dot·econ

800MHz and 2.6GHz linear reference prices and additional spectrum methodology

Report prepared for Ofcom

September 2013

DotEcon Ltd
17 Welbeck Street
London W1G 9XJ
www.dotecon.com

Content

Tables & Figures

1 Introduction

Ofcom has been directed by the government to revise annual licence fees (ALFs) for 900MHz and 1.8GHz spectrum after completion of the 4G auction in January 2013 with the requirement that the ALFs should be set in a way that reflects the full market value of this spectrum. To do this the methodology should have regard to the sums bid for 800MHz and 2.6GHz licences in the UK 4G auction.

In a statement in July 2012, Ofcom published its thinking at the time on how to estimate full market value.[1] Ofcom stated that it intended to consider results from applying the linear reference price methodology (LRPM) and the additional spectrum methodology (ASM) to the UK 4G auction, alongside values from auctions for comparable spectrum in other countries. These methods are described in detail in Annex 10 to the March 2011 consultation[2] and Annex 12 and 13 to the January 2012 consultation[3].

In light of the direction given to Ofcom by the government, the successful completion of the UK 4G auction and subsequent publication of auction data, Ofcom has asked us to:

- develop one or more software modules to process the 4G auction bids data to determine price points according to the LRPM and ASM;
- to use the module(s) with the actual UK 4G auction data published by Ofcom as inputs and provide Ofcom with the output of the software; and
- to provide a commentary on the results.

We have developed software, which produces price points using both the LRPM and ASM. We have used the UK 4G auction data published by Ofcom as inputs into this software to derive price points as an output. This report presents the results obtained from both methodologies and provides our commentary on the results.

---

[1] Ofcom, Assessment of future mobile competition and award of 800 MHz and 2.6 GHz, 27 July 2012: http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/statement.pdf.

[2] Ofcom, Consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues, March 2011, http://stakeholders.ofcom.org.uk/consultations/combined-award/

[3] Ofcom, Second consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues, http://stakeholders.ofcom.org.uk/consultations/award-800mhz-2.6ghz/

The report is structured as follows:

- In Section 2 we highlight the fundamental problem of deriving linear prices from the results and bids in a combinatorial auction;

- In Section 3 we summarise the mechanics of the ASM and LRPM and provide explanation on how we applied these two methods to the UK 4G auction bid data. We then discuss the limitations of each approach in the context of the UK 4G auction and present some alternatives.

- In Section 4 we present the results from the ASM and LRPM. We also provide commentary on these results.

2 Fundamental issues

The UK 4G auction was a combinatorial auction in which bids were made for indivisible packages of lots. The base prices determined in the principal stage of the auction were determined using a second-price approach.[4] Rather than determining prices for the component lots within each package, prices are determined that are specific to each winning package and apply to the overall package of lots won.

The second-price approach in a combinatorial auction means that the winning price for a bidder is determined by competition from other bidders, so the set of relevant bids determining prices varies bidder by bidder. In general, it may be impossible to allocate lots efficiently if a uniform price (i.e. the same per lot price for all bidders) is imposed as this may result in lots going unsold unnecessarily. This is illustrated in Box 1.

---

[4] In the principal stage of the auction, bids were made for generic lots whose specific frequencies were determined in a follow-up assignment stage. Exceptionally, certain lot categories (e.g. the A1 800MHz coverage lot) had pre-specified frequencies known in the principal stage.

Box 1: Simple example where an efficient allocation cannot be supported by uniform prices

There are 3 lots available within a single band. The following bids are received from three different bidders (Bidder A, Bidder B and Bidder C):

- A bids £20 for 2 lots
- B bids £12 for 2 lots
- C bids £8 for 2 lots and also £3 for 1 lot

The winning combination maximises the sum of winning bids taking at most one bid from each bidder:

- A wins 2 lots; and
- C wins 1 lot.

The sum of winning bids is 23.

To determine A's price, we find the alternative winning combination had A not taken part in the auction. The alternative winning combination of B's and C's bids is as follows:

- B wins 2 lots; and
- C wins 1 lot.

The sum of alternative winning bids had A not participated is 15. Hence all other bidders could be made better off by 15 - 3 = 12 had A not won its 2 lots. Allocating these two lots to A means B's bid of 12 for two lots cannot be satisfied. A is required to pay 12.

Had C not participated, A would still win 2 lots. The value denied to other bidders from allocating one lot to C is thus zero.

There is no linear price per lot that support this outcome:

- At a price per lot above £4, C prefers nothing; however
- The price needs to be at least £6 per lot otherwise B would not be a happy loser.
- C needs to receive a 'discount' in order to be willing to buy the single lot that is of lower value on a per lot basis

This issue is entirely to do with synergistic valuations (in this case those of B, who only wants two lots). It cannot occur if all bidders had declining marginal valuations.

The question "what is this lot worth?" may simply be ill-defined, as the value depends on what other lots it is combined with. In the example above, two lots in combination are more valuable than a single lot, with the result that there is no uniform price per lot compatible with the auction outcome.

There are certain special assumptions under which this issue can be avoided. In a situation in which valuations of all bidders exhibit declining marginal valuations (i.e. the valuation of a lot is only reduced by winning other lots as well), we can always find a price per lot for each category that supports an efficient allocation of lots. However, outside these special circumstances – such as where the marginal valuations are increasing due to synergies across lots – it is

possible that there may be no uniform linear price that supports an efficient allocation.[5]

Given this fundamental limitation, it is important to recognise that any methodology for constructing prices for individual lots does not create a set of prices that necessarily supports an auction outcome, in the sense that bidders would choose their winning packages if faced by those prices. Therefore, any linear pricing methodology involves compromises and approximations, as we shall explain when considering the different possible methodologies.

---

[5] An outcome is "supported" by a set of prices if the bidders would choose their winning packages if presented with the choice of buying whatever lots they liked paying at those supporting prices. This assumes that the bids made by bidders represent their true preferences, so that a bidders demand for lots at given prices can be found by selecting their surplus maximising package (i.e. the package that maximises the bid amount less the cost of the lots at the supporting prices).

3 Approaches for developing uniform per lot prices

The ASM and LRPM are two possible methods of determining approximate per lot prices in a combinatorial context. They are representatives of broader classes of methods, which can be divided into two groups:

- **Revenue-attribution methods.** These methods aim to allocate out the revenue raised in the auction to create an "average" per lot price. For example, a form of average price can be obtained as a simple linear fit of the base prices to linear per lot prices. A more sophisticated alternative would be to take into account information from losing bids to determine the competitive pressure on the individual categories when determining these "average prices". This is the essence of the LRP methodology.

- **Shadow-price methods.** These methods are based on the concept of shadow prices arising within constrained optimisations, such as the selection of winning bids subject to the constraints of lots available. The shadow price is the change in the objective value obtained by relaxing or tightening a constraint. For example, we might consider the additional value created by hypothetically making extra spectrum available within the auction for specific bidders (Ofcom's Additional Spectrum Methodology) or by hypothetically increasing the spectrum generally made available in the auction.

None of these methods can 'solve' the issue that a linear price for each lot category that supports the auction outcome may not exist. However, they can try to smooth out the variations in lot value that may be created by lots being packaged differently.

3.1 Revenue attribution methods

Where it is not possible to support an efficient allocation through uniform lot prices, we can think about some lots effectively needing to be 'discounted' relative to per lot price so that they do not go inefficiently unsold. The earlier example (see Box 1 above) demonstrates this. It is always possible to set a uniform per lot price that is high enough to choke of demand such that all demand can be accommodated within the available supply. However, such per

lot prices may then result in some lots going inefficiently unsold, creating the need for a 'discount' (and so a deviation from uniform linear pricing).

Any auction revenue attribution method in effect spreads the 'discount' needed to ensure lots do not go inefficiently unsold across all the lots sold. As a result, if there are what might be called 'packing' problems, in that demand cannot neatly fit into the auctioned spectrum, the attributed value of lots will be lowered. For example, suppose that there are an odd number of lots for sale, but bidders much prefer pairs to singletons. In this case, the lot that is sold as a singleton needs to be discounted, lowering the attributed value per lot.

If the packing issues are minor in comparison to the amount of spectrum made available, the impact of spreading such discounts is not important. This would be the case in a situation in which 101 lots are available and bidders much prefer pairs.

However, if packing issues are important and lower attributed value, this might mean that the marginal value of lots once they are within reasonable packages is understated. For example, if five lots are auctioned and bidders are most interested in pairs with a low value for a single lot. This could lower the attributed value by up to 20%. However, this uniform price would not reflect the true marginal value of a pair.

These issues apply to any revenue attribution method, but they are primarily an issue of balance between different lot categories, as the total revenue must be allocated in full. For example, if one category has significant packing issues, but another does not, the attributed lot price in the first category could potentially be depressed relative to the second.

3.1.1 Simple linear fit

A simple approach to determine a uniform price for each lot category is to fit a linear model of base prices:

$$b_i = \sum_j p_j q_{ji} + \varepsilon_i$$

where:

- b_i is the base price of bidder i;
- p_j is the price per lot of category j;
- q_{ij} is the number of lots won by bidder i in category j; and
- ε_i is a residual term which captures the part of the base price that cannot be explained by the linearised package price $\sum_j p_j q_{ji}$.

Best-fit linear prices are those prices that minimise the sum of squared errors in the following optimisation problem:

$$\min_{p} \sum_{i} \varepsilon_i^2 \ \text{ subject to } \sum_{i} \varepsilon_i \ = 0$$

By requiring that the errors sum to zero, the per lot prices allocate out the total base prices paid by winners.

The advantage of this method is that the only input required is the base prices and winning packages. Given that the bid data has not been published for a number of CCAs (such as the Dutch multiband auction in 2012 or the Swiss multiband auction in 2012), this method would still allow to determine a linear price per lot for each category for these auctions based on the winning outcome alone.

The disadvantage of this method, however, is that it does not take into account information about competition from losing bids for lots in each category.

3.1.2 Linear reference prices

The purpose of the linear reference price method is to identify a unique linear price for each lot type that best explains the auction outcome given the preferences expressed by the bids subject to the condition that it recovers the same revenue overall. The method uses information from both winning and losing bids.

The idea behind this method is to suppose that we had hypothetical linear prices and then that bidders choose their most preferred package at those prices. It may be necessary to subsidise a winning package to induce each winner to choose that package at those prices. We call the amount of this subsidy the 'excursion' associated with these linear prices. Total excursions across all bidders are minimised through the choice of linear prices. Therefore, even though the resulting linear prices might not support the auction outcome (in the sense defined earlier) they are nevertheless the linear prices that *best* support the outcome given the revenue condition, in that overall incentives for bidders to prefer some other outcome are minimised.

More formally, let there be K categories that were sold in the principal stage.[6] There are I bidders labeled $i = 1, \ldots, I$. Bidder i makes bids (β_{ij}, x_{ij}) where β_{ij} is the bid amount of the jth bid and x_{ij} is the package bid for. Conventionally, each bidder's set of bids includes a zero bid (i.e. a bid of amount zero for an empty package) representing the possibility of that bidder losing. Let $(\beta_i^{\star}, x_i^{\star})$ be the winning bid by bidder i, where $x_i^{\star} = 0$ for a losing bidder.

Let α_k denote the candidate linear price of a lot in category k and α the vector of these prices. Let ρ_k be the reserve price for lot category k and ρ the vector of reserve prices.

The first step in the determination of the LRPs is to find the LRPs which minimise the following linear programme:

$$\min E = \sum_{i=1}^{I} \varepsilon_i$$
$$s.t.$$
$$\varepsilon_i \geq \left(\beta_{ij} - \alpha \cdot x_{ij}\right) - (\beta_i^{\star} - \alpha \cdot x_i^{\star}) \forall i, j$$
$$\sum_{i=1}^{I} \alpha \cdot x_i^{\star} = R$$
$$\alpha_k \geq \rho_k \forall k$$

where R is the revenue from the principal stage and E is the minimum sum of excursions.

This linear programme identifies a set of LRPs that minimises the sum across bidders of the maximum excursion for each bidder. This is subject to the winning packages summing to the minimum revenue at these LRPs and the constraint that LRPs are no lower than respective reserve prices.

