



The First Combinatorial Spectrum Auction

Lessons from the Nigerian auction of fixed wireless access licences

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- ❑ 2001: Nigerian Communications Commission (NCC) announced plans to allocate licences for Fixed Wireless Access (FWA) services
- ❑ Total of 80 licences across 31 states (2/3 per state)
- ❑ DotEcon, working with Radio Spectrum International, designed the licensing process
- ❑ Completed in June 2002 – 67 licences allocated, successful bids totalling 3.78bn Naira (US\$38mn)

The challenge

❑ NCC objectives

1. Transparency

2. Efficiency

3. Regional roll-out

➤ Suggests auction

➤ Large no. of lots, potential synergies / aggregation risks

❑ Lack of market information and potential winners' curse

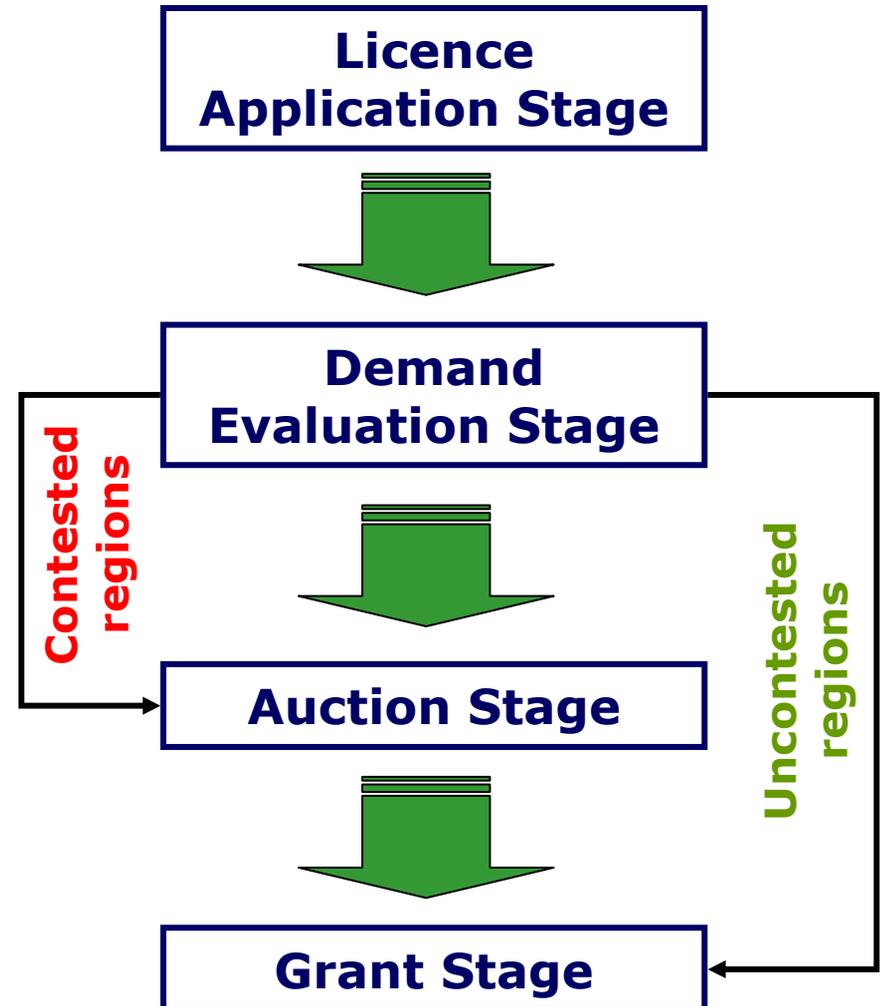
➤ Suggests open, multi-round auction

❑ Unreliable infrastructure

➤ Rules out remote bidding (e.g. over internet) and complex auction formats

Therefore, we developed a multi-stage process

- ❑ Obtain information about level and structure of demand
- ❑ Use to design simple & practicable auction with minimum efficiency loss
 - ❑ Single round sealed bid auction
 - ❑ Combinatorial bids possible, where there are synergies

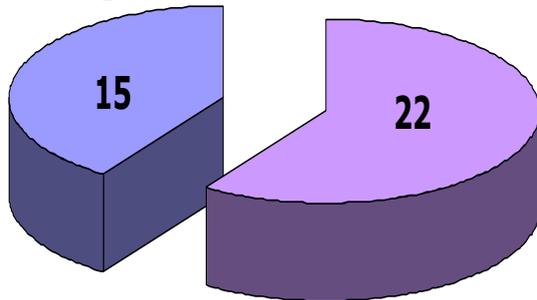


- ❑ Bidders submitted demands for licences at the reserve prices
- ❑ Bids were **binding** and **constraining** – provides incentive to reveal true preferences
- ❑ To allow bidders to manage aggregation risks, two special features:
 - ❑ Up to 5 separate, mutually exclusive combinatorial bids
 - ❑ Individual states marked as 'critical' or 'non-critical'

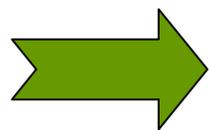
Demand evaluation produced two key observations

