



Massachusetts
Institute of
Technology

Reduced Surface Emissions through Airport Surface Movement Optimization

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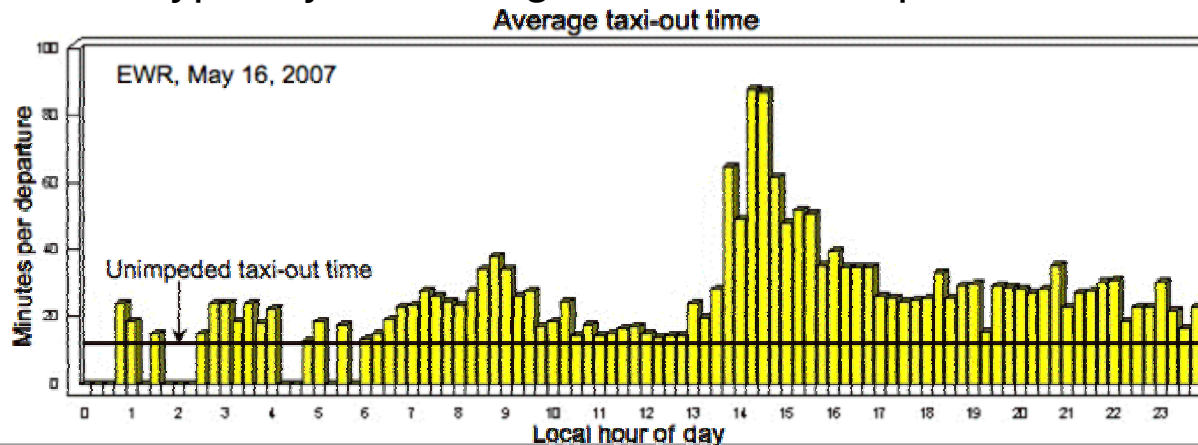
Aeronautics & Astronautics and Engineering Systems

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Motivation

- Opportunities to improve the environmental and economic performance and efficiency of airports and airlines
- Increased Congressional/public pressure to improve environmental performance
- In 2006, aircraft in the U.S. spent over 20 million minutes taxiing in to their gates, and over 49 million minutes taxiing out for departure
- Taxiing aircraft burn fuel, and contribute to surface emissions of CO₂, hydrocarbons, NO_x, SO_x and particulate matter
- Taxi times are typically much larger than the unimpeded taxi times



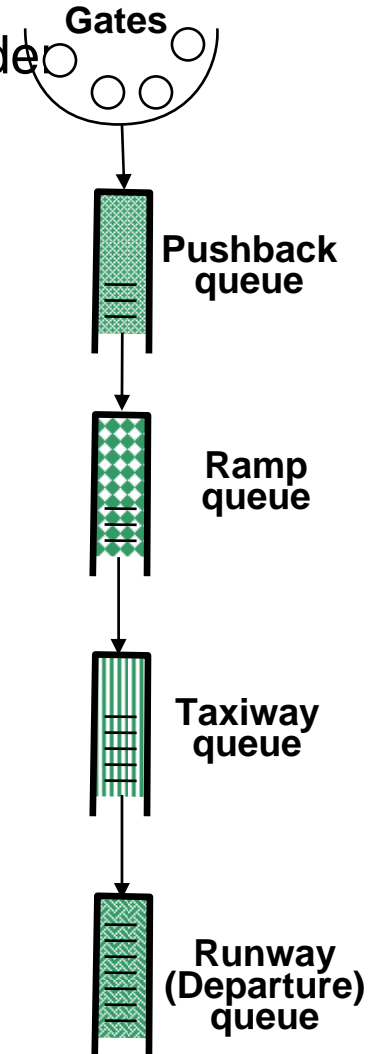
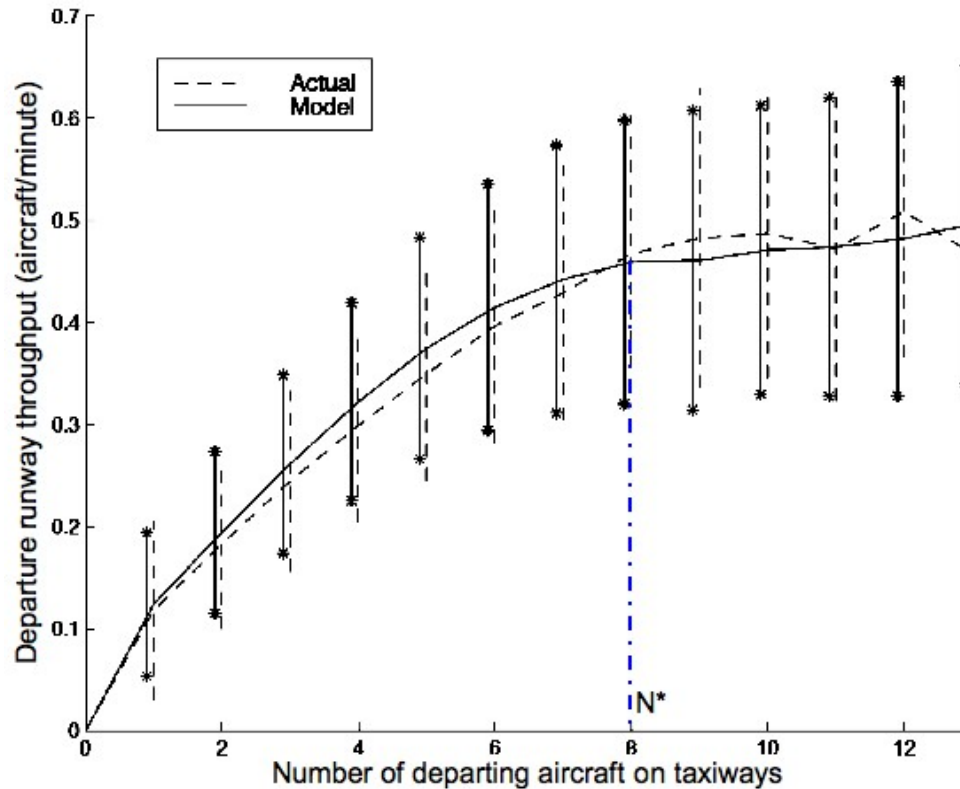