If there is more than one set of LRPs which miminises the sum of maximum excursions for each bidder, the set of LRPs is chosen which minimises the sum of squared differences relative to reserve prices:

---

[6] Note that categories in which no lots were allocated in the principal stage are ignored in this analysis. In the auction, there was no winner for lots in categories D1 and D2. These categories therefore do not feature in the LRP determination. This means that any bids for packages including lots in D1 or D2 are considered to be for the sub-packages that do not include D1 or D2. For example, a bid for one A1 lot, four C lots and a D2 lot is considered to be a bid for one A1 lot and four C lots.

$$\min_{\alpha} \sum_k s_k \rho_k \left(\frac{\alpha_k}{\rho_k} - \lambda\right)^2$$

$$s.t.$$

$$\varepsilon_i \geq \left(\beta_{ij} - \alpha \cdot x_{ij}\right) - \left(\beta_i^\star - \alpha \cdot x_i^\star\right) \forall i, j$$

$$\sum_{i=1}^{I} \varepsilon_i = E$$

$$\sum_{i=1}^{I} \alpha \cdot x_i^\star = R$$

$$\alpha_k \geq \rho_k \forall k$$

where $s_k = \sum_{i=1}^{I} x_{ik}^\star$ is the sum of all sold lots in category k.

The parameter λ is determined by its derivative condition as $\lambda = R/(\sum_{i=1}^{I} x_i^\star \cdot \rho)$.

This step in the LRP determination resolves any uncertainty in the calculation of prices resolves by aligning prices to be as close as possible to a multiple of the reserve prices.

The LRP approach uses information from the losing bids as well as the winning bids, as losing bids constrain the linear prices that explain the outcome. This is a distinct advantage over the much simpler linear regression approach as more information is being used from the bid data.

The LRPs are fairly robust in the sense that small perturbations of most losing bids amounts do not affect the resulting LRPSs. This is because, for each bidder, there are (barring non-generic knife-edge cases) two possibilities:

- The winning package would be chosen if faced by the LRPs, in which case that bidder's winning and losing bids have no effect on the LPRs (for small bid perturbations) for given auction revenue R;

- The bidder would choose a package different to its winning package if faced by the LRPs, in which case the LRPs are affected only by the difference between winning bid amount and the bid amount for the most preferred package, but not any other bids (again for small bid perturbations).

Because LRPs are not considering hypothetical situations in which additional spectrum is made available (unlike the ASM), LRPs are not systematically affected by binding spectrum caps that limit the potential demand that any bidder could express for lots additional to its winning package. (This is not to say that there may not be effects, but these are complex.)

The disadvantage of the LRP method is that a low LRP for a category may simply reflect some packing problem within an auction. Where different categories have packing problems to different extents, the

resulting relative differences between these LRPs might not reflect the true relative value differences.

A very specific issue in the UK 4G auction was the discount given for H3G's single A1 lot resulting from the competition constraint as we will discuss in Section 4.2.

The LRP method has only been applied to the bid data from the principal stage to determine a linear reference price for each category. In theory, it is possible to use the LRP method for the assignment stage as well to determine the price of a specific frequency block. However, such block values are not informative for pricing 900MHz or 1.8GHz spectrum as they reflect competition for specific assignments in the 800MHz and 2.6GHz bands. Therefore, we do not provide LRP results for the assignment stage here. As the assignment stage prices were paid on top of base prices for spectrum, an argument could be made that they are part of the competitive price paid and so revenues from the assignment stage could be taken into account when determining the price paid for 800MHz or 2.6GHz spectrum. To this end, we provide the average value of each block for these bands in our results.

3.2 Additional spectrum methodology

3.2.1 Overview

The additional spectrum methodology is based on the idea of a shadow price in constrained optimisation. In constrained optimisation, the shadow price of a particular constraint is obtained by determining the change in the objective value when this constraint is relaxed by one unit. The shadow price then tells us what it is worth to relax this constraint by one unit. Where the constraint reflects a resource limit (such as only a limited number of lots being available), the shadow price reflects an implicit marginal valuation of the resource.[7]

This concept can be applied to the winner determination problem, which in itself is a constrained optimisation problem. The constraint we relax is the supply constraint on a particular category. For

---

[7] This concept is more typically used in concave optimisation problems in which a constraint is parametrised by some continuous variable that can be altered infinitesimally. In such a case, the shadow price is simple the corresponding Lagrange multiplier of the constraint. This idea can be generalised to non-concave optimisation problems and situations in which the constraint can only be discretely changed (e.g. adding an exact lot), but calculus-based methods (such as Lagrange's methods) do not then apply.

example, we could hypothetically make one additional lot available in a category and then re-determine the winning bids; the total value of winning bids can only increase by making one extra lot available, with the increase in value being the shadow price of that lot category.

For exactly the same reasons that the value of a lot may depend on what other lots it is packaged with (as we have already discussed), adding different numbers and combinations of hypothetical additional lots can lead to different shadow prices. In the special case that bidders make bids that exhibit diminishing returns (i.e. the value of a lot is only ever reduced by winning other lots with it), it follows immediately that making additional hypothetical lots available will also demonstrate diminishing returns; the increase in value of winning bids on making one additional lot available will exceed that of making a further additional lot available (i.e. two new lots in total). However, where valuations are synergistic (so winning other lots may increase the value of a lot), this does not follow. For example, if bidders are primarily interested in paired lots, and an even number are sold, then adding one additional lot might not increase the value of winning bids much, but adding two might to a much greater extent. Therefore, we need to consider various possible hypothetical increments to the available supply, not just the entire amount available.

This approach can be expanded to consider the potential value of operator-specific holdings that were not included in the auction, such as the holdings in the 900MHz and 1.8GHz bands. The hypothetical question is if we increase the supply of lots in the auction by the spectrum that is held by a specific operator, then what value could have been generated for other bidders. To this end, Ofcom proposes to treat spectrum already held by operators (900MHz and 1.8GHz) as if it were additional lots in broadly corresponding bands:

- Adding 900MHz blocks as additional 800MHz;
- Adding 1.8GHz blocks as additional 800MHz or additional 2.6GHz paired.

Ofcom's proposed methodology excludes the bids made by the bidder releasing spectrum and its winning bid (i.e. in effect constraining the hypothetical outcome to one where the releasing bidder wins the same package as in the auction outcome). This procedure is described in Ofcom's consultations and is adopted in the results given below. The effect of excluding these bids is that the value of spectrum released by a bidder is determined only by bids from rival bidders, not by demand from the bidder itself for spectrum additional to what it had already won.

3.2.2 Calculation method

Ofcom describes the ASM in detail in Annex 13 to the second consultation. The following description is a more formal summary of the mechanics of the calculation.

To determine the additional value generated by the current holdings of a specific operator, we proceed as follows:

i.   Determine the baseline bid amount as the total amount of winning bids of all winners other than the specific operator being considered;

ii. Determine the baseline spectrum on offer. This comprises of all the spectrum on offer in the auction less the amount of spectrum won by the specific operator being considered;

iii. The total spectrum available to all other bidders in the re-optimisation of winning bids is then the baseline spectrum plus the current holdings of the specific operator, treated as additional spectrum in either 800MHz and/or 2.6GHz band.

iv. We then determine the highest value combination of bids that could be achieved by allocating this total spectrum to all other bidders based on the bids they submitted. This re-optimisation excludes the bids of the bidder we are considering.

v.   The additional amount that other bidders would have been willing to pay for the current holdings of the specific operator is then the difference between this new total value and the original baseline total bid amount.

3.2.3 Specific considerations

How to treat additions to the supply in the 800MHz band

Spectrum in the 800MHz band was offered in two categories:

- 4 lots of 2x5MHz in category A1; and
- 1 lot of 2x10MHz in category A2. The winner of this lot is required to serve roll-out obligations.

The development of the primary bid rounds as well as the eventual base prices suggests that the spectrum in both categories was

broadly similar in value (per MHz).[8] This means that whether hypothetical additional 800MHz spectrum were offered as additional A1 or A2 lots is not critical, as coverage obligation does not appear to have affected the value of A2 much.

To address this issue of whether additional hypothetical 800MHz spectrum should be treated as A1 or A2 lots, we have considered three possible approaches:

- Approach 1: Collapse the distinction between A1 and A2 in the bids made and re-formulate the auction as if there were just a single 'A' category of 2x5MHz lots at 800MHz. Note that this does not change the outcome of the auction in the specific case at hand. There is then no need to split additional 800MHz lots between A1 and A2 as the distinction has gone. Set the reserve price of an 'A' lot at £125m which is half the reserve price of A2.

- Approach 1b: As Approach 1, but use a reserve price of £225m which is the reserve price for A1.

- Approach 2: Turn extra 800MHz lots into extra A1 and A2 lots in all the possible ways and then take the highest value outcome;

The difference between Approaches 1 and 1b is that in the latter case we may have to exclude some bids from Telefónica for the A2 lot, as they would fall below the higher reserve price. If unallocated lots are valued at reserve in the re-optimisation, Approach 1b would lead to a different additional value if lots do go unsold in the reoptimised outcome.

We argue below that the value of unallocated lots should not be taken into account in the re-optimisation for the purposes of assessing the value of additional hypothetically available spectrum. We therefore focus on Approach 1 rather than 1b, as this ensures that we take into account all bids made in the auction.

Regarding Approach 2, it should be noted that A1 and A2 had very similar value in the actual auction, so in practice it should not matter whether we add A1 or A2 as long as bidders submit equivalent bids for packages including A1 and A2. If there is a significant cost associated with serving the coverage obligation, we expect adding A1 instead of A2 to generate at least as much value as the equivalent additional A2 cases. Using all combinations of additional A1 and A2 simply ensures that we do not miss the 800MHz demand

---

[8] Two bidders switched between A1 and A2 lots largely on the basis of their relative per MHz prices, suggesting that the two lot categories were close to perfect substitutes.

that a bidder expressed for A2 but where this bidder did not submit an equivalent bid for A1 lots.

Impact of caps on demand for additional hypothetical spectrum

If we are considering the additional value that could be created from more spectrum, then this must come from at least some bidders winning more spectrum than they won in the initial outcome. This is not to say that some bidders might not win less than in the original outcome (as it might be optimal to reorganise the winning bids), but not all winners can win less (otherwise the original outcome could not have been optimal).

However, if the additional value of additional spectrum necessarily comes from at least some bidders winning more, we then need to consider the impact of spectrum caps. There may be little competition for hypothetical additional spectrum due to spectrum caps preventing bidders from bidding for packages larger than their winning packages. This becomes more important the greater is the amount of spectrum hypothetically released, as there is correspondingly less opportunity for bidders to acquire this spectrum without breaching spectrum caps.

In the auction, the winning packages resulted in:

- Vodafone and Telefónica being at their caps for 800MHz spectrum; and
- EE being at its overall spectrum cap (across 800MHz and 2.6GHz).

The additional value for 800MHz spectrum in the re-optimisation of winning bids has to come from allocating larger packages to EE and H3G. Both EE and H3G expressed demand for more 800MHz spectrum than they won. EE bid for up to 2x20MHz, but won 2x5MHz and H3G bid for up to 2x15MHz but won 2x5MHz.

Arguably, if additional spectrum had been available then even if the caps were the same, there could have been further bids from H3G or other parties. Therefore, the ASM approach may well understate the additional value, especially if considering hypothetical release of larger amounts of spectrum. This is another reason for presenting results of the additional value generated by adding different amounts of additional spectrum for each party currently holding spectrum in the 900MHz and 1.8GHz band.

How to treat unallocated lots in the reoptimisation

Unallocated lots could either be valued at zero or at reserve in the reoptimisation. If unallocated lots are valued at reserve, the value

from adding additional lots to the auction cannot be lower than when these lots are valued at zero. This would, however, treat reserve prices as a lower bound on the minimum opportunity cost of holding spectrum in the 900MHz and 1.8GHz bands.

Valuing unallocated lots at reserve would undermine the idea of ASM being a measure of the opportunity cost of holding spectrum. The ASM aims to establish what other bidders would have been willing to pay for additional spectrum. Clearly if there is little demand for this, this opportunity cost might be lower. In such a case, there is need to then consider whether the ASM might understate market value (for example, as bids for additional spectrum might not have been expressed). However, interpretation of the results is simplest if we derive an opportunity cost measure without reference to the reserve prices of the UK 4G auction.

