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Complexity in spectrum auctions: how much is too much?

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Richard Marsden

Managing Director, NERA Economic Consulting
New York City

Insight in Economics™

NERA – Recent experience

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Incentive Auction

- Simulation software for broadcasters who together accounted for >15% of nationwide revenues (US$1.5bn+)
- Four firewalled groups providing support to participants in the forward & reverse auctions
- Analysis of auction rules and channel share arrangements for broadcasters
- Support to rural mobile operators lobbying FCC regarding geographic license size

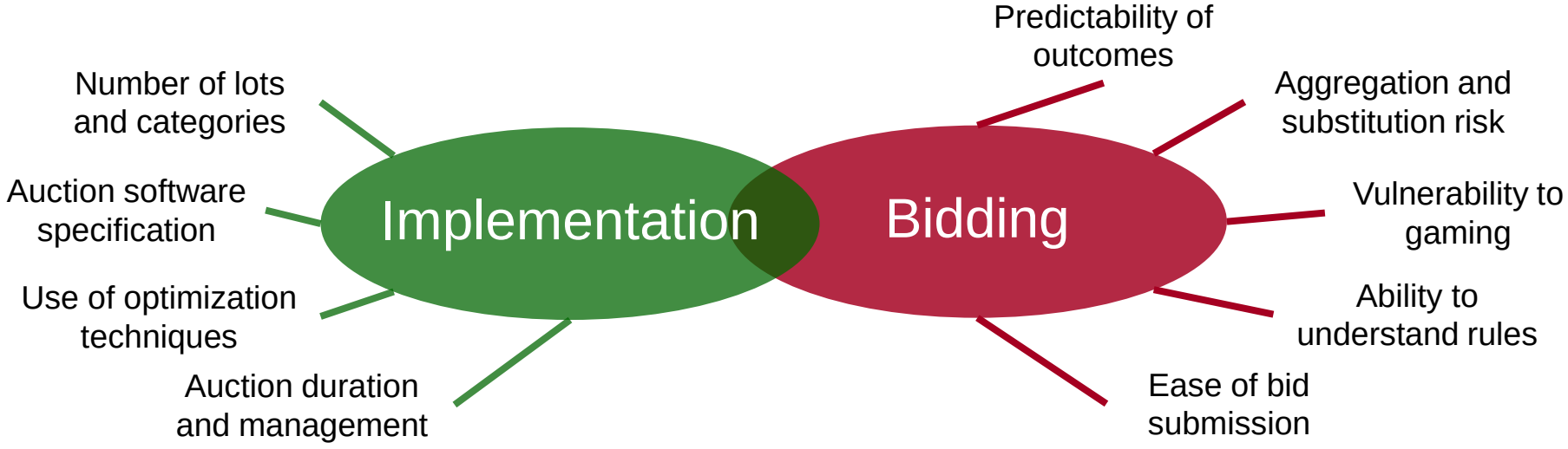
Other recent projects

- Design and implementation of spectrum auctions in Mexico, Singapore & Saudi Arabia
- Bid strategy support for mobile operators in awards around the world (Canada, Costa Rica, Germany, Ireland, Myanmar …)
- Reports on effective spectrum pricing for GSMA:

  www.gsma.com/spectrum/effective-spectrum-pricing

What do we mean by "complexity" in auction design?

- Common perspective is that spectrum auctions are becoming increasingly complex
  - In fact, many new features have simplified the bidding process
  - Main area of controversy is use of package bidding and optimization techniques
- Important distinction between implementation complexity (for auctioneer) and bidding complexity (for bidders)



Best Practice

Design auctions to be as simple as possible without sacrificing core policy goals

If complex situations, it is preferable for auctioneer to take on greater implementation complexity if this can reduce bidding complexity

“New features” in auction design

North American regulators have embraced “new features” in auction design designed to:

- Simplify bidding process
- Reduce risk for bidders
- Eliminate gaming options

Recent North American auctions for cellular spectrum	 Generic lots for each band or category	 Clock pricing With non-discretionary bid increments	 Limited information	 Optimization / Package bidding
 2500 MHz	✓	✓	✓	✓
 AWS	✓	✓	✓	✓
 600 MHz Reverse	✓	✓	✓	✓
600 MHz Forward	✓	✓	✓	✗

How do these features impact complexity?