Objectives

- Reduction of surface emissions through improved surface movement optimization
- Investigate promising near-term opportunities for surface optimization
 - Limiting build up of queues on the airport surface
 - Gate-hold strategies
 - Taxi route planning
- Assess challenges to implementation, and develop strategies to overcome them
 - Gate usage
 - ATC procedures
- Ensure equitable treatment of airlines

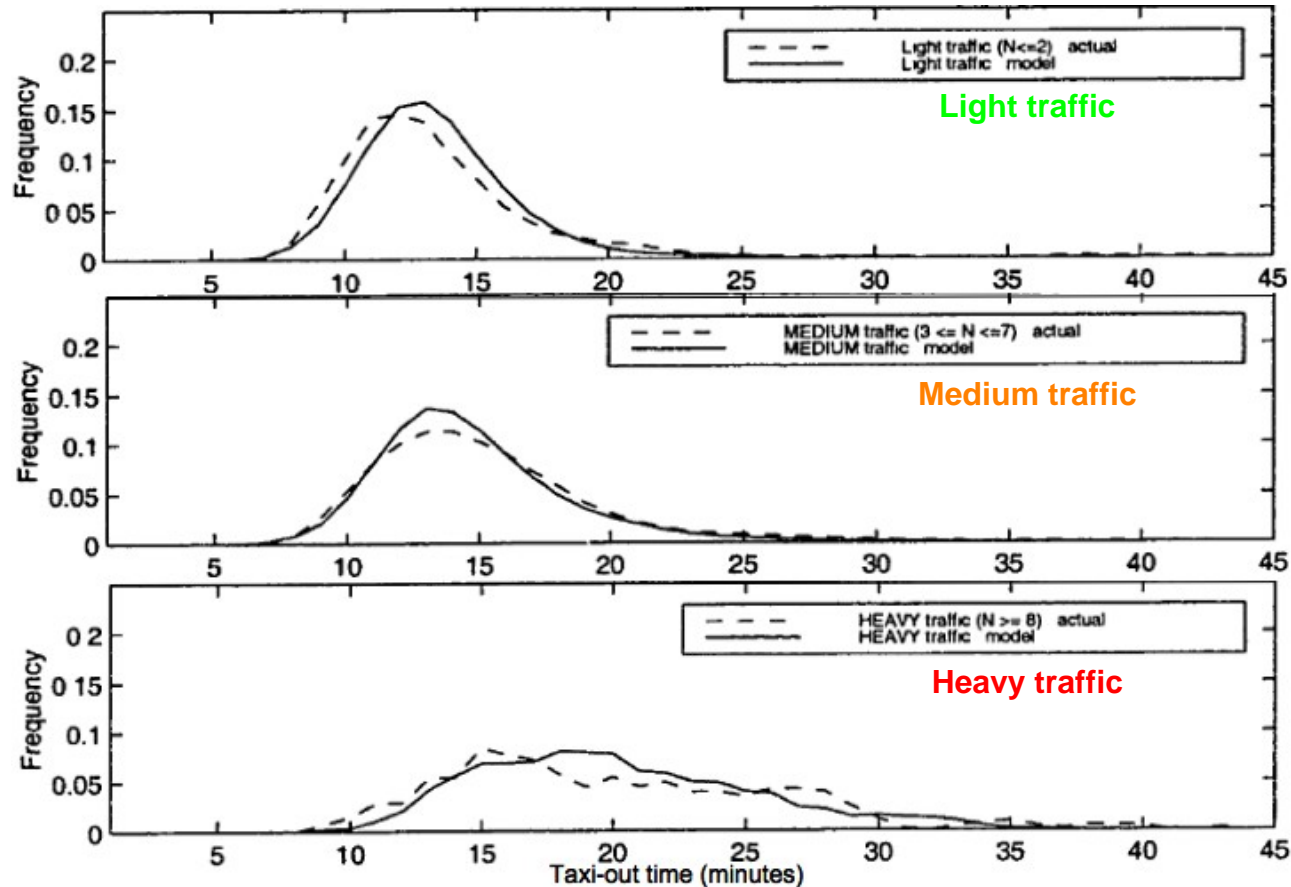
What is the “right” number of aircraft on the surface?