How to incorporate the competition constraint in the reoptimisation

Should we impose the competition constraint in the re-optimisation of winning bids when additional spectrum is hypothetically made available? If the competition constraint is applied, then this would mean that whenever H3G's bids are included in the reoptimisation, it would be required to win at least one of its minimum-spectrum portfolios.

We understand from Ofcom that whilst the competition constraint was a constraint applied on the 4G auction, it represents a more fundamental view about the outcomes that are compatible with effective downstream competition at present. Therefore, if we were to ask – entirely hypothetically – whether one bidder might buy released spectrum from another bidder, it is reasonable to suppose that similar constraints would apply as to whether the transaction would be acceptable to Ofcom on competition grounds. In this case, the requirement for effective downstream competition should be taken into account when determining the additional value generated by hypothetically reallocating an operator's current spectrum holdings.

3.2.4 Alternative approach to bidder-specific additions to available spectrum

The ASM looks at each bidder holding spectrum and considers hypothetically releasing this spectrum to other bidders. This means that we avoid any impact of a bidder's own bids on the valuation of its existing spectrum holdings.

However, we could ask the much simpler question of what happens if we add one generic lot to the overall supply of 800MHz and

2.6GHz and re-optimise winning bids taking into account all the bids received. This would determine the shadow price of the supply constraint of that category (subject to the discussion above about the impact of valuation synergies on the additional value created by adding different amounts of additional spectrum).

The advantage of this approach is that it determines a uniform value per 2x5MHz that is the same for all current spectrum holders in 900MHz and 1.8GHz, respectively. The ASM on the other hand could lead to very different values for essentially the same spectrum due to differences in the extent of competition for each bidder's hypothetically released spectrum.

The disadvantage of this simpler approach is that it can create what we might call 'self-competition'. This arises because part of the additional value generated by adding the current holdings of a particular party to the available spectrum supply could be determined by the additional value that party attributes to winning a larger amount of spectrum than it won in the auction. If bidders knew in advance of the 4G auction that fees for their existing spectrum holdings would be calculated in this manner, this could create incentives to modify their bids and bid less and/or avoid bidding for packages larger than they expected to win. This concern about incentive distortions within the auction was a reason that Ofcom favoured the more complicated ASM that excludes each bidder considered in its January 2012.

However, now that the auction is complete, it is less clear that this concern about incentive distortions to bidding behaviour is a relevant concern. It is not unreasonable to at least pose the question of what implicit value is placed on an increase in the supply of available lots without differentiating according to who might buy them (as this cannot be the bidder being considered under the ASM). This simpler approach also accords closely with the intuitive notion of a market value.

3.2.5 Hypothetical cases for additional lots

Based on each operator's current holdings, the maximum number of 2x5MHz blocks in the 900MHz band and the 1.8GHz band that could be created from those holdings is set out in Table 1. Any leftover spectrum that is insufficient to create a full 2x5MHz block is ignored for these purposes.

Table 1: Holdings of full 2x5MHz blocks in 900MHz and 1.8GHz

Operator	Number of 2x5MHz blocks held in 900MHz	Number of 2x5MHz blocks held in 1.8GHz
Vodafone	3	1
Telefónica	3	1
EE	0	9
H3G	0	3

Operators' current holdings can then be hypothetically added in different quantities and mixes to the supply of 800MHz and/or 2.6GHz available in the auction. For example, Vodafone's holdings in 900MHz and 1.8GHz can be added as follows:

- An additional 2x5MHz in 800MHz (as either one 900MHz or one 1.8GHz block);
- An additional 2x10MHz in 800MHz (as either two 900MHz blocks or one 900MHz block and one 1.8GHz block);
- An additional 2x15MHz in 800MHz (as either three 900MHz blocks or two 900MHz blocks and one 1.8GHz block);
- An additional 2x20MHz in 800MHz (as three 900MHz blocks and one 1.8GHz block);
- An additional 2x5MHz in 2.6GHz (as one 1.8GHz block); and
- An additional 2x15MHz in 800MHz (as three 900MHz blocks) and an additional 2x5MHz in 2.6GHz (as one 1.8GHz block).

We use an exhaustive list of all possible hypothetical additions to the supply in 800MHz and 2.6GHz that can be achieved within each operator's current holdings. We assume that 1.8GHz spectrum can either be converted to additional 800MHz lots or additional 2.6GHz lots, but not to a combination of both.

 In addition to these operator-specific additions, we also consider a generic case of an additional 2x5MHz in 800MHz and an additional 2x5MHz in the 2.6GHz band without any restrictions on who may win this. The additional spectrum cases we consider are presented in Table 2.

Table 2: Additional spectrum cases considered

Bidder	Additional spectrum case
Vodafone	2x5MHz 800MHz
	2x10MHz 800MHz
	2x15MHz 800MHz
	2x5MHz 2.6GHz
	2x5MHz 800MHz & 2x5MHz 2.6GHz
	2x10MHz 800MHz & 2x5MHz 2.6GHz
	2x15MHz 800MHz & 2x5MHz 2.6GHz
	2x20MHz 800MHz
Telefónica	2x5MHz 800MHz
	2x10MHz 800MHz
	2x15MHz 800MHz
	2x5MHz 2.6GHz
	2x5MHz 800MHz & 2x5MHz 2.6GHz
	2x10MHz 800MHz & 2x5MHz 2.6GHz
	2x15MHz 800MHz & 2x5MHz 2.6GHz
	2x20MHz 800MHz
EE	2x5MHz 2.6GHz
	2x10MHz 2.6GHz
	2x15MHz 2.6GHz
	2x20MHz 2.6GHz
	2x25MHz 2.6GHz
	2x30MHz 2.6GHz
	2x35MHz 2.6GHz
	2x40MHz 2.6GHz

	2x45MHz 2.6GHz
	2x5MHz 800MHz
	2x10MHz 800MHz
	2x15MHz 800MHz
	2x20MHz 800MHz
	2x25MHz 800MHz
	2x30MHz 800MHz
	2x35MHz 800MHz
	2x40MHz 800MHz
	2x45MHz 800MHz
H3G	2x5MHz 2.6GHz
	2x10MHz 2.6GHz
	2x15MHz 2.6GHz
	2x5MHz 800MHz
	2x10MHz 800MHz
	2x15MHz 800MHz
Generic addition	2x5MHz in 800MHz
	2x5MHz in 2.6GHz

4 Results

4.1 Simple linear fit

In this section we present the results of the simple linear fitting method described in Section 3.1.1. The attraction of this method is that it only requires information about the winning packages and prices and not the entire set of bids submitted. Therefore, it can be applied to the results of recent 4G auctions in Europe even where the regulator decided not to publish the bids submitted during the auction.

However, there are some practical difficulties in applying this method. In some auctions, the number of winners is smaller than the number of lot categories; as a result it is impossible to derive linear prices for all lot categories, as the winning bids alone cannot provide sufficient information (i.e. there are too few degrees of freedom). In such situations, it may be possible to reduce the number of parameters to be estimated by assuming that certain lot categories have equal prices (and so the distinction between the categories can be collapsed) or prices are linked in some fixed ratio (e.g. unpaired spectrum is half the price of paired spectrum). However, even when collapsing parameters in this way, there are also cases in which winning bid packages are collinear, which means that some fixed bundle of lots is always bought together. This makes it impossible to ascribe prices to the individual lots within that bundle.

UK 4G auction

The following table presents the results of the UK 4G auction.

Table 3: UK 4G auction results

Bidder	A1	A2	C	E	Base price (in £000)
EE	1	0	7	0	588,876
H3G	1	0	0	0	225,000
Niche	0	0	3	4	186,476
Telefonica	0	1	0	0	550,000
Vodafone	2	0	4	5	790,761

The five winning packages are sufficiently dissimilar to allow us to estimate a linear price for each category. The results are presented in Table 4.

The results of the simple linear fit are not too dissimilar to the LRP results presented in Section 4.2. The A2 category contains one block of 2x10MHz that is associated with a coverage obligation. Compared with the linear price for category A1 (which consists of four blocks of 2x5MHz without a coverage obligation) the linear fit indicates a premium for serving the coverage obligation. This is counterintuitive and is a result of this method not taking into account information from losing bids. The LRP results presented in Section 4.2 attribute a premium of about £31 million to A1 instead.

Table 4: Simple linear fit - UK 4G auction

Category	Linear price (in £)
A1	251,500,000
A2	542,125,000
C	47,160,800
E	14,748,400

Other 4G auctions in Europe

The simple linear fit method can be applied to results of other auctions to determine a linear price for each lot category. In this context, we have considered the results of the following recent 4G auctions in Europe:

- The Irish multiband auction in 2012 in which spectrum in the 800MHz, 900MHz and 1.8GHz band was awarded;
- The Swiss multiband auction in 2012 in which spectrum in the 800MHz, 900MHz, 1.8GHz, 2.1GHz and 2.6GHz bands was awarded;
- The Dutch multiband auction in 2012 in which spectrum in the 800MHz, 900MHz, 1.8GHz, 1.9GHz, 2.1GHz and 2.6GHz bands was awarded; and
- The Romanian multiband auction in 2012 in which spectrum in the 800MHz, 900MHz, 1.8GHz and 2.6GHz band was awarded.

Unfortunately there are insuperable problems in the case of the Dutch and Swiss multiband auction due to the model being underdetermined and there being collinearity. As bids were made for packages of lots, it is also not possible to simply drop categories (such as 2.6GHz unpaired) from the analysis. We will therefore only present results from the Irish and Romanian multiband auctions.

Table 5 presents the results of the Irish multiband auction. Spectrum in the different bands was available in two time slices. Licences in the first time slice cover the period 2013 to 2015 and licences in the second cover the period 2015 to 2030.

Winners of spectrum in the Irish auction were subject to substantial spectrum usage fees. Arguably, these should be taken into account when establishing a market value of the spectrum. We have therefore added the total spectrum usage fees to the final upfront fees.

Table 5: Results of Irish multiband auction

Bidder	800MHz TS1	800MHz TS2	900MHz TS1	900MHz TS2	1.8GHz TS1	1.8GHz TS2	Total price (in 2012 €000)
H3G	0	0	1	1	2	4	105,010
Meteor	2	2	1*	2	2**	3	244,420
Telefonica	2	2	2	2	0***	3	224,570
Vodafone	2	2	2	2	3	5	280,640

Source: ComReg, 2012, Results of the Multi-Band Spectrum auction - Information Notice, available online at: http://www.comreg.ie/_fileupload/publications/ComReg12123.pdf.

★Before the start of the auction Meteor held two 900MHz GSM licences that expire in 2015. Current holders of GSM licences could liberalise these licences by notionally adding them into the auction as additional supply for the respective first time slice

category and then winning them back. Meteor only liberalised one of its GSM licences in the 900MHz band.

**Meteor retained two of its current four 1.8GHz GSM licences on a non-liberalised basis.

***Telefonica retained its three current 1.8GHz GSM licences on a non-liberalised basis.

All winning packages contained the same number of lots in time slice 1 and 2 in the 800MHz band. It is therefore impossible to separate out the prices for the two time slices. We therefore collapse these two categories in the following.

Table 6: Irish auction - collapsed winning packages

Bidder	800MHz	900MHz TS1	900MHz TS2	1.8GHz TS1	1.8GHz TS2	Base price (in 2012 €000)
H3G	0	1	1	2	4	105,010
Meteor	2	1	2	2	3	244,420
Telefonica	2	2	2	0	3	224,570
Vodafone	2	2	2	3	5	280,640

The results of the simple linear fit method for the Irish auction are presented in Table 7.

Table 7: Simple linear fit - Irish multiband auction

Category	Linear price (in 2012 Euro)
800MHz (2x5MHz)	59,993,750
900MHz TS1 (2x5MHz)	0
900MHz TS2 (2x5MHz)	32,570,000
1.8GHz TS1 (2x5MHz)	9,925,000
1.8GHz TS2 (2x5MHz)	13,147,500

H3G paid much less for a winning package that includes 900MHz instead of 800MHz. This is reflected in the linear prices. The linear price for 900/1 is zero as Meteor only won one lot in that category whereas it won two in 900/2. All other winners of 900MHz won the same number of categories in either time slice. As the prices of all

sold lots need to sum to zero (i.e. the sum of deviations across bidders needs to be zero), all the weight is put on the second time slice instead of the first as this has twice the impact on reducing the deviation of Meteor than the price of the second time slice. We could therefore collapse the two time slices for 900MHz and fit linear prices to this collapsed set of winning bids. The resulting linear prices are the same as before for all other categories and the collapsed 900MHz category would have a linear price of €32,570,000.

