# Plans and Procedures for the Experimental Testing of the FCC Package Bidding 

 System for the 700 MHz Band AuctionSubmitted by Cybernomics Inc. under Subcontract FCC-00-003

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## I. Overview

Cybernomics Inc., in consultation with Computech, has designed a test environment and protocol to verify the algorithms and rules of the FCC Package Auction for the 700 MHz Band Auction. The test environment uses human bidders to submit strategic bids into the auction system designed by the FCC and implemented by Computech. The bidders have an incentive to discover and exploit any weaknesses in the system, since they will be paid based on the success of the bids they make in the auction vis-à-vis other participants. In addition, they will be given a monetary bounty for any errors they find in the software implementation of the auction rules. Thus, real people with real incentives will be providing Cybernomics and Computech with feedback on the system operation.

In addition to the human subject checking procedure, Cybernomics is building a backend system to check the solution and eligibility constraints obtained by the Computech system. The backend system will use a different solver than that used by Computech.

Our plan is to have subjects trained in the rules of the auction and then have them participate in a series of auctions. At the end of each day Cybernomics will supply Computech with a summary of the results of the experiments and comments by subjects. Any discrepancies between what the system provides and what the backend or subjects' calculate will be the first items in the report.

## II. Backend Checking Procedure

Cybernomics is developing a backend system that will take the round bids in a standard format and calculate the optimal set of winning bids (bids that maximize revenue and allow each license to be assigned to at most one bidder). The solver used by Cybernomics is based on an off-the-shelf package XA (a professional linear/integer programming system). In addition to XA, Cybernomics has written code to check for minimum bids and eligibility. We will be using a dual Pentium III 500 Mhz processor with 500 MB of memory to run the backend. We will post our calculation results on the website $\mathrm{http}: / /$ linus.econlab.arizona.edu/Test after each round.

## III. Experimental Procedure

The Computech system will be tested in the Economic Science Laboratory (ESL) at the University of Arizona using methods in Experimental Economics. The auctions that will be conducted at ESL will use human subjects who will participate in a series of auctions. The subjects will be motivated to participate by being paid based on the success of the bids they make in the auction. Each subject will be paid the difference
between their private value for any license they obtain, minus the cost of winning that license in the auction. The private values of each license to each subject will be induced. That is, each license and several packages of licenses will have monetary values for the subjects. They get these values if they win the licenses. Of course they must pay their bids for the license package they win. In the table below, we supply the values for 15 bidders in two environments. Values are stated in experimental dollars that can be redeemed in our experiment at a rate of $1,000,000$ experimental dollars equals one US dollar. Thus, in Table 1, subject 9 has a value of 200,000,000 experimental dollars for license 10 MHz - Northeast.

Table 1
Value Parameters (Values are stated in US Dollars)
Warm-up Case
Subjects $\rightarrow$

| License | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 10-NE | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 200 | 100 | 100 | 100 | 100 | 100 | 100 |
| 10-MA | 50 | 50 | 50 | 50 | 50 | 150 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 10-SE | 150 | 150 | 150 | 250 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| 10-GL | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 200 | 100 | 100 | 100 | 100 |
| 10-CM | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 175 | 75 | 75 | 75 |
| 10-P | 120 | 120 | 120 | 120 | 220 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| 20-NE | 270 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 |
| 20-MA | 200 | 200 | 200 | 200 | 200 | 200 | 300 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| 20-SE | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 400 | 300 |
| 20-GL | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 150 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 20-CM | 75 | 75 | 175 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 |
| $20-\mathrm{P}$ | 100 | 200 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| $10-$ <br> NE,SE,GL | NA | NA | NA | NA | NA | NA | NA | NA | NA | 350 | NA | NA | NA | NA | NA |
| $10-P, 20-$ <br> NE,MA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 490 | NA | NA |
| 20-CM,P | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 275 |

