Spectrum Auctions
(Stanford CS269I, Lecture 6)

Tim Roughgarden

F.C.C. Backs Proposal to Realign Airwaves

The New York Times

September 28, 2012 **By EDWARD WYATT**

WASHINGTON — The government took a big step on Friday to aid the creation of new high-speed wireless Internet networks that could fuel the development of the next generation of smartphones and tablets, and devices that haven't even been thought of yet.

The five-member Federal Communications Commission unanimously approved a sweeping, though preliminary, proposal to reclaim public airwaves now used for broadcast television and auction them off for use in wireless broadband networks, with a portion of the proceeds paid to the broadcasters.

The initiative, which the F.C.C. said would be the first in which any government would pay to reclaim public airwaves with the intention of selling them, would help satisfy what many industry experts say is booming demand for wireless Internet capacity.

Mobile broadband traffic will increase more than thirtyfold by 2015, the commission estimates. Without additional airwaves to handle the traffic, officials say, consumers will face more dropped calls, connection delays and slower downloads of data.

FCC Incentive Auction

Broadcast Television Incentive Auction (3/16-3/17):

- Reverse Auction: buy TV broadcast licenses
  - Final tally: ≈$10 billion cost
- Forward Auction: sell wireless broadband licenses.
  - Final tally: ≈$20 billion revenue
- Revenue to cover auction costs, fund a new first responder network, reduce the deficit (!)
  - "Middle Class Tax Relief and Job Creation Act"

The Reverse Auction

Reverse Auction Format

"Descending Clock Auction":

[Milgrom/Segal 14] (extending [Moulin/Shenker 01],[Mehta/Roughgarden/Sundararajan 09])

- each round, each broadcaster offered a buyout price (decreases over time)
  - declined => exits, retains license
    accepted => moves to next round
- different prices allowed for different broadcasters

Milgrom

Segal

The Stopping Rule

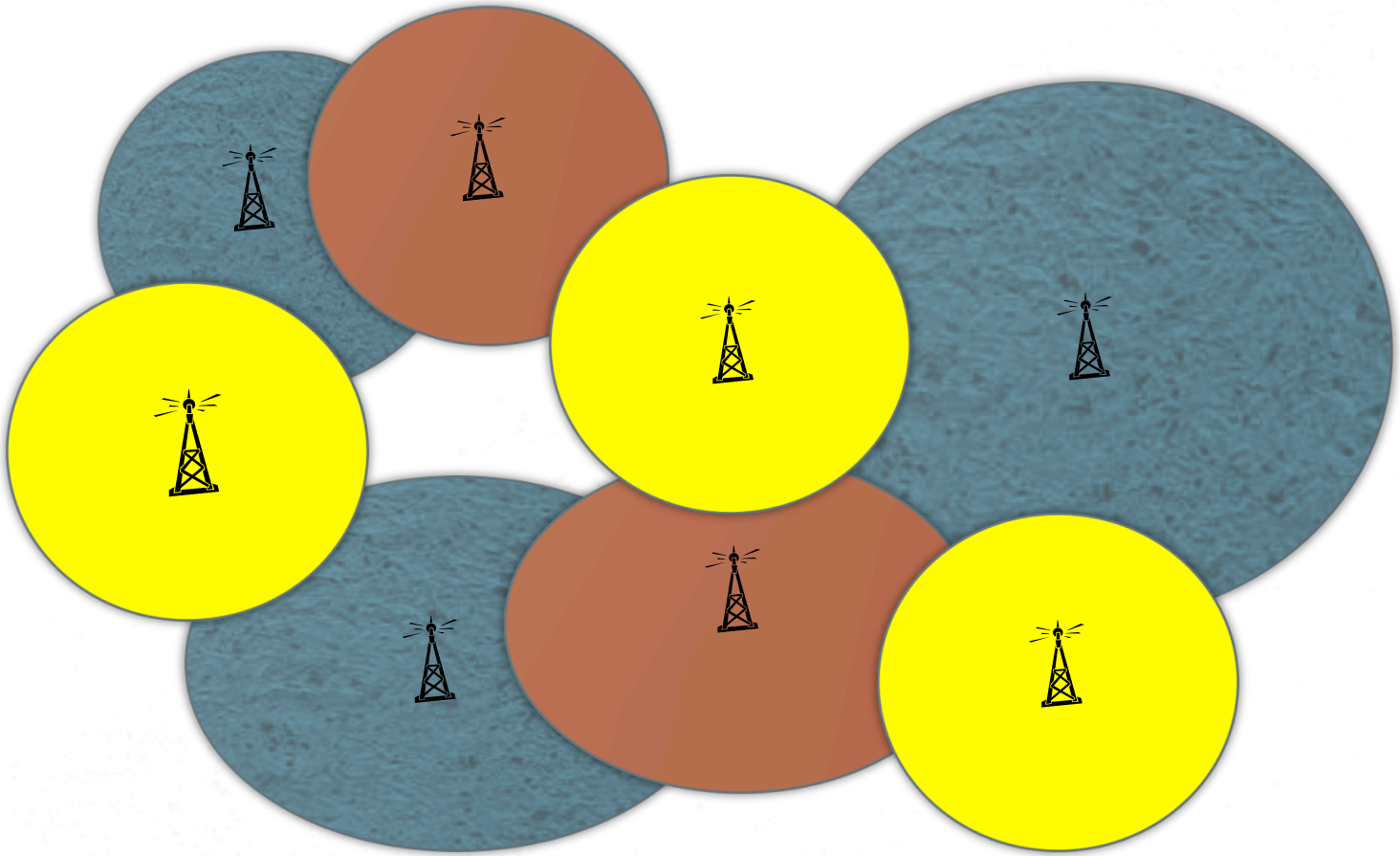
Intuition: stop auction when prices are as low as possible, subject to clearing enough spectrum.