The results of the Romanian auction are presented in Table 8.

Table 8: Romanian auction results

Bidder	800MHz	900MHz (2013-2014)	900MHz (2014-2029)	1.8GHz (2013-2014)	1.8GHz (2014-2029)	2.6GHz FDD	2.6GHz TDD (15MHz)	Price (in 2012 €000)
Cosmote	1	0	2	0	5	2	0	179,880,000
Orange	2	5	2	3	4	4	0	227,135,002
RCS/RDS	0	0	1	0	0	0	0	40,000,000
Vodafone	2	5	2	3	6	0	1	228,520,034
2K	0	0	0	0	0	0	2	6,601,000

There are more categories than winners in the Romanian spectrum auction. As the 900 (2013-2014) and 1800 (2013-2014) categories contain licences for the old GSM bands with extremely short licence duration, we have collapsed them in the linear fit model. We then collapsed the 800 and 900 (2014-2029) categories into a sub-1GHz category and the other categories into a super-1GHz category. A block in the 2.6GHz unpaired category (15MHz) is counted as one and half 2x5MHz paired block. The collapsed winning packages are shown in Table 9.

Table 9: Romanian auction - collapsed winning packages

Bidder	Sub-1GHz	Short licences (2013-2014)	Super-1GHz	Price (in 2012 €000)
Cosmote	3	0	7	179,880,000
Orange	4	8	8	227,135,002
RCS/RDS	1	0	0	40,000,000
Vodafone	4	8	7.5	228,520,034
2K	0	0	3	6,601,000

The results of the linear fit method for the Romanian auction results are presented in Table 10.

Table 10: Simple linear fit - Romanian multiband auction

Category	Linear price (in 2012 Euro)
Sub-1GHz (2x5MHz)	48,249,600
Short licences (2013-2014)	67,059
Super-1GHz (2x5MHz)	4,002,670

4.2 Linear reference pricing

4.2.1 Linear reference prices for 4G auction results

The following table presents the results of the LRP method. The low-power shared-use D1 and D2 category lots were not awarded in the UK 4G auction. In the LRP determination, the prices for these categories were held at zero.

Table 11: Linear reference prices for 4G auction results

Category	Linear reference price (in £)
A1	268,530,650
A2	506,061,300
C	49,530,650
E	7,500,000

Table 12 compares the cost of the winning packages at these LRPs with the base prices paid in the auction. The cost at LRPs of H3G's winning package is £43.9 million higher than its base price. On the other hand, Telefónica's winning package at LRPs is £43.9 million lower than its base price. The numbers suggest that H3G received a 'discount' relative to uniform pricing. H3G paid the reserve price for its winning package of one lot in A1, which is a result of how the competition constraint was taken into account in the price determination. This discount is partially removed by moving to the linearised package prices.

Table 12: Linearised package prices

Winner	Winning package (A1/A2/C/D1/D2/E)	Base price (£000)	Linearised package price (£000)	Difference (£000)
EE	1/0/7/0/0/0	588,876	615,245.20	26,369.20
H3G	1/0/0/0/0/0	225,000	268,530.65	43,530.65
Niche	0/0/3/0/0/4	186,476	178,591.95	-7,884.05
Telefónica	0/1/0/0/0/0	550,000	506,061.30	-43,938.70
Vodafone	2/0/4/0/0/5	790,761	772,683.90	-18,077.10

4.2.2 Linear reference prices for hypothetical 4G auction results without the competition constraint

As we have discussed in the previous section, the base price paid by H3G is a result of the way the competition constraint was imposed interacting with the second price rule. In the specific case at hand, the imposition of the competition constraint with the second price rule meant that H3G had to pay the reserve price for its winning package rather than the opportunity cost resulting from not

allocating this spectrum to other bidders. Imposing the competition constraint led to lower revenues and a 'discount' for H3G for its winning package. This discount also reduces the LRPs (the linearised package prices at the LRPs are required to sum to the overall revenue achieved in the auction).

Impact on outcome of competition constraint

We can re-calculate the outcome in the auction using the same bids but with the competition constraint disabled. This shows what the effect of the competition constraint was on the auction outcome and prices. It should be noted that it would be unsafe to assume that the bids received from all bidders would have been the same in the event that H3G had not opted in, especially given that the primary bids submitted by H3G and therefore the information disclosed during the open stage could have been different. Notwithstanding this, the exercise allows us to assess the revenue impact of the spectrum reservation given the bids submitted by bidders.

If we simply remove the requirement that H3G should win one of its minimum spectrum portfolios, the outcome of the winner determination (using the bids submitted in the auction) remains unchanged. This means the bid amount submitted by H3G for the package it won exceeds the opportunity cost of selecting this as a winning bid, and that it would still be optimal to allocate a single A1 lot to H3G given the bids received even if the competition constraint had not been imposed. The competition constraint did not affect the selection of the winning bids.

However, disabling the competition constraint has an impact on H3G's opportunity cost, as there would be no spectrum reservation and therefore all spectrum could be allocated to other bidders in the counterfactual. This would result in a base price for H3G of £384 million, instead of £225 million, an increase in total auction revenue of £159 million. Base prices would change, but not the winning outcome, if the competition constraint had not been applied in the auction. The auction results when the competition constraint is disabled are presented in Table 13.

Table 13: Auction results without competition constraint

Bidder	A1	A2	C	E	Base price (in £000)	Base price (in £000) without competition constraint	Impact of competition constraint (in £000)
EE	1	0	7	0	588,876	588,876	0
H3G	1	0	0	0	225,000	384,000	159,000
Niche	0	0	3	4	186,476	186,476	0
Telefonica	0	1	0	0	550,000	550,000	0
Vodafone	2	0	4	5	790,761	790,761	0
				Total:	2,341,113	2,500,113	159,000

This result suggests that H3G benefited from the competition constraint because it was able to enjoy a discount for the spectrum it won. However, based on the bids received in the auction, it was efficient to allocate H3G its winning package.

Linear reference prices for hypothetical 4G auction results without the competition constraint

To determine the impact of the competition constraint on the LRP results, we re-ran the LRP determination using the higher base price for H3G as determined in the previous section. The results are presented in Table 1 together with the initial results.

Removing the competition constraint leads to higher reference prices for all categories. The increase in H3G's base price of £159 million is spread across all categories with most of the additional revenue being attributed to the 800MHz categories.

Table 14: Linear reference prices for hypothetical 4G auction results without the competition constraint

Category	Linear reference price with the competition constraint (in £)	Linear reference price without the competition constraint (in £)	Impact of increased revenue (in %)
A1	268,530,650	278,028,810	3.5%
A2	506,061,300	525,057,610	3.7%
C	49,530,650	56,565,550	14.2%
E	7,500,000	7,891,390	5.2%

Table 15 compares the cost of the winning packages at the LRP to the base prices that would have been paid in the auction assuming that the competition constraint was not applied. To avoid any confusion, the prices shown in this table are not the base prices actually paid in the auction. Relative to the linearised package prices, EE and Niche seem to get a 'discount' of £85.1 million and £14.8 million in their base prices. The situation is now reversed for H3G (relative to the case where the competition constraint is applied) as its base price is now £106 million higher than its linearised package price.

Table 15: Linearised package prices without competition constraint

Winner	Winning package (A1/A2/C/D1/D2/E)	Base price (£000)	Linearised package price (£000)	Difference (£000)
EE	1/0/7/0/0/0	588,876	673,987.64	85,111.64
H3G	1/0/0/0/0/0	384,000	278,028.81	-105,971.19
Niche	0/0/3/0/0/4	186,476	201,262.19	14,786.19
Telefónica	0/1/0/0/0/0	550,000	525,057.61	-24,942.39
Vodafone	2/0/4/0/0/5	790,761	821,776.74	31,015.74

4.2.3 Impact of reserve prices on LRP results

The way reserve prices were imposed in the price determination of the Combined Auction had an impact on the prices paid by winning bidders. This is particularly important for the 800MHz band. In this

band, both Telefonica and Vodafone won spectrum at their sub-1GHz cap. This meant that these two bidders could not express demand for additional 800MHz spectrum beyond what they won. As a result of their sub-1GHz caps being constraining in the winning outcome, these bidders could not impose any opportunity cost on other winners of 800MHz spectrum. Only EE and H3G could express valuation for 800MHz spectrum additional to what they won. Therefore, the price paid by winners of 800MHz spectrum could only be determined by losing bids from EE and H3G for lots in the 800MHz band additional to those that they won. As there was no competition from H3G for additional 800MHz lots in its supplementary bids over and above reserve price differences, H3G's losing bids could only have an indirect effect on the prices paid for 800MHz through their effect on rearrangements of winning bids in 2.6GHz in the counterfactual cases determining opportunity costs. EE, on the other hand, won spectrum at its overall cap, so any competition for additional 800MHz spectrum would have had to come from trade-offs with fewer 2.6GHz lots. When determining the Vickrey price for a bidder, unsold lots were valued at reserve.

As there was only limited competition for additional 800MHz lots, this meant that the Vickrey prices for winners of 800MHz spectrum were determined largely by the reserve price of unsold lots. The table below shows the original auction results and contrasts them with the prices that would have resulted had unsold lots been valued at zero in the price determination, rather than at reserve prices.

This assumes that the same bids would have been made, whereas additional or different bids might have been made if unsold lots had been valued at zero rather than reserve prices. With this assumption, when unsold lots are valued at zero, competition from EE for 800MHz spectrum determines the prices paid by Telefonica and Vodafone in that band, which is why their prices drop by less than the reserve price of an A1 lot. The EE's price would drop significantly (almost the reserve price for an A1 lot) as there is no competition from H3G for additional 800MHz lots.

The total revenue impact of the way reserve prices were imposed in the price determination is roughly £272 million.

Table 16: Auction results when unallocated lots are valued at zero

Bidder	A1	A2	C	E	Base price (in £000)	Base price (in £000) when valuing unallocated lots at zero	Impact of reserve prices (in £000)
EE	1	0	7	0	588,876	388,875	200,001
H3G	1	0	0	0	225,000	225,000	-★
Niche	0	0	3	4	186,476	186,476	0
Telefonica	0	1	0	0	550,000	498,000	52,000
Vodafone	2	0	4	5	790,761	770,261	20,500
				Total:	2,341,113	2,068,612	272,001

★ *The way H3G bid in the auction guaranteed it to win one of its opt-in selections at reserve. So in a way, its base price was also determined by reserve prices. However, if reserve prices had been different, it is unclear whether H3G would have behaved the same way so that its base price would still be determined by reserve prices. This is why we do not include the impact of reserve prices for H3G in this table.*

LRP results when unallocated lots are valued at zero

If unallocated lots were valued at zero, rather than at reserve prices, then the prices paid would be *solely* a function of the amounts bid. The impact of using non-zero reserve prices on total auction revenue is about 10%, so fairly modest overall. In this case, reserve prices would have no impact on the LRP calculation other than in their role in tie-breaking within the second phase of the procedure (for which only the *relative* reserve prices matter across lot categories, not their absolute values). Therefore, it is reasonable to conclude that the *predominant factor* determining the LRPs are the bids made, rather than the reserve prices.

The results of the LRP determination when the reduced revenue is used instead are shown in Table 17 below. The impact of reserve prices is different across the bands, with the greatest relative impact being seen in the 2.6GHz band with a 15% reduction. The price points for the 800MHz band are only reduced by 10%.

Table 17: LRP results when unallocated lots are valued at zero

Category	LRPs when using initial revenue (in £)	LRPs when using reduced revenue with unallocated lots valued at zero (in £)	Impact of reduced revenue (in %)
A1	268,530,650	241,831,571	-10%
A2	506,061,300	452,663,143	-10.5%
C	49,530,650	42,100,000	-15%
E	7,500,000	6,580,286	-12.3%

Table 18 compares the cost of the winning packages at the LRPs to the base prices that would have been paid in the auction assuming that unsold lots are valued at zero. To avoid any confusion, the prices shown in this table are not the base prices actually paid in the auction. Relative to the linearised package prices, EE and H3G appear to get a 'discount' of £147.7 million and £16.8 million in their base prices.

