Estimating Current and Future Benefits of Airport Surface Congestion Management Techniques*

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Outline

- Introduction to Surface Congestion Management
- Surface Congestion Management Benefits Assessment Methodology
- Current and Future Benefits Estimates at 8 key US airports
- Conclusions
Surface Congestion Management (SCM)

- Surface congestion => increased taxi times, fuel burn & emissions

- Annually, at major airports in the United States (2010 ASPM)
  - Over 48 million mins taxi-out delay (over unimpeded times)
  - 194 million gallons excess taxi fuel => $388-582 million @ $2-3/gal

- Surface congestion management can help:

![Diagram showing time intervals and demand on surface](Image)
Surface Congestion Management (SCM)

- At times of congestion, hold aircraft at gate or other designated location (with engines off) to reduce surface congestion & fuel burn while not adversely affecting throughput
  - Concepts demo-ed at BOS, JFK, MEM, MCO airports

JFK: Pre-metering
15 a/c in 31L queue

JFK: Post-metering
8 a/c in 31L queue, 8 being held
Benefits Assessment Needs & Methodology

- Benefits assessment activities required to understand impacts of SCM at different airports and make case for deployment
Throughput Saturation Curves

- Throughput saturation curves at core of methodology

- Current year: curves can be established from operational data

- Future years: curves estimated from demand/capacity forecasts

Traffic Metric, e.g. No. of aircraft on surface, Dep queue length, etc.

Airport X, Configuration Y, Condition Z

Departure rate

Saturation throughput, $T^*$

Saturation point, $N^*$

Control point, $N_{ctrl}$

Impacts of future capacity increases

Benefits of holding all flights above control point

$\text{Taxi time benefits} = N_{\text{Congestion}}(\tau_{\text{Congestion}} - \tau_{\text{Ctrl}})$
Simulations

• Inputs
  – Current year: ASPM OOOI, ASDE-X
  – Future year: FAA demand/capacity predictions 2015, 2020, 2025, 2030

• Future year saturation curves
  – Random Forest method
  – Forests “grown” on 2000-2010 data
  – Relationships between key input vars, N* & T* => future year N* & T*

• Future year traffic simulations
  – Simple queuing model of taxi time as f(future yr demand, service time)
  – Operating point on future yr curve
Results Generation/Validation

- **Current year validation**
  - Simulated current year benefits estimates compared to field trial results where available
    - BOS, JFK

- **Future year estimation**
  - Operating point on curve => “unconstrained” benefits calculated at each future year
    - Limited gate/hold space physical constraints
    - Benefits in last year with sufficient gate/hold space => “practical benefits”
    - Taxi time & fuel burn benefit metrics
• Gate utilization calculated for each airport & year & compared to number available
Results: JFK Airport

- Unconstrained benefits rise over time as demand increases without added capacity
- Practical benefits capped at 2015 levels due to gate constraints
- Validation against field trial results
Results: Aggregate Across Study Airports

- Fuel burn benefits estimation using ICAO ground idle fuel flows
- Dominant airports: JFK, ATL, ORD
- Gate constraints limit benefits at different years
## Results: Aggregate Across Study Airports

<table>
<thead>
<tr>
<th>Airport</th>
<th>Practical Benefits Aggregated 2010-2030</th>
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<tbody>
<tr>
<td></td>
<td>Thousand Hours Taxi Time Reduction</td>
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<tr>
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- Fuel cost of $2.43/gallon per FAA recommendation
  - Higher fuel costs => proportionately higher fuel cost savings
- % taxi-out and total fuel estimates based on actual fuel upload at each airport from 2010 BTS data and scaled to future traffic
Conclusions

- Surface congestion management is an effective solution for addressing surface inefficiencies
- Need for current & future year benefits assessment
- Methodology and simulations developed to develop benefits estimates at 8 key US airports
- Total practical benefits estimated to be over $2bn fuel saving (≈18% of taxi-out and 1% of total) at study airports over 20 yrs
- Related work:
  - Create system-wide benefits estimates
  - Explore practical SCM implementations at range of airports