely to increase the volume of fibres where MNOs would otherwise have been forced to use radio. By reliance on analysis from 2011, none of these factors have been taken into consideration.

Vodafone questions whether there has been any evidence presented in the analysis that [own-use] demand is outstripping supply. Table 1 provides an analysis of the applications for fixed links submitted by Vodafone



in the last six months, together with how many were accepted versus rejected for spectrum congestion reasons. As can be seen, ✂.

Table 1 – Vodafone point-point licence applications

Frequency Band	Licence applications submitted	Licence applications rejected
15 GHz	✂	✂
18 GHz	✂	✂
23 GHz	✂	✂
26 GHz	✂	✂
38 GHz	✂	✂
80 GHz	✂	✂

Plum seem to agree with our experience, concluding³

*In summary, the future outlook for spectrum demand from fixed links is that excess demand at current fees **could** continue to be an issue in bands below 20 GHz but this is unlikely in bands above 20 GHz.*

Vodafone's position is that AIP should apply only where there is evidence of excess demand, and that other links should be licensed on the basis of an administration fee. It would seem that, having been given the task of addressing **how** AIP should be applied to fixed link frequency plans, Plum have considered it out of scope as to **whether** AIP should actually be applied, based upon their forecasts.

As we move forward, it is also instructive to consider the dynamic of the applicant that would be blocked from their preferred band: in a scenario of the vast majority of demand coming from two mast share networks, an applicant that is unable to use a given band at a given location because it is already in use will find that it's a 50/50 chance that the incumbent usage is in fact by themselves. It would be perverse to charge licence fees that reflects that a licence-holder is blocking further usage by themselves as the issue should be self-managed, and in the event that the blocked applicant relates to the other mast-share network, then in all practicality it's a flip-of-the-coin type scenario of which was first, with one set of

³ Plum analysis, P39, Vodafone emphasis.



stakeholders losing out and having to use suboptimal spectrum on some links, the other set losing out on others. Indeed, there's an argument to say that AIPs shouldn't be applied at all and where an applicant is blocked, instead they should be given the identity of the incumbent in order that they can commercially negotiate whether trading the right-to-use in that area is feasible.

Therefore, Vodafone considers that there is a case to examine whether the bands in the 18-38 GHz range should in fact have AIP applied, or whether an administration-based fee would be more appropriate.

For e-band, we believe the situation is more clear-cut. E-band links are typically used for short distance / high bandwidth applications, for example in an urban environment where using fibre isn't practicable. Along with the other MNOs, Vodafone requested that rather than being self-coordinated, these links be administered by Ofcom. It should be stressed that we did this not because of a large probability of interference between e-band links, but because of the high impact (i.e. loss of connectivity to a mast, potentially with safety-of-life implications) should that interference occur.

Further, due to the specific frequency characteristics of e-band and e-band antennas, beam widths are narrow and atmospheric absorption is high. Both of these factors increase re-use, minimise saturation and thus undermine the argument that there is likely to be excess demand.

Against this backdrop, Vodafone considers that it is totally inappropriate to apply AIP, especially on a formulaic basis, to these frequency bands. Table 1 backs this up – we have yet to have a single e-band application rejected on the basis of likely interference. E-band should be exempted from the AIP regime until there is evidence of excess demand, with administration-based fees being used instead.

Question 3 Do you agree with Plum's analysis of current and future demand of spectrum for PES and TES? Please give your reasoning.

Vodafone agrees with some of the reasoning, however there are also flaws.

We would note that in general the frequency bands to be used are outside the control of the UK earthstation operator that applies for the licence. As set out in our response to Question 1, even absent AIP, there is an industry move to higher frequencies, reflective that it is known that lower frequencies will become congested with other applications – good planning practise motivates this move rather than additional regulatory actions. Also, there is increasing customer preference for low visibility impact VSAT applications,



which favours usage of Ku and Ka over lower frequencies. We therefore agree with the outcome foreseen by Plum, if not entirely with the logic.

Question 4 Do you agree with the approach taken by Plum to calculate the opportunity cost of the spectrum? If not, how would you suggest the LCA is calculated? Do you also agree that this methodology is likely to provide a more conservative estimate?

Question 5 Do you agree that Plum has identified the correct options for its LCA analysis? If not, what option(s) do you suggest we consider for the Least Cost Alternative?

Question 6 Do you agree with the cost assumptions that Plum has used in its analysis? Please provide documentary evidence if you disagree.

Vodafone agrees with Plum's approach of assuming the whole link would move to another mechanism should an application be rejected, rather than just the excess demand (i.e. it isn't realistic that the link would be split partially across the preferred and alternate bands).