- There is a critical number of aircraft on the surface in order to achieve efficient surface operations



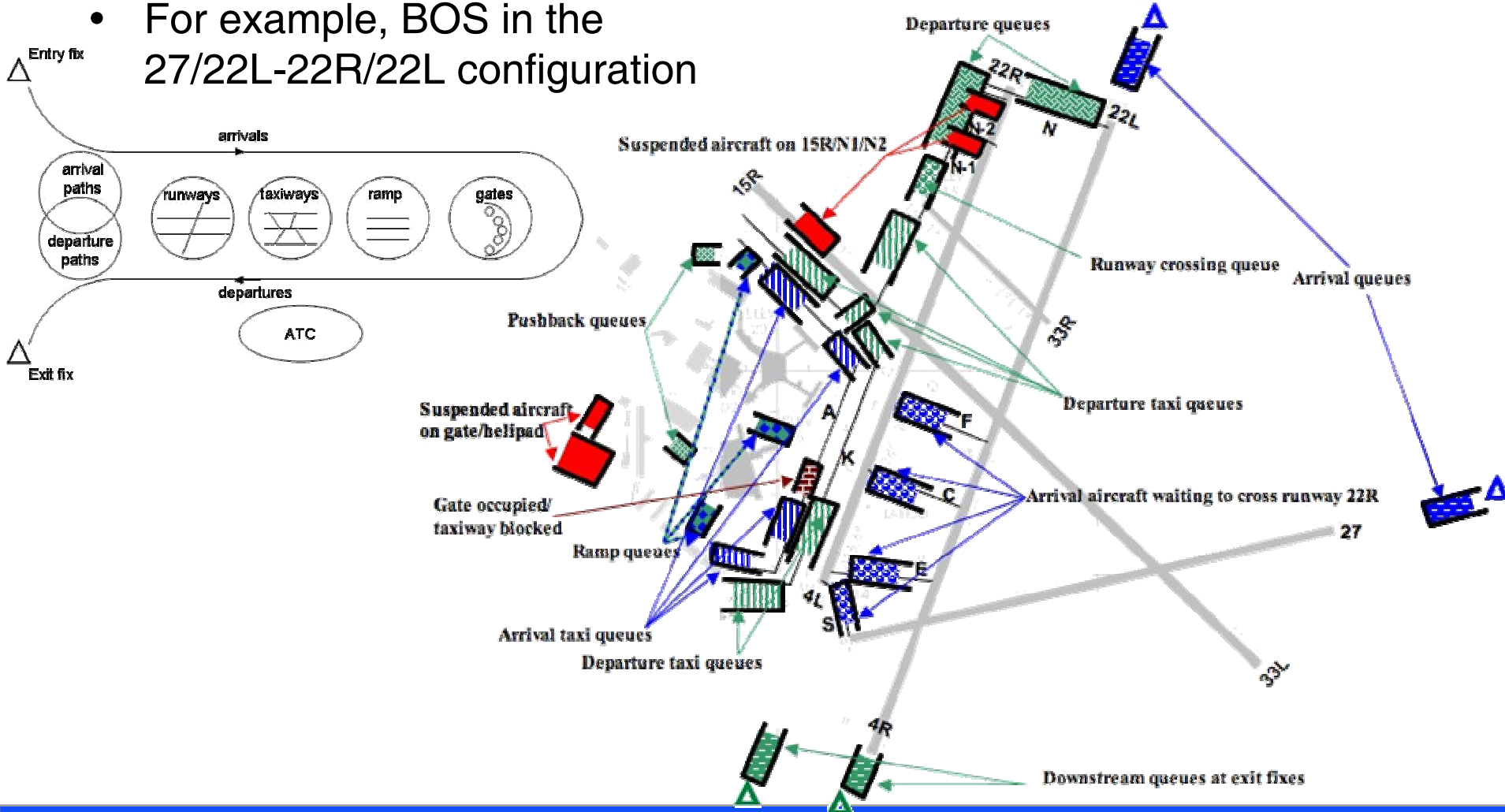
Surface congestion increases taxi times

- Taxi times are closely correlated with the number of aircraft on the airport surface