- Many of these new features are (relatively) uncontroversial and likely to be common to many auctions going forward:

Generic lots

- promotes contiguous assignment, simplifies bidding

Clock prices

- simplifies bidding, eliminates price signaling

Limited information

- maintains scope for price discovery while making gaming more risky

In many situations, these features are easy to implement and tend to make bidding easier and bid strategy more straightforward

- The impact of package bidding and optimization is more complicated to assess:

Optimization & package bidding

- Highly flexible tools for achieving policy goals (e.g. US repack or Mexico AWS band defragmentation)
- In complex settings, bidders struggle to understand rules and dislike outcome uncertainty
- Practitioners still in learning phase regarding impact of these tools on bidder behavior

These tools are much more complex to implement and their impact on bidding is ambiguous

Case study: US Reverse Auction for broadcasters

- Key features of Reverse Auction design
  - Maximum implementation complexity: repacking algorithm
  - Very simple bidding rules: accept / reject price
- Efficient repack would not have been possible without optimization algorithm
- However, this approach also had downsides:
  - Very challenging for bidders to comprehend broader process
  - Huge asymmetry in understanding of auction process across broadcasters
- Unclear whether these issues had any impact on bid behavior in auction, but they certainly affected the secondary market
  - Few broadcasters had good tools for estimating auction revenues and those that did had to grapple with uncertainty over clearing scenario
  - Impossible to estimate value of high-VHF stations with any certainty
  - ➢ Very challenging to agree channel share deals
  - ➢ Many station sales were likely mis-valued, some grossly so

Optimization is a powerful tool that could have many future applications

But challenges for bidders created by lack of transparency should not be under-estimated

Case study: Combinatorial clock auction (CCA)

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- Functional package bid auction that has been used to sell spectrum in Canada, Mexico and elsewhere
  - Uses optimization to allocate spectrum in packages
  - Uses "opportunity cost" based pricing rules (winners pay price based on denying spectrum to rivals)
- Originally promoted to regulators on basis that it:

1. **Eliminates aggregation risk** 

2. **Supports fully efficient auction outcomes** 

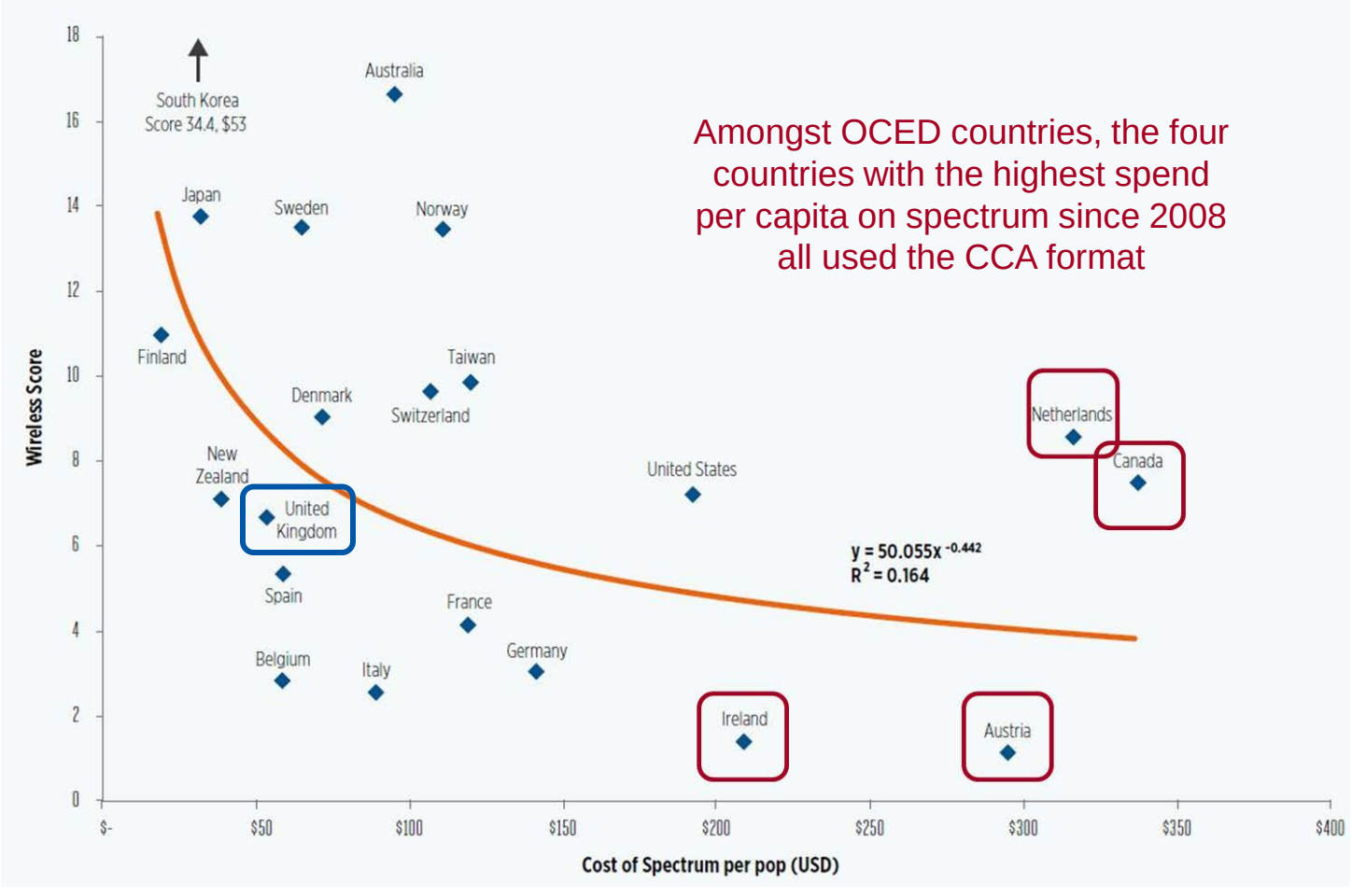
3. **Promotes straightforward bidding & eliminates gaming options** 