In general where a link application is rejected, we would look to the alternate mechanisms of either using higher frequency spectrum, or alternatively whether this change to our planning assumptions means that fibre would now cost in. In the overwhelming volume of cases, it is the higher frequency spectrum that represents the Least Cost Alternative (LCA).

Where we differ from Plum's analysis is how the higher frequency spectrum would be used. Plum's counterfactual is to assume that an applicant would seek higher frequency spectrum, and "split the link" with a repeater site achieving the same outcome. The incremental LCA costs are therefore the cost of the repeater site. Having reviewed Plum's cost assumptions, we consider these to be reasonable for that approach. However, as Ofcom is fully aware from the debate on mobile coverage, securing suitable mast sites at a commercially feasible cost is an incredibly difficult task. The fact that in Plum's solution the site would only be used as a repeater on a point-point link, will be of little relevance to the prospective landlord; the chances of finding a suitable site are remote. Therefore, "splitting the link" is simply not a realistic scenario of how the "blocked" applicant would mitigate lack of access to their preferred band.

Instead, the more realistic outcome when the preferred spectrum is not available, is that the applicant will take the next highest frequency and use bigger antennas, accepting the marginal reduction in performance. As such, the LCA costs should be based upon engineering larger antennas for the original single hop, with



consequent increase in mast rentals to reflect the higher load placed by that antenna. We urge Ofcom to request Plum to revisit their analysis on this basis and would be more than happy to supply cost data to facilitate this.

Question 7 Are there any other pieces of publicly available evidence we could use to estimate the opportunity cost of the use of 3.6-3.8 GHz for mobile use now?

Vodafone agrees that the outcome of the 3.4 GHz auction will present the most accurate evidence of the value of the 3.6 – 3.8 GHz band. We note that the process of reviewing the AIPs is an exercise which is planned to take well into 2016, meaning the data will be available by the time Ofcom implements any changes. In the event of any delay on the 3.4 GHz auction, Vodafone considers it best to await the outcome before applying the changes to the 3.6-3.8 GHz bands – these fees have not been reviewed in a decade, so better to take a marginal delay than to rely on potentially misleading data.

In the context of the 1.4 GHz band referred to in our response to Question 1, we note that Qualcomm has announced its intention to trade its holdings in the 1452-1492 MHz band. As a private exercise, the monetary outcome of this trade may not be made public⁴, but it is conceivable that Ofcom could obtain an aggregate/average value from Qualcomm to inform this process.

Question 8 Do you have any comments on Plum's suggestion to remove the path length factor?

Vodafone concurs with Plum's analysis. We are technically incentivised to apply for the highest frequency that will support a given path length, as this provides the potential for highest bandwidth to meet forecast demand. As such, the path length factor is redundant.

Question 9 Do you have any comments on Plum's suggestion to add a location factor?

Vodafone agrees with this proposal. Where there is excess demand from "own use" applications, this is highly localised. As such, AIP should have an effect only in these areas, with the remaining locations having pricing analogous to an administration fee.

⁴ The trade will be subject to the Mobile Trading Regulations, but Ofcom's review for this purpose will likely be as to the suitability of the prospective licensee rather than the amount that said licensee is prepared to pay.



Question 10 What are your views on the need to revise the bandwidth factor in the fixed link algorithm?

Vodafone agrees with Ofcom's analysis that a given unit of bandwidth at low frequencies will consume far more spectrum than that at higher frequencies – it is for this reason that we seek from a spectral efficiency perspective to use as high a frequency as practicable. If Ofcom was to incorporate this into the AIP formula in some way, then it would be most welcome and provide a financial incentive rather than our simply being a good corporate citizen. Notwithstanding this, we must re-iterate that we see no justification for charging AIPs on e-band, the example used by Ofcom in para 6.11.

Question 11 What are your views on the benefits of additional incentives for the use of high performance antennas? How might these best be implemented in our fees algorithm?

Vodafone would be supportive of some factor to encourage the use of high performance antennas, although we would not support an outright requirement. We believe it should be possible to incorporate into the fee algorithm by applying a weighting to the fee. This could be table-driven, taking the performance of a "standard" antenna as the reference price and applying a discount according to the reduction in spectrum footprint yielded by the high performance antenna. The table could be developed via a consultative process with Ofcom and stakeholders prior to reform of the AIP regime.

Question 12 What are your views on the suggestion that we further consider ways to incentivise the use of automatic power control, a suggestion we are minded not to take up?

Whilst the usage of Automatic Transmit Power Control (ATPC) is to be encouraged, Vodafone is sceptical about its use as part of the AIP fees regime. In many cases, if a pair of [geographically] adjacent links are configured to use ATPC to use lower transmit power in normal operation, the conditions under which they would crank up the power (e.g. climatic) would coincide, so it is false premise that not assuming the worst case scenario would necessarily mean more links could be deployed. We note that this may not universally be the case and there could be conditions where "link A" could continue to operate at lower power while "link B" cranked up to full power, but relying upon that orthogonality would be dangerous.