Table 18: Linearised package prices when unallocated lots are valued at zero

Winner	Winning package (A1/A2/C/D1/D2/E)	Base price (£000)	Linearised package price (£000)	Difference (£000)
EE	1/0/7/0/0/0	388,875	536,531.6	147,657.6
H3G	1/0/0/0/0/0	225,000	241,831.6	16,832,6
Niche	0/0/3/0/0/4	186,476	152,621.1	-33,854.9
Telefónica	0/1/0/0/0/0	498,000	452,663.1	-45,336.9
Vodafone	2/0/4/0/0/5	770,261	684,964.6	-85,296.4

4.2.4 Dropping the revenue constraint entirely

There are alternative procedures that could be adopted, other than simply re-computing base prices and applying the LRP methodology with effectively zero reserve prices. An alternative way of *entirely* removing the impact of reserve prices would be to drop the revenue constraint from the LRP determination. This

would give us prices that are as close as possible to separating the winning and the losing bids.

Arguably, such an approach could also lead to price points that are a lot closer to the notion of a "market" value for each category as it is not restricted by the requirement that the LRPs of all sold lots need to sum to the minimum revenue achieved in the auction. These prices are closer to those that might have been achieved in some hypothetical market with an institutional constraint of uniform pricing (i.e. the same price per lot for everyone), whereas the CCA allows discounting from uniform pricing to avoid inefficiently unallocated lots when there complementarities across lots. However, bidders may have placed different bids in such circumstances.

There may be an argument to adapt the LRP determination slightly to allow for an initial tiebreak by minimum revenue before the LRPs are aligned relative to reserve prices. The LRP determination would then be a three-step process:

- First step: Minimise the sum of excursions;
- Second step: Identify the sets of LRPs which minimise the sum of excursions and also minimise revenues (the sum of prices of all lots sold);
- Third step: If there is more than one set of LRPs which minimises revenues and the sum of excursions, use the alignment of LRPs to relative reserve prices to break any remaining ties (subject to the conditions that the minimum sum of excursions and the minimum revenue from the second step are achieved).

The reason for adding this additional step is best illustrated when considering a simple single lot example. Suppose that bidder B1 bids 2 and bidder B2 bids 5 on this lot. The price minimising the sum of excursions can be anywhere between 2 and 5. In this situation, the price would be closest to a market price if it makes bidder B1 indifferent between winning and not winning. This would be at a price of 2.

The following table provides the results of the LRP determination when the revenue constraint is removed and we follow the procedure outlined above. The minimum revenue determined in the second step is £2.64 billion.

Table 19: Linear reference prices without revenue constraint

Category	LRPs when using initial revenue (in £)	LRPs when dropping revenue constraint (in £)	Impact of dropping revenue constraint (in %)
A1	268,530,650	309,296,121	15.2%
A2	506,061,300	587,592,232	16.1%
C	49,530,650	54,296,121	9.6%
E	7,500,000	6,666,667	-11.1%

The resulting LRPs are higher than the initial results as they are not constrained by the requirement to sum to the minimum revenue. The sum of excursions is now £103,968,667, which is much lower than the sum of excursions when the revenue constraint is imposed (see above). Hence, these prices much better separate the winning from the losing bids than the prices that have to satisfy the revenue constraint.

Table 20 compares the cost of the winning packages at the LRPs to the base prices achieved in the auction. The linearised prices for all bidders are higher than the base prices they paid in the auction.

Table 20: Linearised package prices without revenue constraint

Winner	Winning package (A1/A2/C/D1/D2/E)	Base price (£000)	Linearised package price (£000)	Difference (£000)
EE	1/0/7/0/0/0	588,876	689,369	100,493
H3G	1/0/0/0/0/0	225,000	309,296.1	84,296.1
Niche	0/0/3/0/0/4	186,476	189,555	3,079
Telefónica	0/1/0/0/0/0	550,000	587,592.2	37,592.2
Vodafone	2/0/4/0/0/5	790,761	869,110.1	78,349.1

4.2.5 Sensitivity to the tie-break criterion

The LRP methodology consists of two steps (see Section 3.1.2):

    i.   The minimisation of maximum excursions. This is a linear programme that identifies the minimum sum of

maximum excursions across all bidders. There may be a number of linear prices that minimise this sum; and

ii.   For definiteness, if there is more than one set of linear prices which minimises the sum of maximum excursions, the set of linear prices is chosen which minimises the sum of squared differences of relative LRPs from the relative reserve prices. This is essentially a tie-breaker criterion which ensures that there is a unique solution to the LRP methodology.

In this particular case, the second step of the LRP methodology does not change the result, as the first step of minimising the total excursion across bidders returns a unique solution. Therefore, although there are clearly other tie-breaking criteria that could arguably be used (such as relative distance from the final clock prices in the auction), this is irrelevant to the LRPs in this particular case.

4.2.6 Average block prices in the assignment stage

As explained in the introduction, there is little sense in conducting the LRP calculations at the level of individual frequency block within the 800MHz and 2.6GHz bands. This would be a spurious level of detail as we are in any case only considering these bands as analogues to 900MHz and 1.8GHz spectrum.

Nevertheless, whilst the additional prices are small relative to base prices, a band-average of the additional price could be added on to the LRPs derived for each band from the principal stage bids. This makes very little difference to our earlier results therefore is largely immaterial.

In the case of the 800MHz band, the assignment stage only determined the assignment of winners in A1 as the winner of A2 was assigned the 2x10MHz at the top of the band directly. We therefore spread the revenue in the 800MHz over four blocks of 2x5MHz.

The average revenues per block in the 800MHz band and the 2.6GHz band achieved in the assignment stage are provided in Table 21.

Table 21: Assignment stage revenue

Band	2x5MHz blocks sold	Assignment stage revenue	Average block value
800MHz	4	£8,060,020	£2,015,005
2.6GHz paired	14	£19,100,302	£1,364,307

4.3 Results of the additional spectrum methodology

In this section, we present the ASM results. This considers the impact of making additional spectrum available on the total value of winning bids. We consider both (i) adding spectrum corresponding to some or all of a bidder's existing holdings at 900MHz and 1.8GHz with the restriction that the bidder does not compete for this additional spectrum itself and (ii) making additional spectrum generally available to all bidders. The former approach corresponds to that described in Ofcom's January 2012 consultation, but (as discussed above) the latter method according more closely with intuitive notions of market value for the additional spectrum.

As discussed in Section 3.2, we use the following two variations:

- Approach 1: Combined 800MHz category, competition constrained active; and
- Approach 2: Separate 800MHz categories, competition constraint active.

The results of both approaches are the same except for just one of the cases of hypothetical spectrum release. In the case of adding 2x5MHz of 800MHz on behalf of EE into the auction, the additional spectrum value generated using approach 1 is £25,000,000 and in approach 2 it is £24,999,000. This is a result of Telefónica having submitted a bid for the A2 lot that is £1,000 higher than its bid for 2 A1 lots. Using Approach 2, the value of the additional 2x5MHz is generated as follows:

- H3G wins the A2 lot in the alternative, which generates a value of £25 million.
- Telefónica wins 2 A1 lots instead of the A2 lot. This results in a reduction of £1,000.

In Approach 1, with the A1/A2 distinction collapsed, the value of the additional 2x5MHz is generated as follows:

- Telefónica still wins its bid for A2 (as this version does not distinguish between A1 and A2 and thus takes Telefónica's bid for A2 as the bid for two 800MHz lots rather than the bid for two A1s). The change in value is zero;
- H3G wins 2x10MHz in the alternative, which generates a value of £25 million.

A summary of all alternative outcomes for both approaches is provided in Annex A . The following table summarises our results.

Table 22: ASM results

Additional spectrum case	Additional value (in £000)	Average value per block in (£000)
VF - 2x5MHz 800MHz	383,500	383,500
VF - 2x10MHz 800MHz	528,500	264,250
VF - 2x15MHz 800MHz	921,500	307,167
VF - 2x5MHz 2.6GHz	73,000	73,000
VF - 2x5MHz 800MHz & 2x5MHz 2.6GHz	438,500	N/A
VF - 2x10MHz 800MHz & 2x5MHz 2.6GHz	583,500	N/A
VF - 2x15MHz 800MHz & 2x5MHz 2.6GHz	976,500	N/A
VF - 2x20MHz 800MHz	946,500	236,625
TO2 - 2x5MHz 800MHz	356,000	356,000
TO2 - 2x10MHz 800MHz	529,000	264,500
TO2 - 2x15MHz 800MHz	884,376	294,792
TO2 - 2x5MHz 2.6GHz	45,500	45,500
TO2 - 2x5MHz 800MHz & 2x5MHz 2.6GHz	410,500	N/A
TO2 - 2x10MHz 800MHz & 2x5MHz 2.6GHz	583,500	N/A
TO2 - 2x15MHz 800MHz & 2x5MHz 2.6GHz	930,676	N/A
TO2 - 2x20MHz 800MHz	909,376	227,344
EE - 2x5MHz 2.6GHz	73,500	73,500
EE - 2x10MHz 2.6GHz	128,000	64,000
EE - 2x15MHz 2.6GHz	173,500	57,833
EE - 2x20MHz 2.6GHz	228,000	57,000
EE - 2x25MHz 2.6GHz	263,876	52,775
EE - 2x30MHz 2.6GHz	310,176	51,696
EE - 2x35MHz 2.6GHz	363,876	51,982
EE - 2x40MHz 2.6GHz	390,156	48,770
EE - 2x45MHz 2.6GHz	398,206	44,245
EE - 2x5MHz 800MHz	25,000	25,000

EE - 2x10MHz 800MHz	25,000	12,500
EE - 2x15MHz 800MHz	25,000	8,333
EE - 2x20MHz 800MHz	25,000	6,250
EE - 2x25MHz 800MHz	25,000	5,000
EE - 2x30MHz 800MHz	25,000	4,167
EE - 2x35MHz 800MHz	25,000	3,571
EE - 2x40MHz 800MHz	25,000	3,125
EE - 2x45MHz 800MHz	25,000	2,778
H3G - 2x5MHz 2.6GHz	73,500	73,500
H3G - 2x10MHz 2.6GHz	128,000	64,000
H3G - 2x15MHz 2.6GHz	156,476	52,159
H3G - 2x5MHz 800MHz	384,000	384,000
H3G - 2x10MHz 800MHz	384,000	192,000
H3G - 2x15MHz 800MHz	904,976	301,659
Generic addition 2x5MHz in 800MHz	384,000	384,000
Generic addition 2x5MHz in 2.6GHz	73,500	73,500

TO2: Telefónica, VF: Vodafone.

Average values are omitted for additional spectrum packages including different bands.

Figure 1 shows the value generated from adding an additional 800MHz block. The additional values from adding the holdings of a specific operator to the available spectrum (and restricting the outcome such that the releaser does not compete for this spectrum) are very asymmetric across operators in the 800MHz band:

- Adding 2x5MHz to the 800MHz band for Vodafone results in an additional value of £383.5 million;
- Adding 2x5MHz to the 800MHz band for Telefónica generates an additional value of £356 million;
- Adding 2x5MHz to the 800MHz band for EE generates an additional value of £25 million; and
- Adding 2x5MHz to the 800MHz band for H3G generates an additional value of £384 million.

The main reason for these differences is that Vodafone and Telefónica could not express demand for spectrum in the 800MHz band in addition to what they already won. Each of them is

restricted to bidding for at most 2x10MHz and both won this amount of spectrum. H3G could have potentially competed for more 800MHz spectrum than what was included in its reservation, but it did not. Hence there is no competition for additional 800MHz spectrum added in on behalf of EE. However, adding additional 800MHz spectrum on behalf of other bidders does create value as EE did express demand for 800MHz spectrum above what it won.

