APPLIED MECHANISM DESIGN FOR SOCIAL GOOD

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Lecture #18 – 4/3/2016

CMSC828M
Tuesdays & Thursdays
9:30am – 10:45am

COMPUTER SCIENCE
UNIVERSITY OF MARYLAND

THIS CLASS:

INCENTIVE AUCTIONS

PART I: JOHN DICKERSON

PART II: SANKHA GURIA & ALLEN LEIS

Thanks to: CMU 73-315, Priceonomics, US Department of Commerce, Wikipedia

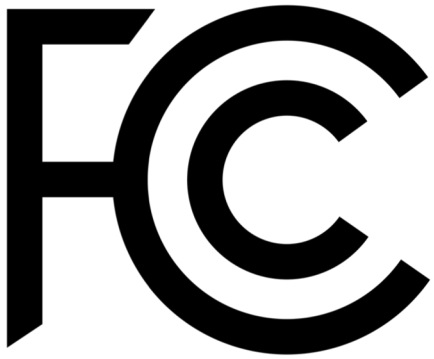
ALLOCATING SPECTRUM

Radio spectrum is a finite natural resource

- Interference issues, not infinitely divisible

Bands are heterogeneous but similar

- Bands support different levels of data transfer
- Bands support different levels of transfer clarity



FCC allocates bands of spectrum to various industries and firms within those industries; wants:

- Efficiency aka maximize social welfare?
- Revenue/Profit maximization?
- Practice: can improve both over, e.g., lotteries

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

Source: US Department of Commerce

PRE-1980S: ALLOCATION BY COMMITTEE

Interested firms present to an FCC committee

Pros:

- Inherently multi-objective
- Firms explicitly make a case for the public welfare

Cons:

- No revenue for the FCC
- Not a transparent mechanism
- Potentially high labor cost / slow speed
- Manipulate via backchannelling, bribery, etc.

THE 1980S: LOTTERIES

Firms apply in advance and are accepted by the FCC

FCC allocates band licenses via lottery

Pros:

- Fair – anyone can win regardless of money
- Simple and transparent

Cons:

- Rent-seeking: firm asks for more than it needs
  - Resell to other firms for profit
  - Negotiations take forever → unused spectrum
- Efficiency issues

THE FAR FUTURE: SPOT MARKETS

What about immediate (re-)allocation of spectrum?

Already exist: spot energy markets

- Some agents produce surplus energy
- Some agents require extra energy
- Market matches supply/demand immediately

What about a spot spectrum market?

- Hardware isn't there yet
- Carriers make huge investments in infrastructure for specific bands of spectra – long-term licenses good here

Flexible hardware → spot market that prices bandwidth for a specific location and time → more efficient (someday)

THE HERE AND NOW: SPECTRUM & INCENTIVE AUCTIONS

Rent-seeking & speculation on lotteries in the 1980s and 1990s publicized that the FCC was giving away a valuable commodity:

- 1993: US Congress tells FCC to implement auctions

This was a new problem!

- Prior fielded large-scale auctions: English (ascending) or Dutch (descending), and bidding on single items
- The value of a band to a firm is a function of whether or not the firm gets neighboring bands, or what other firms are dong with neighboring bands (interference!)
- Complementarities and substitutes amongst bands

THE HERE AND NOW: SPECTRUM & INCENTIVE AUCTIONS

Exposure problem:

- Not sure how much firm will spend → firms underbid
- Firms can spitefully buy up a single area (e.g., NYC) knowing that a competitor has a nationwide buy plan → artificially increase prices
- Solution: combinatorial auctions, multi-clock auctions, etc.

Implemented solution:

- Simultaneous ascending (fixed increments) auctions
- Firm #1 bids $100k on DC, Firm #2 bids $130k on DC and Chicago in one round; both firms see highest bids in each location, can adjust next bids accordingly

COLLUSION

Firms know that the FCC has some incentive to maximize revenue

- Possible workaround: backchannel aka collude to reduce competition
- Explicitly illegal