Vodafone is also concerned about how Ofcom would police that ATPC deployments were actually being used in line with what the licensee had stated to Ofcom; there is scope for licensees to game the system to achieve a lower AIP, while actually configuring ATPC to illicitly use higher transmit powers.



Question 13 What are your views on the proposed revisions to the PES algorithm and the TES ratio? In particular, do you agree we should use the relative denial areas to reflect the difference in opportunity cost between PES, TES and fixed links? Do you have any other suggestions for improvement?

Vodafone agrees that relative denial areas should be used to reflect the different opportunity costs of PES, TES and fixed links. There are, however, flaws with the Plum analysis;

- The plots all appear to be at Ku band or higher.
- The minimum practicable lowest elevation that can be used at C-band should be 5° and at Ku should be 10° . This being the case, why does the Plum analysis have curves for PES at 3° ?
- From the UK the maximum elevation angle to a geostationary satellite is $\sim 30.7^{\circ}$, yet the Plum analysis seems to use 35° as a study point.

Vodafone's fundamental issue, however, is that by considering satellite links from an individual dish in isolation, a distorted AIP analysis results. The links from a earth station should be considered collectively: although deploying an additional link from a new dish within an installation seemingly creates a denial area where for example mobile access cannot be deployed, by treating the dishes in a earth station as being a single installation it becomes clear that the denial area is one which was already there due to the existing links.

We would welcome the opportunity for our satellite planning experts to liaise with Plum to resolve these discrepancies and determine how material they are to the consequent AIP analysis.

Vodafone also notes nascent research by the University of Surrey⁵ that suggests Plum's analysis of denial areas could be unduly pessimistic. University of Surrey researchers have been investigating whether it would be possible to achieve greater coexistence of satellite-based broadband delivery applications with existing PES. Rather than taking "ideal" plots as used by Plum, and indeed as used in conventional coexistence analysis, University of Surrey has sought to incorporate the effect of terrain and ground clutter. As can be seen in the referenced presentation at slide 18 (p20 in the pdf), when this is taken into account the denial

⁵ See <http://www.techuk.org/insights/meeting-notes/item/5165-uk-spectrum-policy-forum-plenary-meeting-notes>, presentation 5 (CORASAT pres)



footprint is considerably more patchy. ~~✗~~. We consider it is too early to definitively state whether such effects should be taken into account in developing PES AIP algorithms and indeed whether the approach is extendable to reduce exclusion zones between terrestrial fixed links, but urge Ofcom to liaise with the University of Surrey to determine whether their research has wider applicability.

Question 14 Do you agree that the benefits of implementing geographic pricing are sufficiently high to warrant us considering this further? Should we look at both where mobile is, and is not, an alternative use? Do you have ideas on how this could be implemented?

Vodafone agrees that the benefits of geographic sharing are high enough to factor it into the AIP algorithm, and in the case where there is a potential alternate use, consider it absolutely essential. Whilst the propagation characteristics of 1.4 GHz are such that its use would be relatively widespread, 3.6 - 3.8 GHz mobile access is more likely to be used in urban/suburban areas, and it would be wholly wrong to penalise satellite applications in remote areas where there is no practicable chance of the alternate mobile usage being deployed.

In this context, while Plum's proposal of a 100km x 100km grid may have superficial attraction in terms of simplicity, it could prove to represent a competitive market distortion. For example, Vodafone operates an earthstation at Whitehill in rural Oxfordshire – whilst it is unlikely that the alternative usage of mobile access at 3.6 – 3.8 GHz would be deployed in this location, a 100km x 100km grid would define this earthstation as being in the same location as the urban areas e.g. Oxford, Swindon and possibly Milton Keynes, therefore being subject to a high AIP. In contrast, earthstations at the geographic extremities of Britain would enjoy a significant discount – this would serve to distort what is a competitive market for earthstation provision.

Therefore, Vodafone is supportive of the implementation of geographic pricing, but the criterion should be whether the link falls into pixels of a 10km x 10km grid incorporating urban areas. We do not consider that creating such a grid would be an onerous task on Ofcom's part.



Question 15 Do you have any comments to make on any issues related to next steps and implementation?

Vodafone is supportive in principle with the next steps outlined by Ofcom. However, we consider that the immediate steps should be to consider whether AIP should apply at all in certain bands, and to revisit the LCA in light of the information we've provided of how we would mitigate inability to get access to our preferred band.

Vodafone UK
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