Market Design in Energy and Communications

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Market design

• Establishes rules of market interaction
• Economic engineering
  – Economics
  – Computer science
  – Engineering, operations research
Market design accomplishments

• Improve allocations
• Improve price information
• Reduce risk
• Enhance competition
• Mitigate market failures
Applications

• *Spectrum auctions*
• *Electricity markets*
• Natural resource auctions (timber, oil, etc.)
• Emission allowance auctions
• Financial securities
• Procurement
Objectives

• Efficiency
• Transparency
• Fairness
• Simplicity
Principle

“Make things as simple as possible, but not simpler” -- Albert Einstein
Electricity
Goals of electricity markets

• Short-run efficiency
  – Least-cost operation of existing resources

• Long-run efficiency
  – Right quantity and mix of resources
Challenges of electricity markets

• Must balance supply and demand 
  at every instant
  at every location

• Physical constraints of network

• Absence of demand response

• Climate policy
Three Markets

• Short term (5 to 60 minutes)
  – Spot energy market

• Medium term (1 month to 3 years)
  – Bilateral contracts
  – Forward energy market

• Long term (4 to 20 years)
  – Capacity market (thermal system)
  – Firm energy market (hydro system)

• Address risk, market power, and investment
Long-term market:

*Buy enough in advance*
Product

• What is load buying?
  – Energy during scarcity period (capacity)

• Enhance substitution
  – Technology neutral where possible
  – Separate zones only as needed in response to binding constraints

• Long-term commitment for new resources to reduce risk
Pay for Performance

• Strong performance incentives
  – Obligation to supply during scarcity events
    • Deviations settled at price > $5000/MWh
    • Penalties for underperformance
    • Rewards for overperformance

• Tend to be too weak in practice, leading to
  – Contract defaults
  – Unreliable resources

• But not in best markets: ISO New England, PJM
Spectrum
Spectrum auctions

• Many items, heterogeneous but similar
• Competing technologies and business plans
• Complex structure of substitutes and complements

• Government objective: Efficiency
  – Make best use of scarce spectrum
  – *Address competition issues in downstream market*
Key design issues

• Establish term to promote investment
• Enhance substitution
  – Product design
  – Auction design
• Encourage price discovery
  – Dynamic price process to focus valuation efforts
• Encourage truthful bidding
  – Pricing rule
  – Activity rule
Simultaneous ascending auction
Prepare
Italy 4G Auction, September 2010
470 rounds, €3.95 billion

• Auction conducted on-site with pen and paper
• Auction procedures failed in first day
• No activity rule
Thailand 3G Auction, October 2012

• 3 incumbents bid
• 3 nearly identical licenses; can only win one
• Auction ends at reserve price + 2.8%
US AWS-3 auction, 65 MHz, after 91 rounds

$43.7 billion, $2.65/MHzPop (paired)

<table>
<thead>
<tr>
<th>Auction 97</th>
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<tbody>
<tr>
<td><strong>Auction Description</strong></td>
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| **Dates** | Opened: 11/13/2014  
| | Closed: |
| **Licenses** | 1,614 licenses in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands |
| **Qualified Bidders** | 70 |

<table>
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<th>Round 91</th>
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<tr>
<td><strong>Rounds Completed</strong></td>
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<td><strong>Bidding Days</strong></td>
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<td><strong>Total PWB Amount</strong></td>
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<td><strong>Licenses with PWBs</strong></td>
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The Future of Mobile Broadband
The future...as with electricity: multiple opportunities to contract

• Long term: investment market like today
• Medium term: one month to three years
• Short term (spot market)
  – One day
  – One hour
  – 5 minutes
  – 4 seconds
  – (10 milliseconds, 10 microseconds, ...?)
Conclusion

• No auction design is perfect
• Design must be customized for setting
  – Simultaneous ascending clock
    • Simple settings (upcoming UK)
  – Combinatorial clock
    • Packaging is essential (UK 4G, Canada 700 MHz)
  – Two-sided clock
    • Incentive auction in US
• Never ignore essentials
  – Encourage participation
  – Demand performance
  – Avoid collusion and corruption
Telecom: *Auction spectrum*

Energy: *Pay for performance*