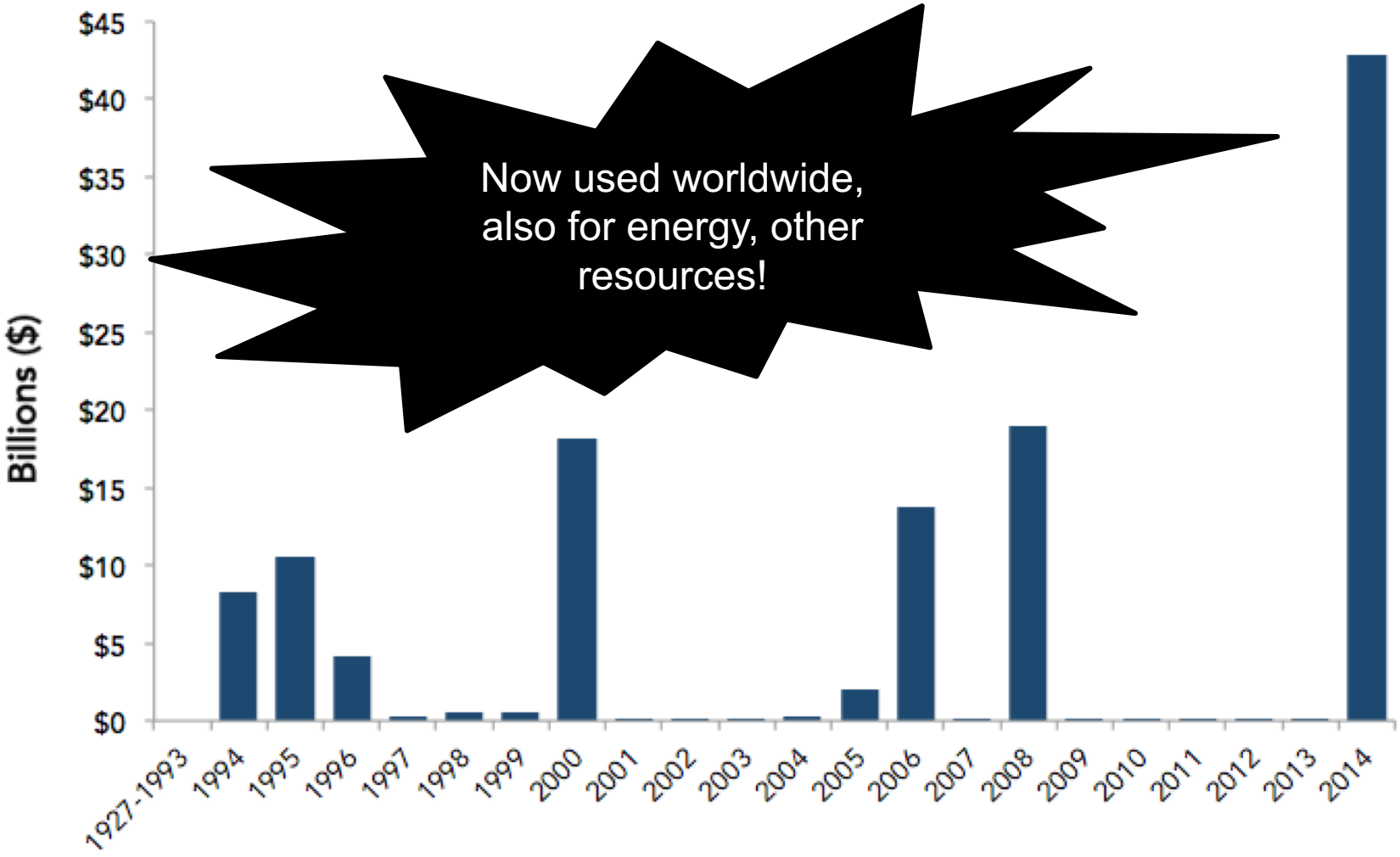
Witnessed in the 1996:

- Mercury PCS, Omnipoint, 21st Century Bidding Corp encoded license area codes into the insignificant digits of their bids
- E.g., Mercury PCS bids $100,000,**486** to signal to competitors to stay out of license area code 486
- Settled with the FCC in 1998

More info:
http://www.nytimes.com/1998/11/11/business/company-news-omnipont-and-two-companies-settle-colluding-charges.html

Over $120 Billion in Revenue over 20 Years

Net F.C.C. Revenue in Billions of Dollars (Nominal), 1994 - 2014



Now used worldwide, also for energy, other resources!

Source: FCC data and Priceonomics

THE HERE AND NOW: SPECTRUM & INCENTIVE AUCTIONS

Previously: FCC "owned" chunks of spectrum, gave them out to interested parties via chat, lottery, auction

Currently: we're all out of spectrum → nothing to allocate!