The marginal value of an additional 800MHz block is broadly the same with or without a single 2.6GHz block for both Vodafone and Telefonica:

- Adding an 800MHz block to a 2.6GHz block for Vodafone generates an additional £365.5m on top of the value already generated by the 2.6GHz block whereas adding an 800MHz block on its own generated a value of £383.5m.

- Adding an 800MHz block to a 2.6GHz block for Telefonica generates an additional £365m on top of the value already generated by the 2.6GHz block whereas adding an 800MHz block on its own generated a value of £356m.

The marginal value of adding 800MHz for Vodafone and Telefonica goes down for the second block and increases again for the third block. This is because EE did not submit a bid for 2x15MHz in the 800MHz band. As shown in Table 26, when 2x5MHz of 800MHz spectrum is added for Vodafone:

- EE wins 2x5MHz in 800MHz and loses 2x5MHz in 2.6GHz relative to its original winning package for an additional bid amount of £310.5 million;

- Niche loses 2x5MHz in 2.6GHz relative to its original winning package with a bid amount that is -£55 million lower than its original winning bid amount; and

- Telefonica wins 2x10MHz in 2.6GHz in addition to its original winning package for an additional bid amount of £128 million.

As shown in Table 27, when 2x10MHz of 800MHz spectrum is added for Vodafone:

- EE wins 2x15MHz in 800MHz and loses 2x15MHz in 2.6GHz relative to its original winning package for an additional bid amount of £748.5 million;

- H3G is pushed out of the 800MHz band and wins 2x20MHz in the 2.6GHz band instead with a bid amount that is -£165 million lower than its original winning bid amount; and

- Niche loses 2x5MHz in 2.6GHz relative to its original winning package at a bid amount that is -£55 million lower than its original winning bid amount.

As shown in Table 28, when 2x15MHz of 800MHz spectrum is added for Vodafone:

- EE wins 2x15MHz in 800MHz and loses 2x15MHz in 2.6GHz relative to its original winning package for an additional bid amount of £748.5 million;
- H3G wins 2x10MHz in 2.6GHz in addition to its original winning package for an additional £100 million;
- Telefonica wins 2x10MHz in 2.6GHz in addition to its original winning package for an additional bid amount of £128 million; and
- Niche loses 2x5MHz in 2.6GHz relative to its original winning package at a bid amount that is -£55 million lower than its original winning bid amount.

The value of adding 2x5MHz of 800MHz spectrum for Vodafone is thus £383 million. When 2x10MHz of 800MHz is added for Vodafone, the value of the additional 2x5MHz is £528.5 million - £383.5 million = £145 million. The marginal value of adding the third 2x5MHz block of 800MHz spectrum is then £921.5 million - £528.5 million = £393 million. The marginal value of the second 2x5MHz block of 800MHz spectrum is thus lower than the marginal value of the first and third block.

When 2x10MHz of 800MHz is added, EE wins 2x20MHz in the 800MHz band and pushes H3G into the 2.6GHz band. Hence the value gained by allocating more 800MHz spectrum to EE is partially offset by having to push H3G into the 2.6GHz band. When 2x15MHz of 800MHz spectrum is added, H3G does not have to be pushed into the 2.6GHz band as EE can be allocated the additional 2x15MHz in the 800MHz band. This frees up some 2.6GHz spectrum that is then allocated to H3G and Telefonica on top of their original winning packages. This is why the marginal value of the second 2x5MHz block of 800MHz spectrum is lower for Vodafone. A similar effect can also be observed when additional 800MHz lots are added for Telefonica (see Table 34, Table 35 and Table 36).

The marginal value of adding the second 2x5MHz block of 800MHz spectrum for H3G is zero for the same reason. EE did not submit a bid for 2x15MHz in 800MHz, so adding the second 2x5MHz block does not generate any value as it is not picked up by EE or any other bidder (see Table 63, Table 64 and Table 65).

Figure 1: Marginal value of additional 800MHz block
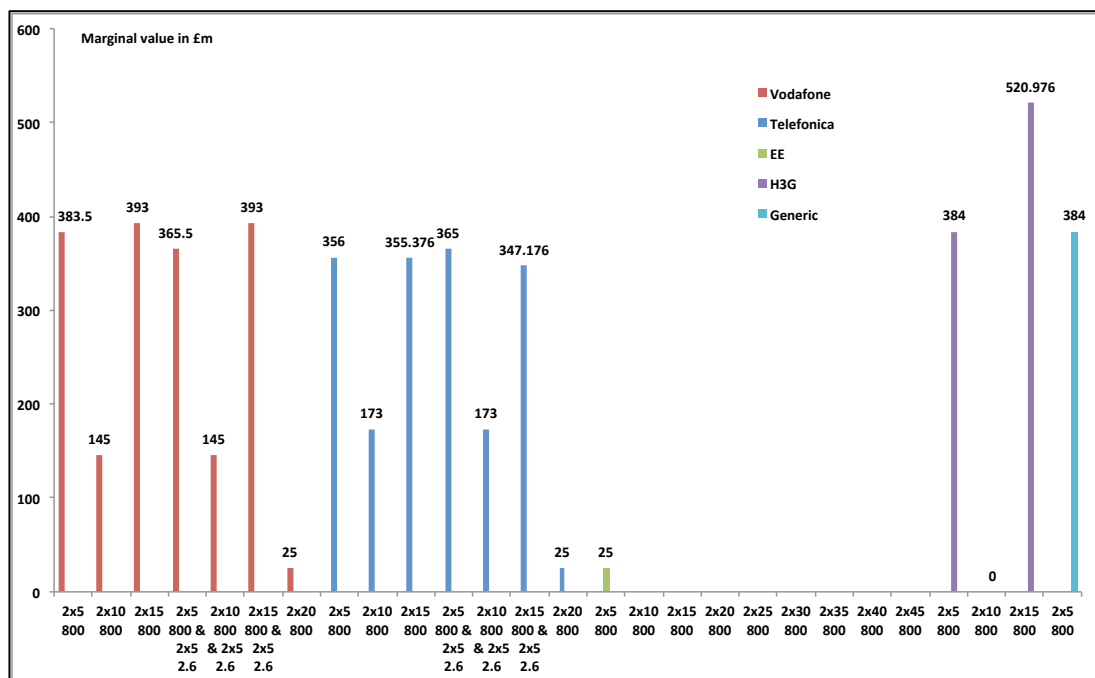
Figure 2 provides a summary of the marginal value of adding 2.6GHz blocks to the auction. Again, the results of the bidder-specific additions differ across bidders:

- Adding 2x5MHz to the 2.6GHz band for Vodafone results in an additional value of £73 million;
- Adding 2x5MHz to the 2.6GHz band for Telefónica generates an additional value of £45.5 million;
- Adding 2x5MHz to the 2.6GHz band for EE generates an additional value of £73.5 million; and
- Adding 2x5MHz to the 2.6GHz band for H3G generates an additional value of £73.5 million

The additional value generated from adding in a 2x5MHz block for Vodafone, EE and H3G is mainly derived from taking one 2.6GHz paired block from Niche and allocating these two blocks to Telefónica. When additional value from adding in a 2x5MHz block for Telefónica, however, is mainly derived from taking one 2.6GHz paired block from Niche and allocating two blocks to H3G. H3G placed a lower marginal bid amount on these additional two blocks (£100 million) than Telefónica (£128 million).

The impact of the spectrum caps on the value generated by adding additional lots is demonstrated by the marginal value when the eighth and ninth block is added for EE.

Figure 2: Marginal value of additional 2.6GHz block
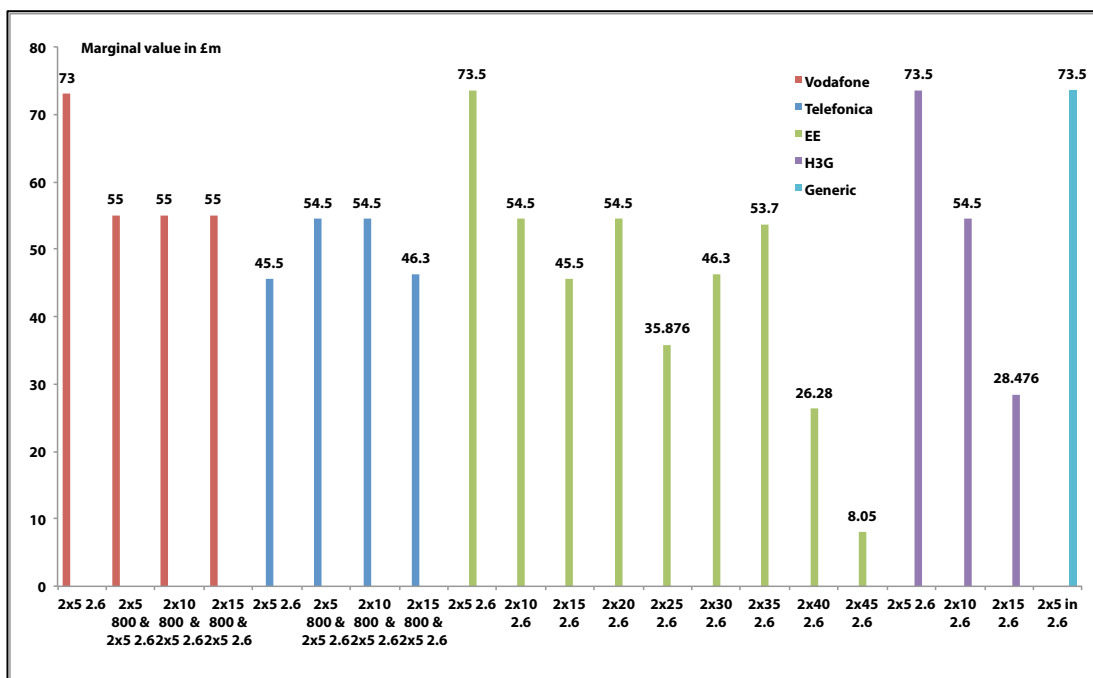
4.4 Comparison of LRP and ASM results

The LRPM and ASM lead to different price points for spectrum in the 800MHz and the 2.6GHz band. This is a result of the different approaches taken in these methods:

- The LRPM allocates the auction revenue across the different lot categories taking into account all bids; and

- The ASM determines the value gained from adding additional lots in these bands to the auction supply. The price points are not subject to any revenue constraint and do take into account potential reallocation of winning bids alongside the allocation of the additional lots.

The LRP results are driven by the bids that have the maximum excursion for each bidder. For some bidders, there is more than one such bid. The set of bids with maximum excursions for each bidder are presented in Table 23 below.

Table 23: Binding bids in LRP case

Bidder		A1	A2	C	D1	D2	E	Surplus (in £000)
EE	Winning bid	1	0	7	0	0	0	434,254.8
	Binding bid 1	2	0	6	0	0	0	525,754.8
	Binding bid 2	4	0	4	0	0	0	525,754.8
	Excursion 1	*1*	*0*	*-1*	*0*	*0*	*0*	*91,500*
	Excursion 2	*3*	*0*	*-3*	*0*	*0*	*0*	*91,500*
H3G	Winning bid	1	0	0	0	0	0	296,969.35
	Binding bid	2	0	10	0	1	7	379,556.2
	Excursion	*1*	*0*	*10*	*0*	*0*★	*7*	*82,587*
Niche	Winning bid	0	0	3	0	0	4	161,839.05
	Binding bid 1	0	0	3	0	1	0	161,841.05
	Binding bid 2	0	0	3	0	1	4	161,841.05
	Excursion 1	*0*	*0*	*0*	*0*	*0*★	*-4*	*2*
	Excursion 2	*0*	*0*	*0*	*0*	*0*★	*0*	*2*
Telefónica	Winning bid	0	1	0	0	0	0	712,941.7
	Binding bid	0	1	0	0	1	0	756,741.7
	Excursion	*0*	*0*	*0*	*0*	*0*★	*0*	*43,800*
Vodafone	Winning bid	2	0	4	0	0	5	1,302,360.1
	Binding bid 1	2	0	4	0	0	4	1,307,860.1
	Binding bid 2	0	1	4	0	0	4	1,307,860.1
	Excursion 1	*0*	*0*	*0*	*0*	*0*	*-1*	*5,500*
	Excursion 2	*-2*	*1*	*0*	*0*	*0*	*-1*	*5,500*

★*Note that excursions for D1 or D2 lots are not taken into account in the LRP determination (see Section 3.1.2).*

Differences in the 800MHz price points

In the 800MHz band the LRP methodology gives a linear price of £268.5 million for the A1 lot and £506.1 million for the A2 lot. Hence the highest price achieved for 2x5MHz of 800MHz spectrum using the LRP methodology is £268.5 million. In comparison the ASM gives a significantly greater linear price for a generic 2x5MHz block in the 800MHz band of £384 million (£115.5 million greater). The ASM result in the 800MHz band is driven by the difference between the 'Winning bid' and 'Alternative bid' for each bidder displayed in Table 24 below.

