

# Ofcom's determination of the Annual Licence Fee for H3G's spectrum at 3.4 and 3.6 GHz

Report for Vodafone

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## 1. INTRODUCTION

On 17 December 2018, Ofcom published a Consultation on the determination of "Annual Licence Fees for UK Broadband's 3.4 GHz and 3.6 GHz spectrum". Vodafone has asked CRA to provide comments on Ofcom's question 2 of the consultation.

*Do you have any views on our provisional conclusion to use the marginal opportunity cost to other users to calculate the lump sum value for the purposes of setting ALFs for these bands?*

Our central view, as set out in this document, is that Ofcom is incorrect in its belief that it has computed the marginal opportunity cost to other users on the basis of bids made in the 2018 2.3 GHz / 3.4 GHz auction. Instead we show that the marginal opportunity cost to other users is most likely higher than in Ofcom's assessment.

Our short report is structured as follows. Section 2 presents our central argument that Ofcom is not measuring the marginal opportunity cost. Section 3 shows that this makes Ofcom's assessment inconsistent with its position regarding ALFs in the 900 MHz and 1800 MHz bands. Section 4 discusses bidding behaviour in the 2.3 GHz / 3.4 GHz auction, which in our view confirms that it is unlikely that bidders' bids reflect marginal value. In Section 0 we argue that the higher alternative value considered by Ofcom (£37.8m rather than £31.1m for 5 MHz of spectrum) is an ALF that, as a marginal valuation, is still most likely below the market value of H3G's un-auctioned ALF spectrum but is more likely to lead to an efficient allocation of spectrum.

## 2. OFCOM IS NOT MEASURING THE MARGINAL OPPORTUNITY COST TO OTHER USERS

### 2.1. Ofcom's valuation proposal

With its acquisition of UK Broadband, H3G became the licence holder of 40 MHz of spectrum at 3.4 GHz and 80 MHz at 3.6 GHz. In its Consultation, Ofcom proposes to set H3G's Annual License Fee (ALF) on that spectrum with reference to the 3.4 GHz auction completed in April 2018 (a SMRA auction). Ofcom identifies a "market clearing price" in that auction of £37.8m per 5 MHz block. This price corresponds to the bid at which H3G dropped its demand from 30 MHz to 20 MHz and the auction was terminated. Ofcom further identifies a "marginal opportunity cost to other users" of £31.1m per 5 MHz block, corresponding to the last bid at which a bidder other than H3G demanded more spectrum than

they eventually got in the auction – this was when Telefónica last submitted a bid for 11 blocks of 5 MHz (equivalent to 55 MHz), before dropping to 8 blocks (equivalent to 40 MHz) when the price was raised to £32.7m per block and it had lost most of its standing high bids at the cheaper price. Ofcom’s provisional view is to base the ALF on the lower of the two values, i.e., the estimated “marginal opportunity cost to other users” of £31.1m per block. We note that the difference between the two approaches is in excess of 20% and therefore substantial.

## **2.2. Ofcom assumes that bids in the 2.3 GHz / 3.4 GHz auction report bidders’ marginal valuations**

As recognized in the Consultation Document, there are various pros and cons to the use of both measures of market value (in fact it is not clear how Ofcom weighed these pros and cons to reach the view that the use of “marginal opportunity cost to other users” is preferable over the use of the “market clearing price”).

However, there is one aspect that is missing in Ofcom’s discussion, namely the accuracy with which the two measures can be estimated: there is not much use in finding that a given theoretical measure is preferable to another if we can compute the latter, but not the former. This is precisely the case here.

While there is little uncertainty as to what the “market clearing price” is (it is, within a range of up to one bid increment, the price at which the auction closed and therefore the price that was actually paid for the spectrum), the “marginal opportunity cost to other users” is a theoretical notion whose value must be estimated from the bids in the auction (or possibly other sources).

In fact, Ofcom’s procedure to estimate the “marginal opportunity cost to other users” from the bids is not well-founded and is very likely to lead to an underestimation of the true marginal value. Ofcom implicitly assumes that the bids in the auction report the bidders’ true marginal valuations for the corresponding quantities of spectrum. In the specific case, Ofcom is assuming that Telefónica’s valuation for an additional three 5 MHz blocks of spectrum in the 3.4GHz band (on top of the 40 MHz they eventually won) is less than £32.7m per block because Telefónica dropped its demand for those blocks when the price per block increased from £31.1m to £32.7m.