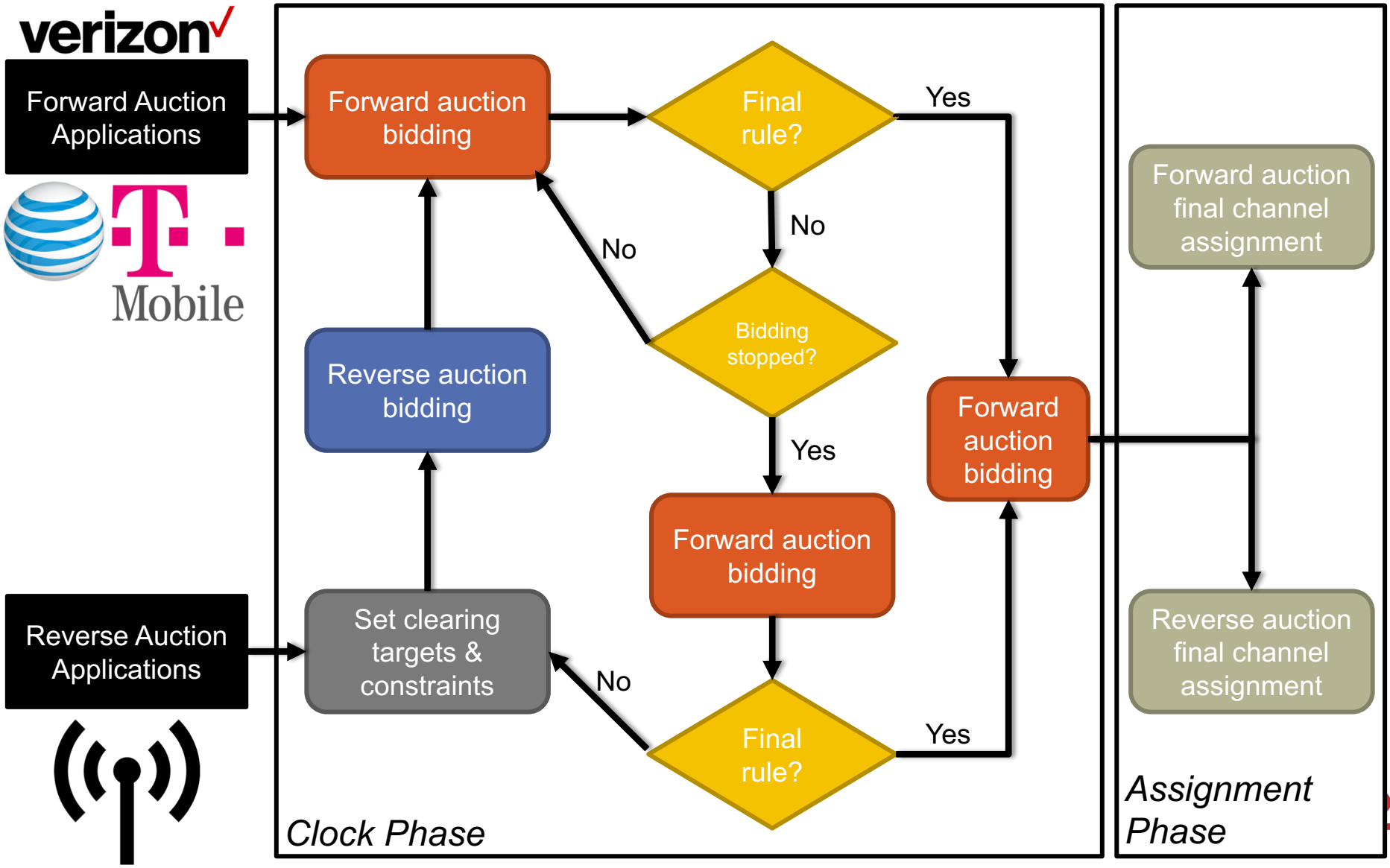
Need to re-allocate spectrum from old tech to new tech:

- Forward auction: buyers compete to buy goods (prices increase)
- Reverse auction: sellers compete to sell goods (prices decrease)

Incentive auction:

1. Reverse auction to incentivize old firms to relinquish broadcast rights to the FCC, aka sell their goods to the FCC
2. Forward auction sells rights to new firms

FCC INCENTIVE AUCTION



REVERSE AUCTION

Initial iteration started in March 2016, ended June 2016!

FCC is now the proud "owner" of 126 MHz of spectrum for the measly sum of US$86.4 billion!

- FCC didn't actually pay; just holding onto it for forward auction
- It's possible that they "paid" too much, might have to redo

How did they get this?

- (Second half of this lecture will talk about those details.)

