

DIGITAL DIVIDEND SIMULATED AUCTIONS FIRST RESULTS

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Structure

- Model assumptions
 - ▶ Spectrum to be auctioned
 - ▶ Auction design
 - ▶ Participants in the auction
 - ▶ Willingness to pay for spectrum
 - ▶ Modelled scenarios
- Experiments methodology
- First results
- Further stages

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Spectrum to be auctioned

- Digital dividend of 120 MHz
- 15 lots of 8 MHz each
- No consideration of interleaved spectrum
- National licences
- No significant differences between blocks

Auction design

- Open auction (bidders can see each others bids)
Sealed bid auction (each bid is secret)
- Sequential auction (bidders bid for one lot after another)
Simultaneous auction (bids for all lots at the same time)
 - SMR, Simultaneous Multiple-Round Auction
 - One single round
- Individual bidding (bids for individual items)
Combinatorial or package bidding (bids for combinations of items)
- Generic lots (“substitute goods”)
- First-price auction (PWYB, pay what you bid)

Participants in the auction

	Bidder	Market target	Expectations / Interest	Number of lots
1		DTT - SD	Medium	3-12
2	TV BROADCASTER	DTT - HD	Medium	3-15
3		DTT - SD / DTT - HD	Limited / Limited	3-15
4		DTT - SD / MobTV	Limited / Medium	1-15
5		Voice+Data (900)	Limited	1-8
6	MOBILE OPERATOR	Voice+Data (900) / MobTV	Limited / Medium	1-14
7		Voice+Data (no 900) / MobTV	High / Limited	1-14
8		Voice+Data (no 900) / Data	High / Limited	1-15
9		DTT - SD	High	3-12
10		DTT - HD	High	3-15
11		Voice+Data (no 900)	High	1-8
12	NEW ENTRANT	Data	Medium	1-8
13		Data	High	1-8
14		MobTV	Limited	1-6
15		MobTV	High	1-6

DTT - SD	Digital terrestrial television (standard definition)
DTT - HD	Digital terrestrial television (high definition)
MobTV	Mobile television
Voice+Data (900)	Mobile communications (having already spectrum in the 900 MHz band)
Voice+Data (no 900)	Mobile communications (not having spectrum in the 900 MHz band)
Data	Mobile broadband (specialist “data only” product)

Willingness to pay for spectrum

- Maximum and minimum values adapted from range of *producer plus consumer value* estimated by Ofcom
- Three ranges of “interest values”
- Synergies between lots (example “24 MHz objective”)

Number of lots	Synergy value	Coefficient
1	0,5	0,167
2	0,75	0,500
3	1	1,000
4	0,9	1,300
5	0,8	1,567
6	0,7	1,800
7	0,5	1,967
8	0,25	2,050
9	0	0

Willingness to pay for spectrum: an example

MOBILE (DATA CENTRIC)		
	Low value scenario	High value scenario
Ofcom data	1	2,5
€/pound change	0,7413	0,7413
Producer/consumer sharing	0,5	0,5
Number of agents	2	2
Spectrum acquired	24 MHz	24 MHz
Other variables in the model	Dominants Moderated demand	Entrants High demand
Adapted value(M€)	Minimum	Maximum
Limited interest	185	324
Medium interest	255	394
High interest	324	463

Modelled scenarios

A. Service neutrality

B. Pre-assigned blocks

	B1		B2		B3		B4	
	Lots	MHz	Lots	MHz	Lots	MHz	Lots	MHz
DTT	12	96	8	64	4	32	0	0
Mobile TV	0	0	2	16	7	56	5	40
Mobile communications	3	24	5	40	4	32	10	80
		120		120		120		120

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Methodology

- An efficient simulator for combinatorial first-price sealed bid auctions has been developed
- The auctioneer determines the combination of feasible bids that maximizes revenues, i.e., solves the Winner Determination Problem (WDP)
 - ▶ To work out the WDP a heuristic search algorithm has been implemented. The selected algorithm is an A* based on a branch on bids (BOB) with an efficient heuristic formulation based on price
- All the scenarios will be run 100 times in a dual Intel QuadCore® processor machine with 8Gb of RAM memory
 - ▶ All the bidders' valuations change in each execution following a Gaussian distribution between spectrum valuation limits

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First results (Scenario A)

Scenario A

Frequency of lots earned by each bidder

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
0	100	99	100	32	100	20	52	74	100	93	76	76	47	55	13
1	0	0	0	1	0	1	1	5	0	0	2	0	0	4	0
2	0	0	0	15	0	25	21	10	0	0	16	0	0	27	13
3	0	0	0	27	0	30	12	5	0	0	6	12	25	9	20
4	0	0	0	21	0	19	6	0	0	0	0	8	18	4	37
5	0	0	0	4	0	3	6	6	0	0	0	3	4	1	15
6	0	0	0	0	0	2	2	0	0	6	0	1	3	0	2
7	0	1	0	0	0	0	0	0	0	0	0	0	3	0	0
8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

First results (Scenario A)

Bids paid by bidders (considering only successful bids)

	B2	B4	B6	B7	B8	B10	B11	B12	B13	B14	B15
Mean	548.7	447.9	419.5	336.4	258.0	593.9	202.3	389.1	447.3	244.9	600.7
Stand. Dev.		155.8	152.1	152.4	152.9	71.9	62.5	103.2	143.2	101.2	226.1
Max	548.7	736.5	784.5	689.4	510.3	748.4	311.1	636.6	796.5	466.7	949.8
Min	548.7	67.1	63.8	74.2	51.7	517.4	44.5	211.5	262.5	57.6	206.1

Price paid per lot

	B2	B4	B6	B7	B8	B10	B11	B12	B13	B14	B15
Mean	78.4	139.2	137.0	109.8	91.5	94.5	92.2	104.5	114.8	101.9	159.2
Stand. Dev.		25.3	28.1	14.2	29.1	3.9	30.1	10.3	31.1	18.1	32.1
Max	78.4	185.6	191.7	136.7	107.2	97.3	109.8	117.5	136.5	135.1	211.9
Min	78.4	67.1	63.8	74.2	51.7	86.2	44.5	70.5	87.5	57.6	97.2

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Further stages

- Different size of digital dividend?
- Different scenarios?
- Other bidders?
- Other potential synergies (neighbour countries)?
- Whole-Europe auctions?
- Other type of auctions?
 - SMR, Simultaneous Multiple-Round Auction?

COST
605

Econ@Tel. A Telecommunications Economic COST Network
Plenary Meeting. Limassol. 2-4 February 2009

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