Group D: FAA Landing Slots

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Different (easier?) than FCC:
- Transparency.
  - Every 10\textsuperscript{th} ticket known.
  - Costs known.
  - Load factors known.

Different (harder?) than FCC:
- Grandfather issues, along with usual technical, social, and political issues.
Group D - FAA Landing Slots

- Background info
- Valuation Models
- Other people’s valuation models
- Papers D9, D10, D13
Why schedule landing slots?

- Unregulated, airlines may schedule operations that exceed the safe arrival/departure rate of an airport
- Airlines want as many flights as possible at popular airports
- Airlines worry that they need to have a stronghold at an airport in case slots become regulated
Background: Airport Landing Slots

- Four High-Density Rule airports in the US use slot allocation
  - Kennedy, LaGuardia, O’Hare, Ronald Reagan
  - All other airports have unallocated slots
  - eg, LGA has one arrival runway with 32 arrivals per hour

- Airlines control their own gates and schedules but the FAA controls landing slots
Background: Airport Landing Slots

- What is the purpose of landing slots?
  - Rationing airport usage more than scheduling purposes
  - Imprecision is okay
  - Busy international airports may also use slot allocation

- What is a slot?
  - “A reservation for an IFR takeoff or landing by an aircraft”
    - 3 categories: air carriers, commuter airlines, general aviation
All kinds of Slot Problems!

Candidates for class:

1. Ground Delay Program Slots (D10, D12)
2. All airports, all O/D Slots
3. One airport, many slot times.

We’ll focus on 3rd for this discussion.
In hazard conditions, currently use *ration-by-schedule* to determine who can take off.

- But FAA/airlines would like to allow conditional cancellations, credit in future exchanges, etc.
- Exchange run every N minutes for a 2-6 hour window.
- Combinations of slots, offers possible.

Agent valuation in this model:

Value for bundles of slots in exchange window.
Slots at all airports.

- Look domestically; pick rough slot times (morning, afternoon evening)
- Valuation for bundles of airport pairs, at the times requested.
- Too complex for class. (Technical, social, and political problems of a single airport, extended to whole map.)
Slots at Single Airport

- Several papers suggest phased-in market mechanisms.
  - Focus on single airport, look at combinations of slots. (448 possible time slots = 7 days * 64 intervals.)
  - Pick a real airport, with real traffic.
  - We can get passenger numbers and ticket revenue for various markets.
  - We have reasonable estimates on max. revenue for any particular time, given constraints of airline.
Current Regime - IATA allocation system

- At HDR airports
  - Limited number of slots for IFR takeoffs/landings per hour or half hour
  - Grandfather rights: current holders of slots can sell or lease them but must return it if it’s used less than 80% of the time
  - Airlines can exchange slots
  - Often no room for new entrants
D13. Auctioning Airport Slots

- Slots are scarce at London-Heathrow and Gatwick
- Lack of runway capacity caused by carriers not scheduling movements at the best times
  - Only carriers who can afford it should schedule slots at peak times
- Create opportunity for mid-size carriers to expand
- Peak slots go to airports willing to pay - more efficient allocation
D13. Auctioning Airport Slots

- Auction off slots by week in a season
  - Divide the week into 15 or 30 min windows
- Bundle rights to use runway with stands (gates) and terminal capacity
  - Bid must state aircraft size, destination, terminal choice, and passenger load
  - Complex winner determination
- Simultaneous multiple round auction
- Secondary market for trading slots
Simultaneous Multiple Round Auction

- All lots auctioned simultaneously
- Bid in multiple rounds
  - Build up combinations of lots
  - Switch between lots
  - Min bid set for each round
- No guaranteed completion time
One-shot Sealed Bid Auction

- Can bid on combinations of slots
- Secondary market can help for more efficient reallocation
Case Study: Atlanta Airport

- Paper D9 (Le, Donohue and Chen)
- Queuing simulation to study effects of auction-determined schedule on arrival delays
- Two optimization models to reflect conflicting goals of FAA/airport & airlines
Auction Model

- Simultaneous Multiple-Round with Package Bidding
- Goods: takeoff and landing slots
- Airlines
  - Maximize profits, prefer “stable” schedules, and want to leverage investments at hub
- Airports/FAA/Dept. of Transportation
  - Optimize use of scarce resource while ensuring safety and fair market access opportunity
Evaluating bids

1. Passenger throughput
2. Flight Origin-Destination pair
3. Prior airline infrastructure investment at the airport
4. Historical on-time performance
5. Monetary bids

The model proposes a weighted linear combination to rank the bids.
Optimization Models

- Airport Optimization Models
  - Pick highest ranking bid s.t. capacity constraint (# of arrivals/departures for each slot)

- Airline Optimization Models
  - Maximize surplus (revenue - bid price)
Overview of Case Study

- Simulation
  - Landing slot auction
  - Queuing delay simulation

- Scenario
  1. (Baseline) Delay for OAG schedule
  2. Delay of auction-generated schedule
Assumptions/Parameters

- Single airport: Atlanta
- Slots: 15 minute windows
- 11-airport network to simulate traffic
- Airlines bid for each slot independently
- Upper bid threshold proportional to aircraft size
- Single item (not combinatorial)
- Ranking based only on monetary bids
- Airline bids for adjacent slots if it fails to acquire current slot until max tolerable deviation reached
- Maximum tolerable deviation from original time slot: 45 min
Results of Simulation

- Auction constrained arrival traffic
  - “Depeaking congested periods
  - Filled neighboring slots
- Delay reduced by 75%
- Mean auction revenue per slot -> double of initial bid

Valuation Model

- Valuation models in papers D9 (and D1)
  - Very simple – combinatorial aspects, revenue/cost of route, competitive aspects not taken into account
  - Not based on actual airline revenue/cost data

- Our valuation model need to consider (not exhaustive!)
  - Slots owned before auction (= initial conditions)
  - Synergies between slots
  - Substitutability/complementarity of other slots
  - Real-world revenue (demand) and cost