CAMBRIDGE
Judge Business School

17 August 2008

DDR Cleared Award Project Team
Spectrum Policy Group, Ofcom
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Re: Response to Question 28, DDR Consultation of 6 June 2008

Dear Project Team members,

In this letter, I am responding to the consultation for the Digital Dividend Review: 550-630 MHz and 790-854 MHz Consultation on detailed award design, 6 June 2008. Kalpesh Brahmbhatt informed me that I would be permitted to submit my response early in the week beginning Monday 18 August. I have attached as well the Ofcom consultation coversheet as well. Specifically, I am addressing Question 28: Do you agree that the combinatorial clock auction is the most suitable auction design for the cleared DDR award?

Response: The underlying idea behind the combinatorial clock auction is good, as the two phases have complementary features. Phase 1, the primary bids round—the clock phase—will facilitate price discovery. Phase 2, the supplementary bids round, is aimed at promoting efficiency. However, it is my considered belief that the auction design requires refinement in order to avoid two problems: (1) difficulty of winner determination and (2) lack of transparency. Specifically, I suggest that Phase 2 be modified to allow for *composite bidding*, which corresponds to "Stage 2" of the PAUSE auction described in Kelly and Steinberg (2000). Such a modification would promote efficiency without suffering from the two above-mentioned problems. Further details are as follows:

(1) Problem of Winner Determination. As discussed in the consultation under "Practical concerns" (8.38–8.58), there is the difficulty of winner determination in combinatorial auctions. However, I take issue with the assertion that the "obvious" computing approach would be to break down the problem into smaller "chunks" that could each be solved in parallel on separate computers. It is unlikely that any winner determination problem that could not be solved by a single computer could be solved on any number of separate computers. Placing restrictions on supplementary bids, as discussed in Section 8.148, might be viewed by bidders as arbitrary, and might nevertheless be unsuccessful in significantly reducing the computational burden on Ofcom.

(2) Problem of Lack of Transparency. At the conclusion of the current Phase 2, it will be very difficult for bidders to understand how the prices and winners were determined. The bidders will need to trust that Ofcom's computers arrived at the "fair" result. This could be the source of difficulties to Ofcom after the auction results were announced.

Suggested refinement of Phase 2. I recommend replacing Phase 2 by a phase of *composite bidding*, based on "Stage 2" of the PAUSE package auction design (Kelly and Steinberg 2000). This will achieve what the current Phase 2 aims to achieve, i.e., promote efficiency by allowing package bidding. However, in this New Phase 2, it will always be possible to accomplish this, since the winner determination problem is obviated under composite bidding. Further, the process of allocating lots and assigning prices will be made transparent to the bidders. In addition, the New Phase 2, like the PAUSE auction design on which it is based, prevents against "package jump bidding."

The New Phase 2 works as follows. As in the existing Phase 2, bidders can make multiple, mutually exclusive bids for alternative package of lots across categories, subject to constraints created by their primary round bids. However, unlike the existing Phase 2, this New Phase 2 would be an ascending bid auction. Rather than submitting a single package bid, each bidder would be required to submit his bid as part of a *composite bid*, which is a set of non-overlapping package bids that cover all the lots in the auction. In general, a bidder will be interested in only a subset of all the lots. However, for those lots on which a bidder has no interest, he fills out his composite bid by making use of previously submitted bids by any of the bidders. The bidding in the New Phase 2 goes through ascending rounds until the auction terminates. Specifically, a package bid composed of k lots is called a *block* of size k. The New Phase 2 progresses in sub-stages, 2, 3, 4, ..., where in sub-stage k a bidder can include in his composite bid only blocks up to size k. This progressive structure on allowable block size thwarts the problem of bidder submission of large inefficient package bids.

Three important consequences of composite bid submission are: (1) Rather than having to face the winner determination problem, Ofcom will have a computationally easy problem to simply verify that composite bid are valid; (2) each losing bidder can compare his bid with the winning composite bid to see why he lost; (3) at the conclusion of the auction, no bidder would prefer to exchange his allocation with that of another bidder ("envy-freeness").

More details can be found in the paper of Kelly and Steinberg (2000), in which the PAUSE auction was developed for a procurement auction for Universal Service support in the U.S.

Reference
Kelly, F. and Steinberg, R, "A Combinatorial Auction with Multiple Winners for Universal Service," *Management Science* 46 (2000), 586–596.

Yours sincerely,

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attachment: Ofcom consultation cover sheet

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