Table 24: ASM result with generic addition of 2x5MHz in the 800MHz band - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative bid	2	6	0	0	0	1,360,000
	Difference	*1*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative bid	1	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative bid	0	2	0	0	5	287,931
	Difference	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative bid	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative bid	2	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*1*	*0*	*0*	*0*	*0*	*384,000*

The bid that drives the value in the ASM is EE's bid for 2 A1 lots and 6 C lots. This is also one of EE's bids with maximum excursion. In addition to capturing the value EE places on winning this second lot in A1, the ASM also takes into account the value gained from reallocating the now vacant C lot. This additional C lot is allocated as follows:

- Niche is forced to win one fewer C lot and one more E lot (value loss: -£52.5 million);
- Vodafone is allocated one fewer E lot (value loss: -£2 million); and
- Telefónica is then allocated the two C lots (value gained £128 million).

This reoptimisation gain that is unrelated to EE's value for an additional A1 lot is £73.5 million.

EE's excursion in the LRPM is £91.5 million. This means it still prefers the package of two A1 lots and six C lots to its winning package at the LRPs. It would be £91.5 million better off if we allocated it the former rather than the latter at the linear reference prices. To make the first package less attractive, we would have to increase the price for A1 further. However, as the sum of linear reference prices of all sold lots have to sum to the revenue achieved in the principal stage, the A1 lot cannot be increased further without lowering the linear reference price for C or A2 at the same time. This would, in turn, increase the excursions of other bidders. For example, if we were to increase the price of A1 and correspondingly lower the price for C, EE's excursion would be reduced, but H3G's (whose binding bid includes 10 C lots) would be much increased. At the same time, one

of Vodafone's binding bids and its winning bid are for broadly similar packages for either 2x10MHz of 800MHz in A1 or A2 at broadly the same bid amount. Hence to keep Vodafone's maximum excursion small, we would have to raise A2 (which would demand a further reduction of the price for C).

Given the revenue constraint, these excursions are minimised to the greatest extent. The linear reference price of A1 when dropping the revenue constraint (£309.3m – see Section 4.2.4) is similar to the ASM price point less the value gained from the reoptimisation (£384m - £73.5m = £310.5m)

Differences in the 2.6GHz price points

In the 2.6GHz paired band the LRP methodology gives a linear price of £49.5 million for 2x5MHz of spectrum. Again, the ASM gives a higher price point based on a generic addition of 2x5MHz in the 2.6GHz band of £73.5 million. The ASM result in the 2.6GHz band is driven by the difference between the 'Winning bid' and 'Alternative bid' for each bidder displayed in Table 25 below.

Table 25: Bids determining the ASM result with generic addition of 2x5MHz in the paired 2.6GHz band - combined 800MHz category)

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**0**	**1**	**0**	**0**	**0**	**73,500**

The value in the ASM is driven by a reorganisation of the winning outcome. In order to be able to allocate two additional C lots to Telefónica (value gain: £128 million), Niche has to win one fewer lot in C and one more lot in E (value lost: -£52.5 million) and Vodafone has to win one fewer E lot (value lost: -£2 million).

This reorganisation is not taken into account in the LRPM. In fact, Telefónica's bid for two additional C lots that has such a

considerable impact on the value of 2.6GHz in the ASM did not determine the result of the LRPM. The excursion of this bid at the linear reference prices is around £28.9 million which is below its maximum excursion. Hence the LRPM result and the ASM result for the 2.6GHz band were determined by different bids.

Annex A   Alternative outcomes in additional spectrum cases

A.1 Results of additional spectrum methodology for bidder-specific holdings

A.1.1 Combined 800MHz category

Table 26: Vodafone - 2x5MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	**1**	**-1**	**0**	**0**	**0**	**310,500**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	4	285,431
	Difference	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
ASM value		**1**	**0**	**0**	**0**	**0**	**383,500**

Table 27: Vodafone - 2x10MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	**3**	**-3**	**0**	**0**	**0**	**748,500**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	0	4	0	0	0	400,500
	Difference	**-1**	**4**	**0**	**0**	**0**	**-165,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	4	285,431
	Difference	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**2**	**0**	**0**	**0**	**0**	**528,500**

Table 28: Vodafone - 2x15MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	**3**	**-3**	**0**	**0**	**0**	**748,500**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	4	285,431
	Difference	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
	ASM value	**3**	**0**	**0**	**0**	**0**	**921,500**

Table 29: Vodafone - 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	4	285,431
	Difference	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
	ASM value	**0**	**1**	**0**	**0**	**0**	**73,000**

Table 30: Vodafone - 2x5MHz 800MHz & 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	*1*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
ASM value		*1*	*1*	*0*	*0*	*0*	*438,500*

Table 31: Vodafone - 2x10MHz 800MHz & 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	0	4	0	0	0	400,500
	Difference	*-1*	*4*	*0*	*0*	*0*	*-165,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*2*	*1*	*0*	*0*	*0*	*583,500*

Table 32: Vodafone - 2x15MHz 800MHz & 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
ASM value		**3**	**1**	**0**	**0**	**0**	**976,500**

Table 33: Vodafone - 2x20MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	2	0	0	0	690,500
	Difference	*1*	*2*	*0*	*0*	*0*	*125,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	4	285,431
	Difference	*0*	*-1*	*0*	*0*	*0*	*-55,000*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
ASM value		**4**	**0**	**0**	**0**	**0**	**946,500**

Table 34: Telefónica - 2x5MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	*1*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		**1**	**0**	**0**	**0**	**0**	**356,000**

Table 35: Telefónica - 2x10MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	0	4	0	0	0	400,500
	Difference	*-1*	*4*	*0*	*0*	*0*	*-165,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		**2**	**0**	**0**	**0**	**0**	**529,000**

Table 36: Telefónica - 2x15MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	**3**	**-3**	**0**	**0**	**0**	**748,500**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	**0**	**0**	**0**	**0**	**-4**	**-30,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	7	0	0	9	2,240,920
	Difference	**0**	**3**	**0**	**0**	**4**	**165,876**
ASM value		**3**	**0**	**0**	**0**	**0**	**884,376**

Table 37: Telefónica - 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**0**	**1**	**0**	**0**	**0**	**45,500**

Table 38: Telefónica - 2x5MHz 800MHz & 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	*1*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		**1**	**1**	**0**	**0**	**0**	**410,500**

Table 39: Telefónica - 2x10MHz 800MHz & 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	0	4	0	0	0	400,500
	Difference	*-1*	*4*	*0*	*0*	*0*	*-165,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		**2**	**1**	**0**	**0**	**0**	**583,500**

Table 40: Telefónica - 2x15MHz 800MHz & 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	6	0	0	9	2,187,220
	Difference	*0*	*2*	*0*	*0*	*4*	*112,176*
ASM value		*3*	*1*	*0*	*0*	*0*	*930,676*

Table 41: Telefónica - 2x20MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	*3*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	7	0	0	9	2,240,920
	Difference	*0*	*3*	*0*	*0*	*4*	*165,876*
ASM value		*4*	*0*	*0*	*0*	*0*	*909,376*

Table 42: EE - 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**0**	**1**	**0**	**0**	**0**	**73,500**

Table 43: EE - 2x10MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**0**	**2**	**0**	**0**	**0**	**128,000**

Table 44: EE - 2x15MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**0**	**3**	**0**	**0**	**0**	**173,500**

Table 45: EE - 2x20MHz 2.6GH - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**0**	**4**	**0**	**0**	**0**	**228,000**

Table 46: EE - 2x25MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	**0**	**0**	**0**	**0**	**-4**	**-30,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	7	0	0	9	2,240,920
	Difference	**0**	**3**	**0**	**0**	**4**	**165,876**
ASM value		**0**	**5**	**0**	**0**	**0**	**263,876**

Table 47: EE - 2x30MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	**0**	**0**	**0**	**0**	**-4**	**-30,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	6	0	0	9	2,187,220
	Difference	**0**	**2**	**0**	**0**	**4**	**112,176**
ASM value		**0**	**6**	**0**	**0**	**0**	**310,176**

Table 48: EE - 2x35MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	7	0	0	9	2,240,920
	Difference	*0*	*3*	*0*	*0*	*4*	*165,876*
ASM value		*0*	*7*	*0*	*0*	*0*	*363,876*

Table 49: EE - 2x40MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	8	0	0	5	2,237,200
	Difference	*0*	*4*	*0*	*0*	*0*	*162,156*
ASM value		*0*	*8*	*0*	*0*	*0*	*390,156*

Table 50: EE - 2x45MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
HKT	Winning bid	0	0	0	0	0	0
	Alternative	0	0	0	0	2	10,250
	Difference	**0**	**0**	**0**	**0**	**2**	**10,250**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	2	0	0	0	665,500
	Difference	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	4	0	0	0	325,431
	Difference	**0**	**1**	**0**	**0**	**-4**	**-15,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	8	0	0	7	2,250,000
	Difference	**0**	**4**	**0**	**0**	**2**	**174,956**
ASM value		**0**	**9**	**0**	**0**	**0**	**398,206**

Table 51: EE - 2x5MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**1**	**0**	**0**	**0**	**0**	**25,000**

Table 52: EE - 2x10MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**1**	**0**	**0**	**0**	**0**	**25,000**

Table 53: EE - 2x15MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**1**	**0**	**0**	**0**	**0**	**25,000**

Table 54: EE - 2x20MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
	ASM value	**1**	**0**	**0**	**0**	**0**	**25,000**

Table 55: EE - 2x25MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
	ASM value	**1**	**0**	**0**	**0**	**0**	**25,000**

Table 56: EE - 2x30MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*1*	*0*	*0*	*0*	*0*	*25,000*

Table 57: EE - 2x35MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*1*	*0*	*0*	*0*	*0*	*25,000*

Table 58: EE - 2x40MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*1*	*0*	*0*	*0*	*0*	*25,000*

Table 59: EE - 2x45MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	2	0	0	0	0	590,500
	Difference	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*1*	*0*	*0*	*0*	*0*	*25,000*

Table 60: H3G - 2x5MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*0*	*1*	*0*	*0*	*0*	*73,500*

Table 61: H3G - 2x10MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*0*	*2*	*0*	*0*	*0*	*128,000*

Table 62: H3G - 2x15MHz 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	5	0	0	9	2,133,520
	Difference	*0*	*1*	*0*	*0*	*4*	*58,476*
ASM value		*0*	*3*	*0*	*0*	*0*	*156,476*

Table 63: H3G - 2x5MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	*1*	*-1*	*0*	*0*	*0*	*310,500*
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*1*	*0*	*0*	*0*	*0*	*384,000*

Table 64: H3G - 2x10MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	**1**	**-1**	**0**	**0**	**0**	**310,500**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**1**	**0**	**0**	**0**	**0**	**384,000**

Table 65: H3G - 2x15MHz 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	4	4	0	0	0	1,798,000
	Difference	**3**	**-3**	**0**	**0**	**0**	**748,500**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	3	0	0	0	310,431
	Difference	**0**	**0**	**0**	**0**	**-4**	**-30,000**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	5	0	0	9	2,133,520
	Difference	**0**	**1**	**0**	**0**	**4**	**58,476**
ASM value		**3**	**0**	**0**	**0**	**0**	**904,976**

Table 66: Generic addition 2x5MHz in 800MHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	2	6	0	0	0	1,360,000
	Difference	**1**	**-1**	**0**	**0**	**0**	**310,500**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**1**	**0**	**0**	**0**	**0**	**384,000**