## **2.3. In general, multi-unit uniform price auctions such as the 2.3 Ghz / 3.4 GHz auction incentivize early demand reduction**

This implicit assumption of “truthful bidding” does not take into account the balance of incentives that Telefónica faced when dropping demand from 11 to 8 blocks. In particular, Telefonica may well have estimated at that point that it was unlikely to win more than 40 MHz (8 blocks) in total, but risked escalating the price it had to pay for the eight blocks it won. It is a standard result in economic theory

that bidders may indeed have an incentive to engage in this kind of demand reduction in auctions of this type (multi-unit uniform price auctions)<sup>1</sup> – a result that is also supported by experimental evidence.<sup>2</sup>

The incentives are particularly strong in the closing stages of an auction (where the excess demand is known to be approaching zero), and are even stronger in the case where a bidder has to manage budget across two or more auction categories. Both of these additional considerations applied in Telefonica's case, as we shall show below. This implies that such bids are likely to underestimate the true marginal valuations of the bidders.

In general terms,<sup>3</sup> demand reduction in a multi-unit uniform price auction can be explained as follows. A multi-unit uniform auction such as the SMRA used by Ofcom is an extension of a single-object second price auction, since the price paid is equivalent to the highest losing bid. Therefore, analogous to a single-object second price auction, for the first block in a multi-unit uniform price auction, bidders have incentives to bid their value (or, in SMRA terms, to stay in the auction until their bid equals their value). This is no longer true for additional blocks. For additional blocks beyond the first, there is a knock-on effect of increasing the bid (in SMRA terms, of maintaining blocks as the price increases). If a bidder increases a bid, he increases the probability of winning the block, but he also increases the price of his own 1<sup>st</sup> block in the situation in which the increased bid becomes the highest losing bid and the bidder only ends up with one block. The bidder takes the effect of his bidding on the price of his "infra-marginal blocks" into account in his bidding strategy and reduces his bid accordingly. The description highlights why such demand reduction is particularly strong towards the end of an SMRA auction: towards the end, the probability that an increased bid becomes the highest losing bid is very high.

Such demand reduction is not a symptom of collusion, nor need it be seen as an attempt to engineer reciprocal demand reductions from other bidders. Further, in general it will still lead to an efficient auction outcome in the sense that those bidders who value the spectrum most will also win it.

Bidders are in our experience very reluctant to reduce demand below what they think they can realistically win. More typically in the closing auction stages, bidders can anticipate where the auction is heading and realises that any bids for excess blocks (more than he can reasonably expect to win) will influence the price to be paid on the likely winning blocks, and the bidding strategy is adjusted accordingly.

## 2.4. Applying the logic of demand reduction to the 2.3 GHz & 3.4 GHz auction

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1 These are auctions for multiple units of the same type of object where bidders may value winning more than one unit (multi-unit) and all winning bidders pay the same price per unit (uniform price). The SMRA format chosen by Ofcom for the 2.3 GHz & 3.4 GHz auction falls into this category. The small deviations from uniform prices in the 3.4 GHz auction are immaterial. Some of the papers showing incentives for strategic demand reduction (i.e., reducing the volumes demanded at a given price in order to drive down the final auction price) are Ausubel et al (2014) "Demand Reduction and Inefficiency in Multi-Unit Auctions", *Review of Economic Studies*, Riedel F. and E. Wolfstetter (2004), "Immediate Demand Reduction in Simultaneous Ascending Bid Auctions", CESifo WP 1315.

2 See for example Engelmann D. and V. Grimm (2009), "Bidding Behaviour in Multi-unit Auctions – An Experimental Investigation", *The Economic Journal*, vol. 119.