Example goal: from channels 38-51, clear 10 of them nationwide.

Issue: buyouts scattered across channels.

Solution: repack remaining TV stations into a smaller subset of channels (e.g., 38-41).

The Repacking Problem



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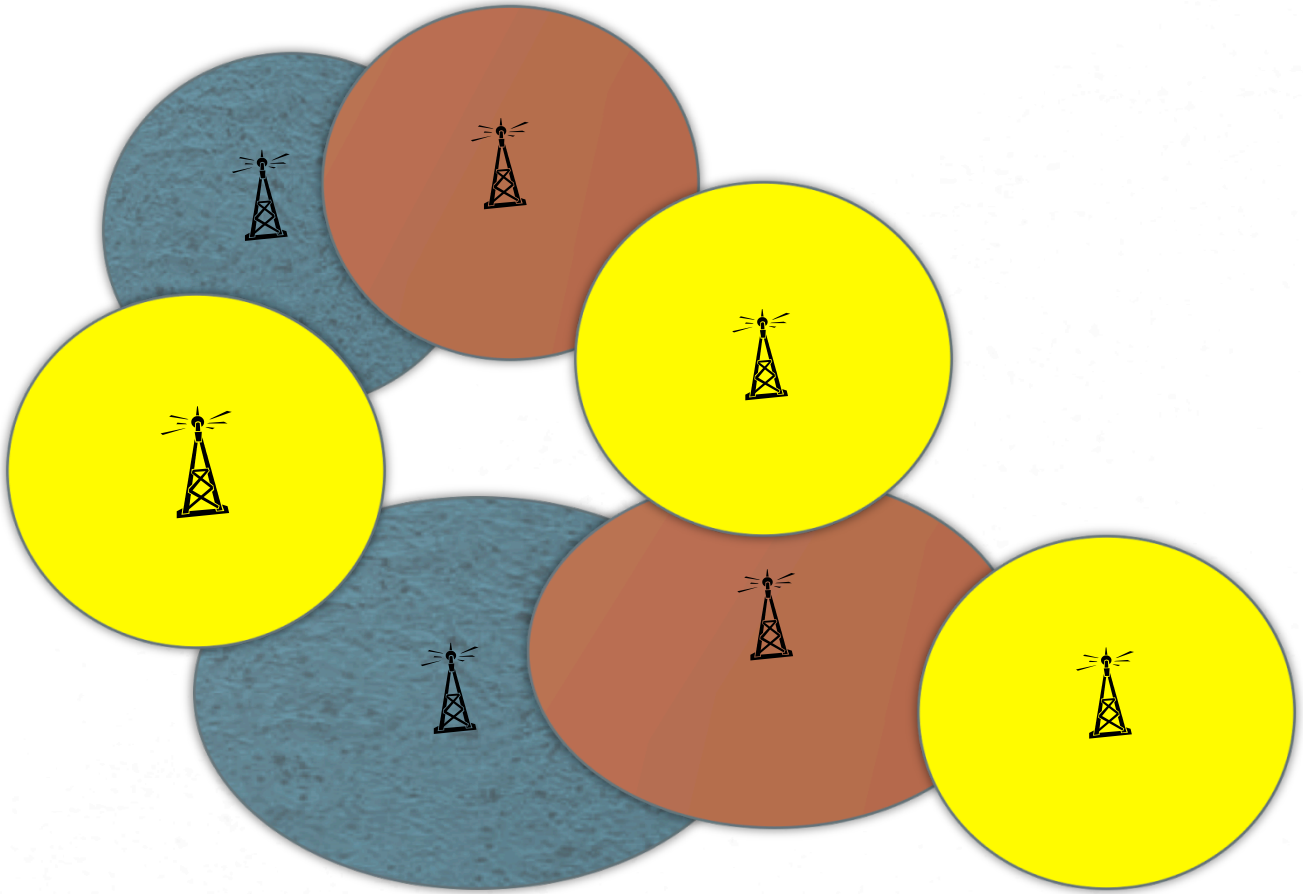