Table 67: Generic addition 2x5MHz in 2.6GHz - combined 800MHz category

Bidder		A1	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	7	0	0	0	1,049,500
	Alternative	1	7	0	0	0	1,049,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
H3G	Winning bid	1	0	0	0	0	565,500
	Alternative	1	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	3	0	0	4	340,431
	Alternative	0	2	0	0	5	287,931
	Difference	**0**	**-1**	**0**	**0**	**1**	**-52,500**
Telefónica	Winning bid	2	0	0	0	0	1,219,003
	Alternative	2	2	0	0	0	1,347,003
	Difference	**0**	**2**	**0**	**0**	**0**	**128,000**
Vodafone	Winning bid	2	4	0	0	5	2,075,044
	Alternative	2	4	0	0	4	2,073,044
	Difference	**0**	**0**	**0**	**0**	**-1**	**-2,000**
ASM value		**0**	**1**	**0**	**0**	**0**	**73,500**

A.1.2 Case 2: Separate 800MHz categories

Table 68: Vodafone - 2x5MHz 800MHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	**1**	**0**	**-1**	**0**	**0**	**0**	**310,500**
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	4	285,431
	Difference	**0**	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	**0**	**0**	**2**	**0**	**0**	**0**	**128,000**
ASM value		**1**	**0**	**0**	**0**	**0**	**0**	**383,500**

Table 69: Vodafone - 2x10MHz 800MHz – 2xA1 only - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	**3**	**0**	**-3**	**0**	**0**	**0**	**748,500**
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	0	4	0	0	0	400,500
	Difference	**-1**	**0**	**4**	**0**	**0**	**0**	**-165,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	4	285,431
	Difference	**0**	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**2**	**0**	**0**	**0**	**0**	**0**	**528,500**

Table 70: Vodafone - 2x15MHz 800MHz – 3xA1 only - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	**3**	**0**	**-3**	**0**	**0**	**0**	**748,500**
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	**0**	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	4	285,431
	Difference	**0**	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	**0**	**0**	**2**	**0**	**0**	**0**	**128,000**
ASM value		**3**	**0**	**0**	**0**	**0**	**0**	**921,500**

Table 71: Vodafone - 2x5MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	1	0	7	0	0	0	1,049,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	4	285,431
	Difference	**0**	**0**	**-1**	**0**	**0**	**0**	**-55,000**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	**0**	**0**	**2**	**0**	**0**	**0**	**128,000**
ASM value		**0**	**0**	**1**	**0**	**0**	**0**	**73,000**

Table 72: Vodafone - 2x5MHz 800MHz & 2x5MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	*1*	*0*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	0	0	0	0	0	0	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
ASM value		*1*	*0*	*1*	*0*	*0*	*0*	*438,500*

Table 73: Vodafone - 2x10MHz 800MHz & 2x5MHz 2.6GHz - 2xA1 only - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	0	4	0	0	0	400,500
	Difference	*-1*	*0*	*4*	*0*	*0*	*0*	*-165,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*2*	*0*	*1*	*0*	*0*	*0*	*583,500*

Table 74: Vodafone - 2x15MHz 800MHz & 2x5MHz 2.6GHz - 3xA1 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
ASM value		*3*	*0*	*1*	*0*	*0*	*0*	*976,500*

Table 75: Vodafone - 2x5MHz 800MHz 2x20MHz 800MHz - 2xA1 and 1xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	2	0	0	0	690,500
	Difference	*-1*	*1*	*2*	*0*	*0*	*0*	*125,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	4	285,431
	Difference	*0*	*0*	*-1*	*0*	*0*	*0*	*-55,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
ASM value		*2*	*1*	*0*	*0*	*0*	*0*	*946,500*

Table 76: Telefónica - 2x5MHz 800MHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	*1*	*0*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*1*	*0*	*0*	*0*	*0*	*0*	*356,000*

Table 77: Telefónica - 2x10MHz 800MHz - 2xA1 only - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	0	4	0	0	0	400,500
	Difference	*-1*	*0*	*4*	*0*	*0*	*0*	*-165,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*2*	*0*	*0*	*0*	*0*	*0*	*529,000*

Table 78: Telefónica - 2x15MHz 800MHz - 3xA1 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	7	0	0	9	2,240,920
	Difference	*0*	*0*	*3*	*0*	*0*	*4*	*165,876*
ASM value		*3*	*0*	*0*	*0*	*0*	*0*	*884,376*

Table 79: Telefónica - 2x5MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	1	0	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*0*	*0*	*1*	*0*	*0*	*0*	*45,500*

Table 80: Telefónica - 2x5MHz 800MHz & 2x5MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	**1**	**0**	**-1**	**0**	**0**	**0**	**310,500**
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	**0**	**0**	**2**	**0**	**0**	**0**	**100,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**1**	**0**	**1**	**0**	**0**	**0**	**410,500**

Table 81: Telefónica - 2x10MHz 800MHz & 2x5MHz 2.6GHz - 2xA1 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	**3**	**0**	**-3**	**0**	**0**	**0**	**748,500**
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	0	4	0	0	0	400,500
	Difference	**-1**	**0**	**4**	**0**	**0**	**0**	**-165,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**2**	**0**	**1**	**0**	**0**	**0**	**583,500**

Table 82: Telefónica - 2x15MHz 800MHz & 2x5MHz 2.6GHz - 3xA1 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	6	0	0	9	2,187,220
	Difference	*0*	*0*	*2*	*0*	*0*	*4*	*112,176*
ASM value		*3*	*0*	*1*	*0*	*0*	*0*	*930,676*

Table 83: Telefónica - 2x20MHz 800MHz - 2xA1 and 1xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	7	0	0	9	2,240,920
	Difference	*0*	*0*	*3*	*0*	*0*	*4*	*165,876*
ASM value		*2*	*1*	*0*	*0*	*0*	*0*	*909,376*

Table 84: EE - 2x5MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*0*	*0*	*1*	*0*	*0*	*0*	*73,500*

Table 85: EE - 2x10MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*0*	*0*	*2*	*0*	*0*	*0*	*128,000*

Table 86: EE - 2x15MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*0*	*0*	*3*	*0*	*0*	*0*	*173,500*

Table 87: EE - 2x20MHz 2.6GH - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*0*	*0*	*4*	*0*	*0*	*0*	*228,000*

Table 88: EE - 2x25MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	7	0	0	9	2,240,920
	Difference	*0*	*0*	*3*	*0*	*0*	*4*	*165,876*
ASM value		*0*	*0*	*5*	*0*	*0*	*0*	*263,876*

Table 89: EE - 2x30MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	6	0	0	9	2,187,220
	Difference	*0*	*0*	*2*	*0*	*0*	*4*	*112,176*
ASM value		*0*	*0*	*6*	*0*	*0*	*0*	*310,176*

Table 90: EE - 2x35MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	7	0	0	9	2,240,920
	Difference	*0*	*0*	*3*	*0*	*0*	*4*	*165,876*
ASM value		*0*	*0*	*7*	*0*	*0*	*0*	*363,876*

Table 91: EE - 2x40MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	8	0	0	5	2,237,200
	Difference	*0*	*0*	*4*	*0*	*0*	*0*	*162,156*
ASM value		*0*	*0*	*8*	*0*	*0*	*0*	*390,156*

Table 92: EE - 2x45MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
HKT	Winning bid	0	0	0	0	0	0	0
	Alternative	0	0	0	0	0	2	10,250
	Difference	*0*	*0*	*0*	*0*	*0*	*2*	*10,250*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	2	0	0	0	665,500
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*100,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	4	0	0	0	325,431
	Difference	*0*	*0*	*1*	*0*	*0*	*-4*	*-15,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	8	0	0	7	2,250,000
	Difference	*0*	*0*	*4*	*0*	*0*	*2*	*174,956*
ASM value		*0*	*0*	*9*	*0*	*0*	*0*	*398,206*

Table 93: EE - 2x5MHz 800MHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	2	0	0	0	0	0	1,219,002
	Difference	*2*	*-1*	*0*	*0*	*0*	*0*	*-1*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*1*	*0*	*0*	*0*	*0*	*0*	*24,999*

Table 94: EE - 2x10MHz 800MHz - 0xA1 and 1xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**

Table 95: EE - 2x15MHz 800MHz - 1xA1 and 1xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**

Table 96: EE - 2x20MHz 800MHz - 2xA1 and 1xA2 – 0xA1 and 2xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*

Table 97: EE - 2x25MHz 800MHz - 3xA1 and 1xA2 – 1xA2 and 2xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*

Table 98: EE - 2x30MHz 800MHz - 4xA1 and 1xA2 - 2xA1 and 2xA2 - 0xA1 and 3xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**

Table 99: EE - 2x35MHz 800MHz - 5xA1 and 1xA2 – 3xA1 and 2xA2 – 1xA1 and 3xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASM value		**-1**	**1**	**0**	**0**	**0**	**0**	**25,000**

Table 100: EE - 2x40MHz 800MHz - 6xA1 and 1xA2 – 4xA1 and 2xA2 – 2xA1 and 3xA2 – 0xA1 and 4xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*

Table 101: EE - 2x45MHz 800MHz - 7xA1 and 1xA2 – 5xA1 and 2xA2 – 3xA1 and 3xA2 – 1xA1 and 4xA2 - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	0	1	0	0	0	0	590,500
	Difference	*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	0	0	0	0	1,219,003
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*-1*	*1*	*0*	*0*	*0*	*0*	*25,000*

Table 102: H3G - 2x5MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	1	0	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*0*	*0*	*1*	*0*	*0*	*0*	*73,500*

Table 103: H3G - 2x10MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	1	0	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	4	340,431
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	5	2,075,044
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
ASM value		*0*	*0*	*2*	*0*	*0*	*0*	*128,000*

Table 104: H3G - 2x15MHz 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	1	0	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	5	0	0	9	2,133,520
	Difference	*0*	*0*	*1*	*0*	*0*	*4*	*58,476*
ASM value		*0*	*0*	*3*	*0*	*0*	*0*	*156,476*

Table 105: H3G - 2x5MHz 800MHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	*1*	*0*	*-1*	*0*	*0*	*0*	*310,500*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*1*	*0*	*0*	*0*	*0*	*0*	*384,000*

Table 106: H3G - 2x10MHz 800MHz - 2xA1 only - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	*1*	*0*	*-1*	*0*	*0*	*0*	*310,500*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*1*	*0*	*0*	*0*	*0*	*0*	*384,000*

Table 107: H3G - 2x15MHz 800MHz - 3xA1 only - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	4	0	4	0	0	0	1,798,000
	Difference	*3*	*0*	*-3*	*0*	*0*	*0*	*748,500*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	3	0	0	0	310,431
	Difference	*0*	*0*	*0*	*0*	*0*	*-4*	*-30,000*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	5	0	0	9	2,133,520
	Difference	*0*	*0*	*1*	*0*	*0*	*4*	*58,476*
ASM value		*3*	*0*	*0*	*0*	*0*	*0*	*904,976*

Table 108: Generic addition 2x5MHz in 800MHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	2	0	6	0	0	0	1,360,000
	Difference	*1*	*0*	*-1*	*0*	*0*	*0*	*310,500*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*1*	*0*	*0*	*0*	*0*	*0*	*384,000*

Table 109: Generic addition 2x5MHz in 2.6GHz - separate 800MHz category

Bidder		A1	A2	C	D1	D2	E	Bid (in £ 000)
EE	Winning bid	1	0	7	0	0	0	1,049,500
	Alternative	1	0	7	0	0	0	1,049,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
H3G	Winning bid	1	0	0	0	0	0	565,500
	Alternative	1	0	0	0	0	0	565,500
	Difference	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Niche	Winning bid	0	0	3	0	0	4	340,431
	Alternative	0	0	2	0	0	5	287,931
	Difference	*0*	*0*	*-1*	*0*	*0*	*1*	*-52,500*
Telefónica	Winning bid	0	1	0	0	0	0	1,219,003
	Alternative	0	1	2	0	0	0	1,347,003
	Difference	*0*	*0*	*2*	*0*	*0*	*0*	*128,000*
Vodafone	Winning bid	2	0	4	0	0	5	2,075,044
	Alternative	2	0	4	0	0	4	2,073,044
	Difference	*0*	*0*	*0*	*0*	*0*	*-1*	*-2,000*
ASM value		*0*	*0*	*1*	*0*	*0*	*0*	*73,500*