3 The discussion in this paragraph draws on V. Krishna (2002), *Auction Theory*, Section 13.4

### **3. INCONSISTENT TREATMENT OF THE 900 MHZ & 1800 MHZ ALF VS. THE 3.4 GHZ & 3.6 GHZ ALF**

In the section above, we have shown that, in general, multi-unit uniform price auctions such as the format chosen by Ofcom for the 3.4 GHz & 3.6 GHz PSSR auction exhibit rational demand reduction strategies. This implies that one cannot equate “marginal valuation” with the “highest losing bid”, since the highest losing bid tends to underestimate the valuation of the bidder.

#### **3.1. Comparison with CCA Format**

This contrasts with the properties – at least to first approximation – of the Combinatorial Clock Auction (CCA) which Ofcom chose for the 800 MHz & 2.6 GHz 4G auction. That auction was an explicit second price auction, in which the prices paid by the bidders were the minimum prices the bidders would have had to bid in order to win their winning combination. In that auction, bidding to one’s valuations appears to be a more rational bidding strategy (as it would be in a pure Vickrey auction).

In practice, in a CCA, there are still reasons to distrust that losing bids truly reflect marginal value, but it is the opposite risk: bidders have an incentive to exaggerate their losing bids in order to increase the prices paid by competitors, without increasing their own prices.

We refer to the literature on this issue, see in particular “Price Distortions in Combinatorial Clock Auctions, a Theoretical Perspective” (Maarten Janssen, 2015), “Raising Rivals’ Cost in Multi-unit Auctions” (Maarten Janssen and Vladimir Karamychev, 2016) and “Spiteful Bidding and Gaming in Combinatorial Clock Auctions” (Maarten Janssen and Vladimir Karamychev, 2016).

#### **3.2. For the determination of ALF, Ofcom mixes different auction formats as if they had the same bidder incentives**

In its consultation on 900 MHz & 1800 MHz ALFs, Ofcom makes use of the 800 MHz & 2.6 GHz 4G auction as a reference in the same way the 2.3 GHz & 3.4 GHz auction is used as a reference for the 3.4 GHz & 3.6 GHz ALFs. Ofcom spends a considerable effort in isolating various measures of “market values”. It develops and applies the methodologies of a decomposition of 4G auction price by hand; the derivation of the opportunity cost by hand using an “Additional Spectrum Methodology” and the decomposition method (put forward by Vodafone); the analysis of price signals provided by 2x5 MHz and 2x10 MHz increments of 800 MHz; linear reference prices; and marginal bidder analysis for 800 MHz.

In our understanding, all of these methods rely on the assumption that bidding in the CCA reflects valuations. From a theoretical point of view, such an assumption could be better supported in the CCA format, though with the risk that the price signals so-derived overestimate marginal values, because of the effect of inflating rivals’ costs identified above.

But the CCA format and the SMRA format do not provide the same bidder incentives and so do not have the same direction of error when attempting to infer marginal value from losing bids. There is a potential for serious distortion in setting ALF for one set of operators by way of analysis that tends (if anything) to over-estimate marginal value; and then to set ALF for another operator (in another band) using analysis which tends to under-estimate marginal value.

Therefore, Ofcom not only mistakes certain bids for marginal valuations in the 2.3 / 3.4 GHz auction as we highlighted in our section above, but also interprets bids in the two auction formats equally, although one would expect different bids in each of them – even if, hypothetically, the same spectrum were sold.

### **3.2.1. International benchmark auction formats are not investigated with the same scrutiny and are instead market prices are taken as reference**

We also observe that in its analysis of international auctions, Ofcom has consistently used prices paid (most specifically the ratios between prices paid) to infer the market value of spectrum, rather than attempting to identify the marginal (losing) bids in the international dataset. Indeed, Ofcom does not carry out an assessment of bidding incentives in each of the benchmark European auction formats. Given that European benchmarks rely on prices paid, we believe that for overall consistency it would be better to also use prices paid when making inferences from UK auctions as well. In that way, one departs from the goal to infer valuations and instead consistently relies on readily available market prices, for both benchmarks.

Alternatively, if Ofcom were going to try to use a “highest losing bidder” methodology to infer marginal value from UK SMRAs, then consistency would dictate that Ofcom would need to re-analyse the entire international dataset of SMRAs that was used when setting the 900/1800 ALFs.