- Full package bidding eliminates aggregation risk
- Optimization can facilitate defragmentation (e.g. Mexico AWS)

- CCAs are disproportionately associated with high prices and asymmetric allocations
- Growing academic literature questioning efficiency of CCAs owing to:
  - Missing bids
  - Budget constraints
  - Spiteful bidding

- CCA linked to "aggressive" and "spiteful" bidding
- Both theory and practice have shown that straightforward bidding often not a good tactic

CCA is linked to high and asymmetric price outcomes



Source: NERA Economic Consulting, report for GSMA on effective spectrum pricing

Dutch 4G

Canada 700 MHz

Combination of CCA and entrant set aside resulted in exceptionally high and asymmetric prices

Austria 4G

Combination of CCA and restricted information led to exceptionally high prices despite only the three incumbents bidding

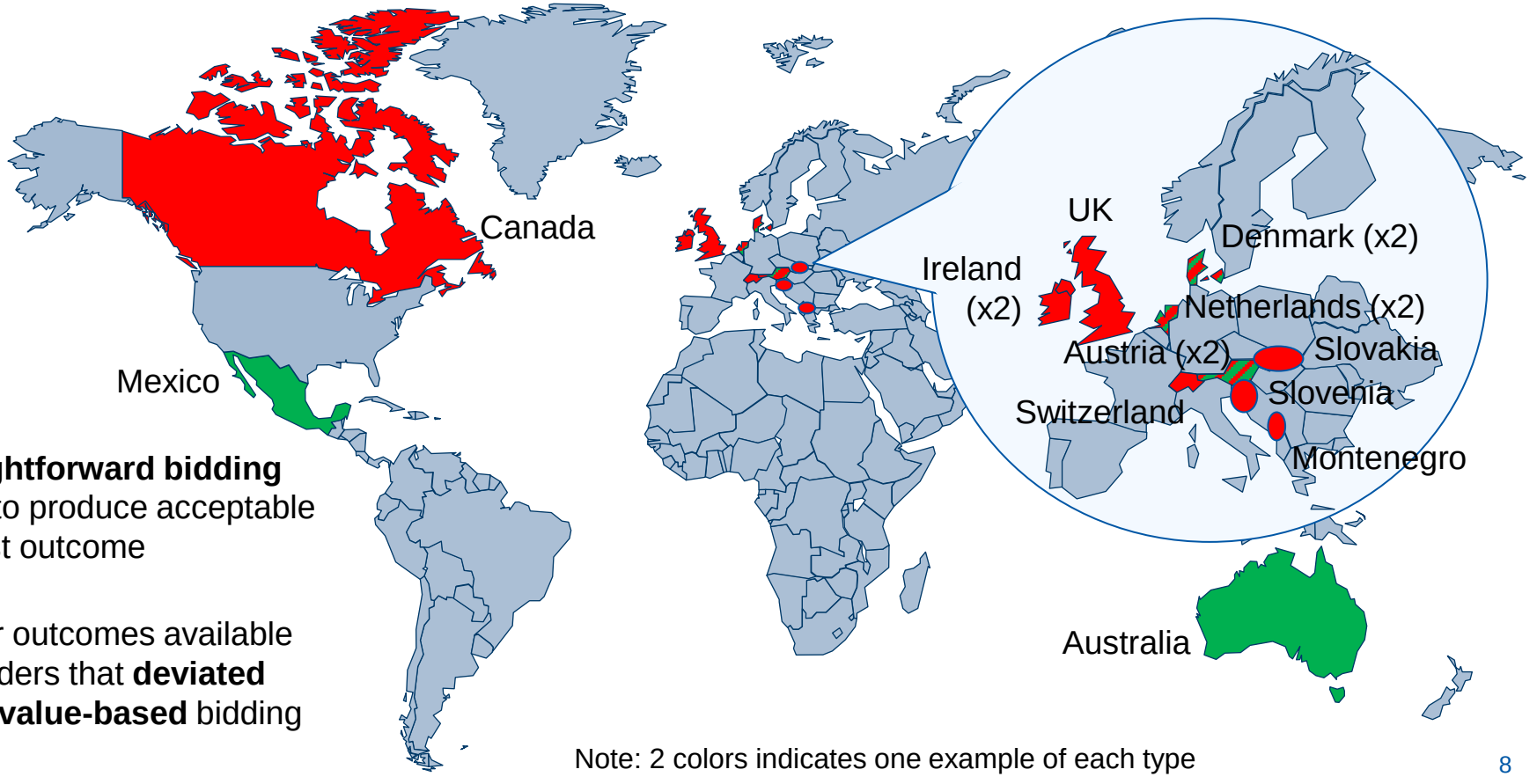
UK 4G

Prices were relatively low but allocation outcome was highly asymmetric – a key bidder later revealed it was budget constrained

“Gaming” behavior in CCAs

- NERA colleagues have been involved in every CCA since 2010, either working for bidders or regulators
- We reviewed all 17 auctions and concluded that “straightforward valuation-based bidding” would only have been a good unilateral strategy for a plurality of bidders in 5 cases

- Typical characteristics of CCAs where “gaming” behavior was advantageous:
  - Multi-band or multi region
  - Lax spectrum caps and/or set asides
  - Predictable asymmetries between bidders
  - Significant excess demand at reserve price



Straightforward bidding likely to produce acceptable or best outcome