Boundary Case

| License | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 10-NE | 78 | 56 | 27 | 16 | 23 | 33 | 87 | 12 | 61 | 56 | 51 | 61 | 92 | 95 | 20 |
| 10-MA | 99 | 107 | 4 | 103 | 87 | 22 | 33 | 69 | 128 | 90 | 2 | 57 | 122 | 138 | 58 |
| 10-SE | 37 | 86 | 100 | 29 | 49 | 51 | 34 | 12 | 33 | 74 | 41 | 44 | 7 | 45 | 32 |
| 10-GL | 47 | 150 | 83 | 79 | 1 | 14 | 2 | 151 | 69 | 195 | 124 | 151 | 54 | 129 | 55 |
| 10-CM | 127 | 39 | 130 | 243 | 173 | 95 | 116 | 8 | 281 | 46 | 53 | 10 | 32 | 24 | 52 |
| 10-P | 56 | 52 | 39 | 60 | 29 | 38 | 65 | 78 | 100 | 77 | 54 | 97 | 82 | 71 | 44 |
| 20-NE | 120 | 124 | 73 | 22 | 125 | 122 | 129 | 91 | 101 | 64 | 87 | 115 | 19 | 146 | 71 |
| 20-MA | 48 | 81 | 70 | 61 | 108 | 111 | 46 | 52 | 82 | 71 | 19 | 72 | 118 | 44 | 41 |
| 20-SE | 96 | 44 | 43 | 76 | 48 | 95 | 87 | 93 | 52 | 50 | 16 | 29 | 80 | 98 | 92 |
| 20-GL | 27 | 180 | 88 | 137 | 43 | 7 | 60 | 193 | 134 | 72 | 190 | 197 | 88 | 9 | 137 |


| $20-\mathrm{CM}$ | 285 | 273 | 142 | 246 | 144 | 235 | 196 | 286 | 184 | 289 | 263 | 195 | 277 | 61 | 239 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| $20-\mathrm{P}$ | 59 | 63 | 66 | 29 | 67 | 59 | 36 | 12 | 67 | 81 | 16 | 73 | 15 | 57 | 18 |


| NE,MA |  |  | 35 | 171 | 138 | 59 | 162 | 137 |  | 151 | 55 | 130 | 219 | 117 |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| NE,SE |  | 145 | 137 | 85 | 107 | 131 | 161 | 43 | 97 |  | 174 | 172 | 172 |  | 99 |
| NE,P | 148 | 154 | 116 | 95 | 99 | 113 |  | 93 | 197 |  | 179 |  |  |  | 111 |
| P2,GL | 125 |  | 252 | 176 | 90 | 102 | 51 | 276 | 143 |  | 222 |  | 93 |  | 89 |
| P2,GL2 | 160 |  | 186 | 194 | 144 | 125 | 115 |  | 235 | 287 |  |  | 163 | 107 | 204 |
| P2,SE2 | 214 | 142 |  | 142 |  |  |  | 116 | 135 |  | 65 | 152 | 101 |  |  |
| CM,NE2 | 437 | 273 | 382 |  |  | 247 | 280 | 164 |  | 196 | 199 | 239 | 83 | 181 | 144 |
| CM,MA2 | 278 | 202 | 325 | 420 |  | 366 | 189 | 78 |  | 151 | 142 | 146 | 205 | 111 | 138 |
| CM,CM2 |  | 596 | 458 |  | 350 | 421 |  | 516 | 538 | 368 | 469 | 310 | 313 | 158 | 481 |
| MA,GL2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 360 |
| GL,CM2 |  |  | 525 |  |  |  |  |  |  |  |  |  |  |  |  |
| SE2,P2 |  |  |  | 225 |  |  |  |  |  |  |  |  |  |  |  |
| NE,GL,CM | 421 | 401 | 302 | 409 | 240 | 158 | 388 | 306 |  | 529 | 290 | 295 | 328 | 435 | 210 |
| NE,NE2,MA2 |  |  | 360 | 258 |  | 25 | 260 | 320 |  |  |  | 303 |  | 278 |  |
| GL,CM,P | 406 | 274 | 500 | 409 | 272 | 180 | 267 | 322 |  | 385 | 264 | 294 | 196 | 405 | 295 |
| GL2,CM2,P2 |  |  | 363 | 507 | 398 | 371 | 456 |  |  | 505 | 571 |  | 466 | 247 | 503 |
| P,NE2,CM2 |  |  | 312 | 384 | 371 |  |  |  |  |  | 455 | 513 |  | 325 | 465 |
| NE2,MA2,SE2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

## IV. Reporting Process

Cybernomics will issue a report after each auction day. The report will consist of any anomalies in the results and potential errors discovered by subjects. In addition, we will post results on our website so that the round files can be compared. The report will also consist of remarks by subjects on screen displays and any other hard to understand interfaces. Any rule inconsistencies or potential loopholes will be reported if found.

## V. Task Plan

Table 2 below lists our planning and reporting timeline.
Table 2
Timeline

| August |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Task | 4 | 5 |  | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| Task Plan |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Protocols and Parameters |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Rule <br> Analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Backend <br> Programming |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Subject Training |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Conduct Auction and Report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