## **4. BIDDING BEHAVIOUR IN THE 2.3 GHZ / 3.4 GHZ AUCTION**

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## **5. USING A VALUATION OF £37.8M IS EFFICIENT AND CONSERVATIVE WITH REGARDS TO MARKET VALUE**

So far, we have argued and illustrated that, from a theoretical point of view, Ofcom confuses bids made in a multi-unit uniform price auction with bidders’ valuations; and that in the reference 2.3 GHz / 3.4 GHz auction, certain bidding behaviour can be observed which further suggests that bidding did not reflect valuations.

We have however so far not proposed a higher bid that Ofcom could use as a reference price. We think that there are good reasons for using the £37.8m that Ofcom considers as its alternative. In our view, such a figure would appear to be conservative for at least three reasons.

Firstly, as even Ofcom admitted, £37.8m is a conservative estimate of the market clearing price. In our view this is not only because Telefónica made a further bid of £39.7m per block, but also because of the bid shading incentives (which applied to all bidders) discussed in the previous sections.

The benefit of using market clearing price vs. values inferred from bids as a reference is that it is an objective measure. Bidders behaved as they did and as we described, but by the end of the auction, the spectrum was sold at a price that bidders accepted.

Secondly, we would expect that H3G’s valuation decreases with increasing spectrum. It has 120 MHz of similar spectrum. When it was willing to participate in the auction and bid £37.8m (in the knowledge that it would need to pay ALF on the UK Broadband spectrum), one would usually believe that its valuation for the existing spectrum is higher than £37.8m.

A third reason for believing that the figure of £37.8m is reasonable is that Ofcom is using a measure of the marginal valuation of spectrum for valuing a very large spectrum holding. A true market mechanism would have seen the introduction of all of UK Broadband’s spectrum into an auction. This would have increased supply in the auction from 150 MHz at 3.4 GHz to 190 MHz, and it would have added 80 MHz of spectrum at 3.6 GHz. While one might believe that an increase in supply would lead to lower prices, demand (more precisely, H3G’s demand) would also have been higher in this hypothetical “auction all spectrum” scenario.

The correct comparison would thus be to find auction closing prices under an outcome where H3G is the winning bidder for 60 MHz of spectrum at 3.4 GHz and 80 MHz of spectrum at 3.6 GHz. In order to win such a large range of spectrum, H3G would have had to outbid all the other operators, i.e. it would have needed to force them to reduce their demand very much earlier than it did itself, since Telefónica and EE only won 40 MHz of spectrum and Vodafone only 50 MHz of spectrum at 3.4 GHz.

Achieving such highly asymmetric spectrum wins in a SMRA auction can be expected to lead to extremely high prices. When one considers the distribution of spectrum allocations across countries, often one finds that spectrum holdings acquired through auctions correspond quite well to the market structure in the mobile markets. Firms with a larger market share usually have slightly larger spectrum holdings than smaller firms, but differences are often not dramatic. Indeed, much consolidation in the European mobile markets affected firms that had relatively small spectrum holdings. This is natural if one thinks of spectrum as “capacity” to offer mobile services in the market. Larger firms have higher customer densities in their cells and therefore, other things equal, need more spectrum. In our experience, when bidding in an auction, operators often consider that post-auction spectrum market shares should bear a relation to mobile market shares downstream. For this reason, one would expect that it would be very difficult and costly to achieve a spectrum distribution highly skewed towards the smallest operator, if all spectrum were auctioned.

A recent example of the price increase caused by asymmetric spectrum allocation is the Italian combined 700 MHz / 3.7 GHz / 26 GHz licence award with official results published on 9 October 2018. In that auction, Telecom Italia and Vodafone eventually won 80 MHz of 3.7 GHz spectrum each, while Wind Tre and Iliad Italia won 20 MHz each. The average 5 MHz price was around €108m or relatively close to £100m and therefore around 2.5 times the price of 5 MHz for a 3.4 GHz block in the UK 2.3 & 3.4 GHz auction.

Since the purpose of ALF is to reproduce (as much as possible) the market price that an operator would have likely had to pay to buy their spectrum at auction, we see that the actual 3.4 GHz auction price appears to be a very conservative estimate of ALF.