Better outcomes available to bidders that **deviated from value-based** bidding

Note: 2 colors indicates one example of each type

What next?

- Regulators appear to be following different paths with respect to implementation complexity in auction design …

Less implementation complexity

Mexico 2.5 GHz – Proposes to use clock auction with no package bidding for award with simple lot structure than previous auctions

UK 2.3 & 3.4 GHz – Ofcom pioneered the CCA format but plans to switch to hybrid SMRA format for dual band award

USA C-band – Despite complex shared use setting, CBRS proposals lend themselves to clock auction with no package bidding

More implementation complexity

Austria 3.6 GHz – Consulting on using CMRA instead of CCA for award that may feature regional licenses

Canada 600 MHz – Consulting on new versions of CCA with more complex activity and pricing rules, despite simpler band plan than previous awards

Denmark 1800 MHz – Implemented new "CMRA" format (first price package bid auction) for award with coverage obligation opt-outs

- But all these auctions will likely share other features that reduce bidding complexity: generic lots, (quasi) clock bidding and limited information

Open question: Is the greater complexity that some regulators are embracing really needed and how will this impact bidders?

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Contact NERA's spectrum & auctions team

Richard Marsden

Managing Director
NERA New York City
+1 212 345 2981
Richard.Marsden@nera.com

Dr Soren Sorensen

Associate Director
NERA London
+44 207 659 8808
Soren.Sorensen@nera.com

Hans-Martin Ihle

Senior Consultant
NERA Tokyo
+81 3 3500 3784
Hans.Ihle@nera.com