FORWARD AUCTION

Ascending auction:

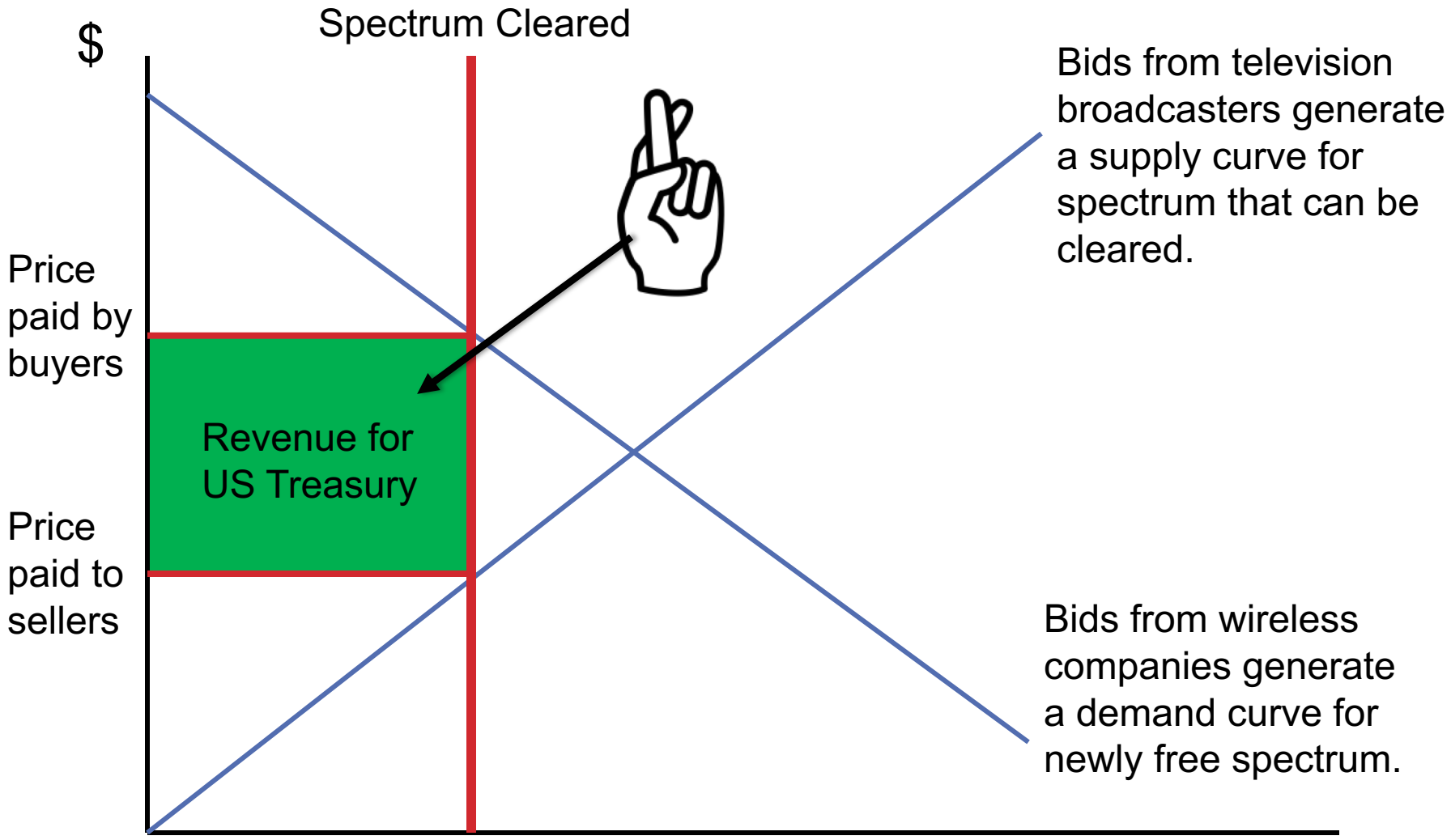
- Not open cry, rather ascends in fixed increments (5-15%)
- Bidders reveal how many “units” they would buy at this price
- Constraints put on bidders based on previous rounds (activity rule)
- Various types of bids, e.g.:
  - All-or-nothing: satisfy entire bid or give me nothing
  - Switch bids: move demand from one generic spectrum band to another one

If demand < supply, or prices won’t cover reverse auction:

- Increase price in high-demand areas until bidders drop out

If bidding stops & clearing target accomplished & profitable: finish!

THE DOUBLE AUCTION



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NEXT UP:
SOLVING THE REPACKING PROBLEM