Truthful Prioritization Schemes for Spectrum Sharing

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Imagine...
“My brilliant idea...”
“My brilliant idea...”
No wi-fi!
$0.01 / MB?
Tethering is easy

What’s the problem?
Design for sharing
General setting
Design goals

Efficiency

Truthfulness
Contributions

Truthfulness without counterfactuals or probabilistic model of the future

Seller faithfulness via revenue pooling
Contributions

Truthfulness without counterfactuals or probabilistic model of the future

Seller faithfulness via revenue pooling
Focus on single seller
Model sketch

- Bids
  - "My idea..."
  - Allocation period
    - $t$
  - Paid!

- Verification
- Server
Model sketch

Constant per-packet value per period

Routing-independent demand
Efficiency: priority routing
Priority routing
Priority routing

What about payments?
Truthfulness: VCG?

Computes correct externality
A problem with VCG

(bid value without you) - (bid value with you)
A problem with VCG

(bid value without you) - (bid value with you)

Realized allocation
A problem with VCG

Counterfactual allocation - not available

(bid value without you) - (bid value with you)
VCG not feasible

+ Computes correct externality

- Requires unavailable counterfactuals

- Dynamic VCG requires probabilistic model

[Parkes, Singh ’03]
What do we do?

Randomly sample counterfactuals

[Babaioff, Kleinberg, Slivkins ’10]
The BKS Mechanism

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The BKS Mechanism

Compute resampled bid

[Babaioff, Kleinberg, Slivkins ‘10]
With probability $1 - \mu$:

- Pay your bid

- resampled bid = submitted bid

[Babaioff, Kleinberg, Slivkins ’10]
With probability $\mu$

Get rebate based on allocation

[Babaioff, Kleinberg, Slivkins ’10]
Result: Truthful in expectation

[Babaioff, Kleinberg, Slivkins ‘10]
Result: Truthful in expectation

[Babaioff, Kleinberg, Slivkins ’10]
BKS mechanism

+ No counterfactuals needed
+ Truthful-in-expectation
+ “Almost” efficient
  - Large rebates
Simulations

Packet-level simulator

Several buyers sending packets

Router forwarding
Simulation: efficiency

Efficiency loss from bid resampling

Efficient, not truthful

FIFO
Two ideas

Truthfulness without counterfactuals or probabilistic model of the future

Seller faithfulness via revenue pooling
Two ideas

Truthfulness without counterfactuals or probabilistic model of the future

Seller faithfulness via revenue pooling
Seller responsibilities

Correctly resample
Routing priority ~ resampled bids
Give rebates
Seller responsibilities

Correctly resample

Routing priority ~ resampled bids

Give rebates

manipulate → increase revenue
Of course I’ll give you a rebate

BKS relies on seller faithfulness
Solution

Revenue pooling
There are many sellers
Divide into two groups
Use our central server

Rebates paid by center

Sellers credited based on resampled bids
Use our central server

Rebates paid by center

Sellers credited based on resampled bids

First-price auction
Use our central server

Rebates paid by center

Sellers credited based on resampled bids

manipulate ⇒ decrease revenue
Intermediate state

Sellers
- Got all revenue
- Overpaid

Center
- Paid all rebates
- Running deficit
Solution: tax the sellers

Revenue  

Rebate

Revenue  

Rebate
Solution: tax the sellers

Revenue - Rebate

Revenue - Rebate
Solution: tax the sellers

Sellers can’t reduce tax rate
Effect of revenue pooling

Still BKS for buyers

Taxed first-price auction for sellers
Effect of revenue pooling

Still BKS for buyers

Taxed first-price auction for sellers

manipulate $\rightarrow$ decrease revenue
Pooling decreases variance
Pooling decreases variance
Final mechanism

Truthful-in-expectation for buyers

"Almost" efficient

Non-manipulable for sellers
See paper for more details
Conclusions: two ideas

Truthfulness without counterfactuals or probabilistic model of the future

Seller faithfulness via revenue pooling
Questions?

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XKCD!

**Panel 1**: While I'm up, does anyone want a sandwich? Is "sandwich" a metaphor?

**Panel 2**: No, I'm bad at metaphors. But I could try a simile. I guess that's like a metaphor. I sure.

**Panel 3**: Well, "a simile is like a metaphor" is a simile. Is that simile itself a metaphor for something? Maybe it's a metaphor for analogy.

**Panel 4**: Similes are like metaphors in that they're both analogies. Analogies are like sandwiches in that I'm making one now.