① Excess demand in many regions

Uncontested regions

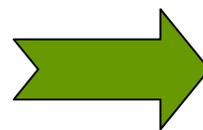
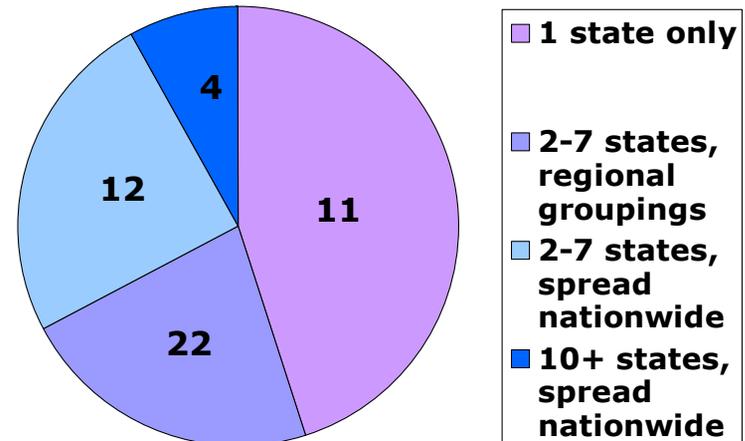


Contested regions



Auction stage required

② Evidence of synergies between states, but varying by bidder



Auction design must consider bidder aggregation risks

Our solution: A series of five sealed bid combinatorial auctions



- ❑ Publish results of demand evaluation – helps bidders to understand competitive environment
- ❑ Divide 22 states into 5 groups of 4-5 states
- ❑ Group together states where there are strong synergies
- ❑ Run separate one-shot combinatorial auctions for each group
 - ❑ Bidders can only bid for states and/or combinations of states that they originally applied for
 - ❑ Tailored bid forms for each bidder showing their options
- ❑ Use computer algorithm to determine set of bids that produces the highest total value
- ❑ Sequence auctions so most important groups come first

Combination		Reserve Price (Naira)	Amount Bid (Whole Naira)	
			in Numbers	in Words
1	Delta	N 16,800,000	-	-
2	Lagos	N 28,000,000	<i>N 50,000,000</i>	<i>FIFTY MILLION NAIRA</i>
3	Rivers	N 16,800,000	-	-
4	Abuja	N 16,800,000	<i>N 36,000,000</i>	<i>THIRTY SIX MILLION NAIRA</i>
5	Delta & Lagos	N 44,800,000	-	-
6	Delta & Rivers	N 33,600,000	-	-
7	Delta & Abuja	N 33,600,000	-	-
8	Lagos & Rivers	N 44,800,000	-	-
9	Lagos & Abuja	N 44,800,000	<i>N 95,000,000</i>	<i>NINETY FIVE MILLION NAIRA</i>
10	Rivers & Abuja	N 33,600,000	-	-
11	Delta, Lagos & Rivers	N 61,600,000	-	-
12	Delta, Lagos & Abuja	N 61,600,000	<i>N 120,000,000</i>	<i>ONE HUNDRED AND TWENTY MILLION NAIRA</i>
13	Delta, Rivers & Abuja	N 50,400,000	-	-
14	Lagos, Rivers & Abuja	N 61,600,000	<i>N 120,000,000</i>	<i>ONE HUNDRED AND TWENTY MILLION NAIRA</i>
15	Delta, Lagos, Rivers & Abuja	N 78,400,000	<i>N 160,000,000</i>	<i>ONE HUNDRED AND SIXTY MILLION NAIRA</i>

Auction results



Auction 1

'Critical regions':
Delta, Lagos, Rivers,
Abuja

105 bids

49 combi. bids

N1.64bn revenues

Auction 2

South-west: Edo,
Ogun, Ondo, Oyo

50 bids

22 combi. bids

N827mn revenues

Auction 3

South: Abia, Akwa
Ibom, Bayelsa,
Cross River, Ibo

21 bids

6 combi. bids

441mn revenues

Auction 4

North / Central:
Gombe, Kaduna,
Kano, Nassarawa,
Plateau

22 bids

4 combi. bids

N351mn revenues

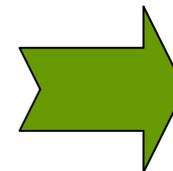
Auction 5

South / Central:
Anambra, Benue,
Ebonyi, Enugu

24 bids

7 combi. bids

N329mn revenues



•**45 bidders**

•**48/50 licences sold**

•**222 bids**

•**88 combination bids**

•**N3.59bn (us\$36mn)
revenues**

Some key observations



- ❑ Where transparency is crucial – auctions can offer a key advantage over other allocation systems
- ❑ There are ways around lack of infrastructure but these preclude complex SMRAs
- ❑ Understanding demand is crucial for auction design
 - ❑ Without the initial application stage, we could not have designed this auction
 - ❑ Many other spectrum auctions poor results (eg many 3G contests) owing to bad design
- ❑ Bidders can cope with sophisticated combinations – but grouping more than 5 states would add significant complexity
- ❑ Payment – Bidders paid what they bid, seen as transparent but created disparities that may have encouraged defaults

Future applications:



- ❑ Combinatorial bidding provides a tool for:
 - ❑ extending sealed bids to situations where separate sealed bids for each lot could produce grossly inefficient outcomes
 - ❑ Making a sealed bid more efficient where multi-rounds impractical or not cost-effective
- ❑ Klemperer (2002): sealed bids may also be more appropriate than multi-round auctions where
 - ❑ competition is weak; or
 - ❑ collusion is a concern
- ❑ For telecoms, most likely applications are situations where:
 - ❑ there are large numbers of regional licences;
 - ❑ there are significant cross-regional synergies
 - ❑ value of individual licences is modest and demand uncertain; and/or
 - ❑ not possible to rely on local communications infrastructure to run auctions remotely