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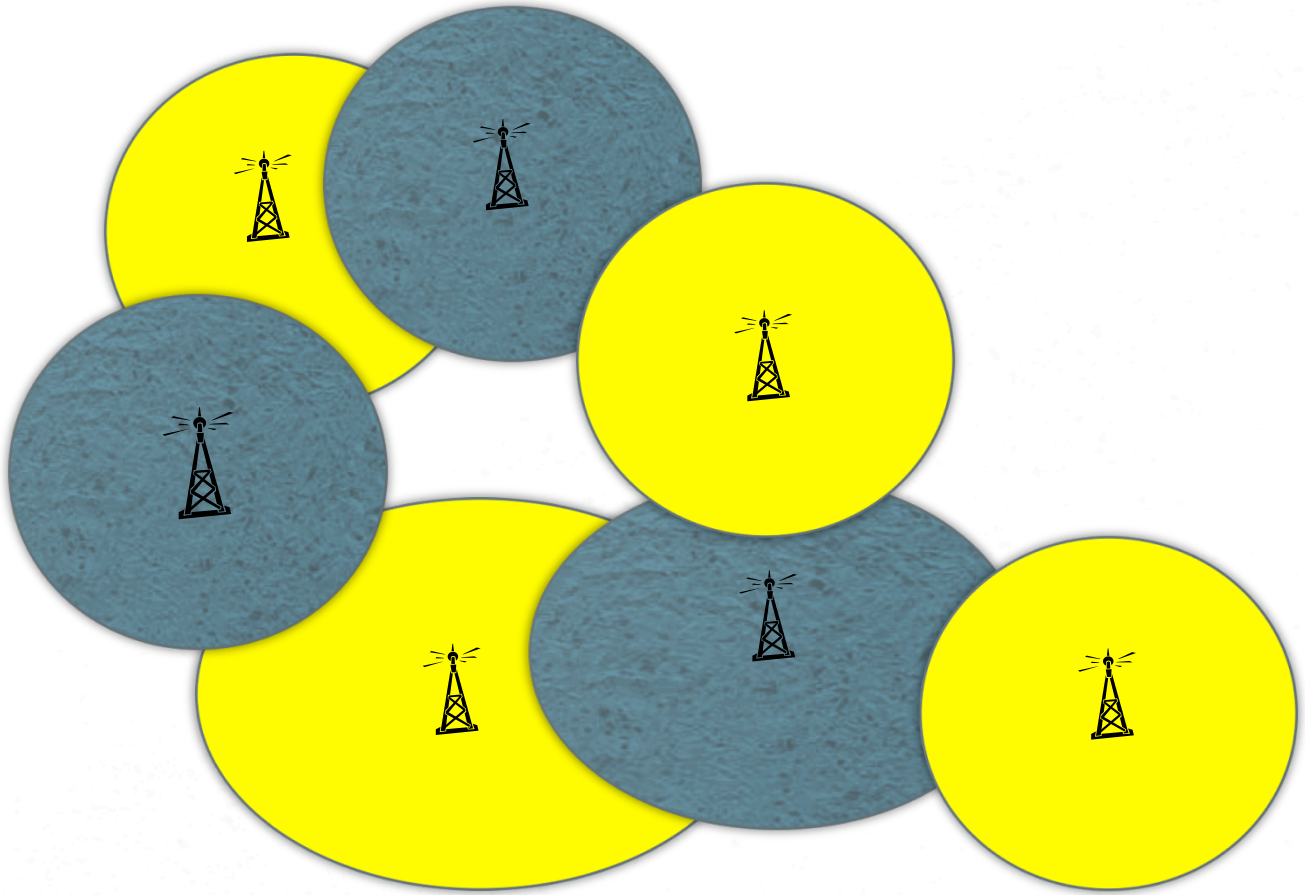

The Need for Algorithms

Cool fact: state-of-the-art algorithms for solving NP-complete problems both necessary and sufficient to solve repacking problem quickly.

[Leyton-Brown et al. 13, 14, 17]

Leyton-Brown

- encode as satisfiability (SAT)
- use presolvers, solver configuations tuned to interference constraints, caching tricks

The Forward Auction

Bad Designs Cost Billions

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- simultaneous sealed-bid 2nd-price auctions for 10 interchangeable TV broadcasting licenses
  - creates tricky coordination problem
- projected revenue: 250M; actual = 36M
- often huge difference between top two bids

US, 2016: 10s of billions at stake.

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- bidder buys fewer licenses to get a cheaper price

Issue #2: *exposure problem.* (with item synergies)

- example: 2 licenses; bidder #1 has value 6 for *both* licenses, bidder #2 wants one license, value = 5