Annex C Recommended process for the assignment of specific frequencies

This annex provides an outline for the recommend process for the assignment of specific frequencies to winners of frequency-generic lots.

Determination of possible assignment plans

The first step in this process is to determine, for each band, the frequency plans that are consistent with the assignment of frequency-generic lots and with the requirement that within each lot category each bidder will be assigned all its spectrum as a contiguous frequency range (the 'candidate plans'), along with any additional band-specific constraints discussed in section 5.2.

We call these the 'candidate assignments'.

Determination of bidder options

The next step is to identify the different options for each winner of frequency-generic lots. To do this, we identify, for each band and each bidder, the alternative combinations of frequency blocks that might be assigned to the bidder in at least one of the candidate assignments. We call these the bidder's 'frequency options'.

In some instances, some bidders will have a unique frequency option for a given band, in which case they will be directly assigned that option without the need for a bidding process. In other instances, bidders may have alternative options, and thus will be allowed to make bids for the alternative options to express their preferences.

Outline of the bidding process

We recommend for the bidding process to follow a sealed bid, second-price, combinatorial bidding process for each of the bands available, which will identify the winning plan:

- each bidder with different frequency options in that band can make (mutually exclusive) bids for its different frequency options – but notice that bidders are not required to make such bids and are in any case guaranteed to win one of their frequency options;

- the value of each candidate plan is calculated as the sum of bids made by bidders for the frequency option they would get in that plan;
- the winning plan is the frequency plan with the highest value (calculated as the sum of bids that bidders made for the frequency option they get in that plan) with any ties broken at random, and the bids for the frequency options in that plan become the winning bids; and
- the prices that winners will be required to pay for the frequency option in the winning plan is determined using an opportunity cost rule that only ensures that the price paid by winners does not exceed their respective bids and is jointly sufficient to outbid loosing bids (thus prices might be lower than winning bids for winners who would have been able to win their option with a lower bid – also notice that the price for any bidder who wins a frequency for which it has not bid will be zero).

Bid submission

An 'assignment bid' is an offer for being assigned a specific frequency option (instead of any of the other options for the bidder). A bidder may submit an assignment bid for every one of its frequency options, though its bid for some or all of its frequency options can be zero.

An assignment bid reflects the maximum price that the bidder would be willing to pay for being assigned that specific frequency option.

Assignment bids simply allow bidders to express specific preferences regarding its frequency options, but bidders are not required to make assignment bids.

Assignment bids must be either zero or positive. By default, and in the event that a bidder does not make a bid for an option, the bid for a frequency option is zero.

Bids are submitted simultaneously for all bands in a single form.

Evaluation of bids

Bids will be evaluated for each band separately.

The 'value' of a candidate plan is calculated as the sum of assignment bids for the frequency options in the plan.

The 'winning plan' for each band will be a candidate plan that achieves the highest value across all the candidate plans for that band, which in the event of a tie will be selected at random. The 'winning bids' are the assignment bids made by bidders' for the option they get in the winning plan in each band.

Calculation of prices

Each bidder will be required to pay a price for being assigned its winning options, which is calculated separately for each band and then aggregated.

The prices that bidders will be required to pay for the frequency options they are assigned in a band is calculated jointly, to take into account the fact that some bidders might win as part of a coalition that jointly outbids other bidders (who would not be outbid by the bidders in the coalition separately) – for these bidders we want to spread the price needed to outbid competitors. Details on the calculation of prices in each are provided in the box below. Bidders would then be required to pay the sum of their prices across all the bands in which they have won spectrum.

By 'prices' (in each band) we refer to a vector of prices that gives us one price for each of the bidders, and by 'individual prices' we refer to the elements of this vector.

We calculate the 'opportunity cost' for a subset of bidders in the band as the difference between:

- the greatest sum of bids from other bidders that could be achieved in any of the candidate plans for that band; and
- the sum of winning bids for that band from other bidders.

The prices in the band are calculated jointly by applying the following conditions:

- the sum of individual prices for each subset of bidders[1] cannot exceed the sum of their winning bids;
- the sum of individual prices for each subset of bidders[2] must be at least the opportunity cost for the subset;
- the sum of individual prices must be the smallest possible subject to prices satisfying the conditions above; and
- the sum of the squared differences between each bidder's individual price and its opportunity cost[3] must be the smallest possible across all prices that satisfy the conditions above.

These conditions yield a unique solution for the prices in each band.

[1] Including the set of all bidders, all possible sets containing only some of the bidders and the sets containing each single bidder.

[2] As above.

[3] I.e. the assignment opportunity cost for the subset including only this bidder.