Queuing network model of surface operations

- For example, BOS in the 27/22L-22R/22L configuration



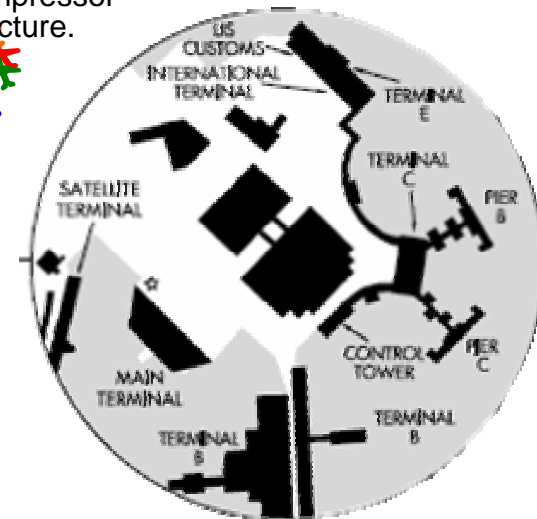
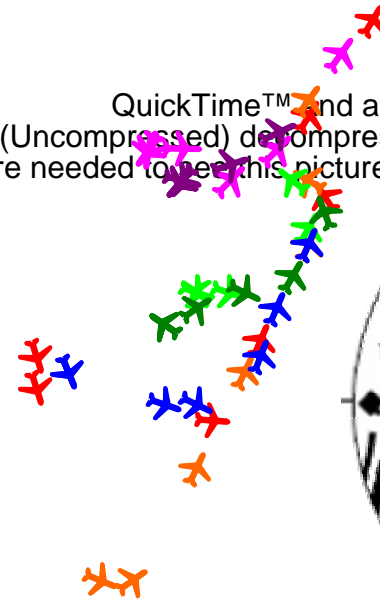


Operational challenges: First-Come-First-Served departure queues

- Pushback order can make a significant difference to the departure time
- Suppose the red aircraft pushes back just before the blue aircraft
- Final departure sequence is:

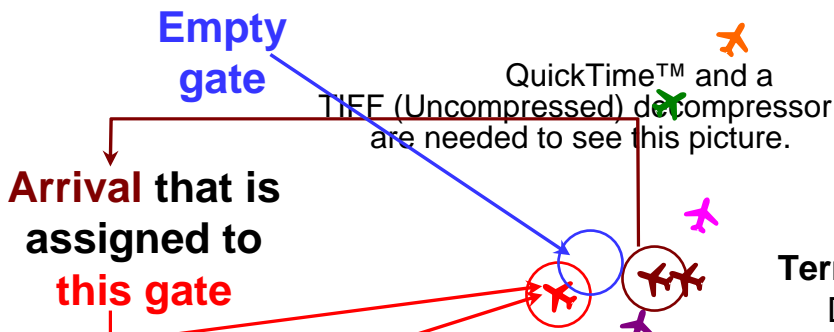


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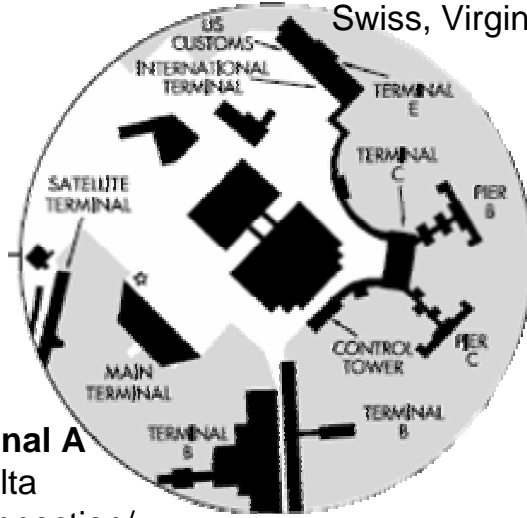
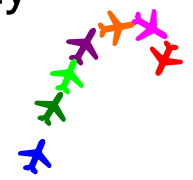


Operational challenges: Gate usage

- Gate assignments affect ability to delay pushback
- Gate leases may make gate-swaps infeasible



QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



Terminal E

Aer Lingus, Air France, Alitalia, American (Int'l), British Airways, Finnair, flyGlobespan, Iberia, Icelandair, JetBlue Airways (Int'l), KLM, Lufthansa, Northwest, SATA, Swiss, Virgin Atlantic Airways

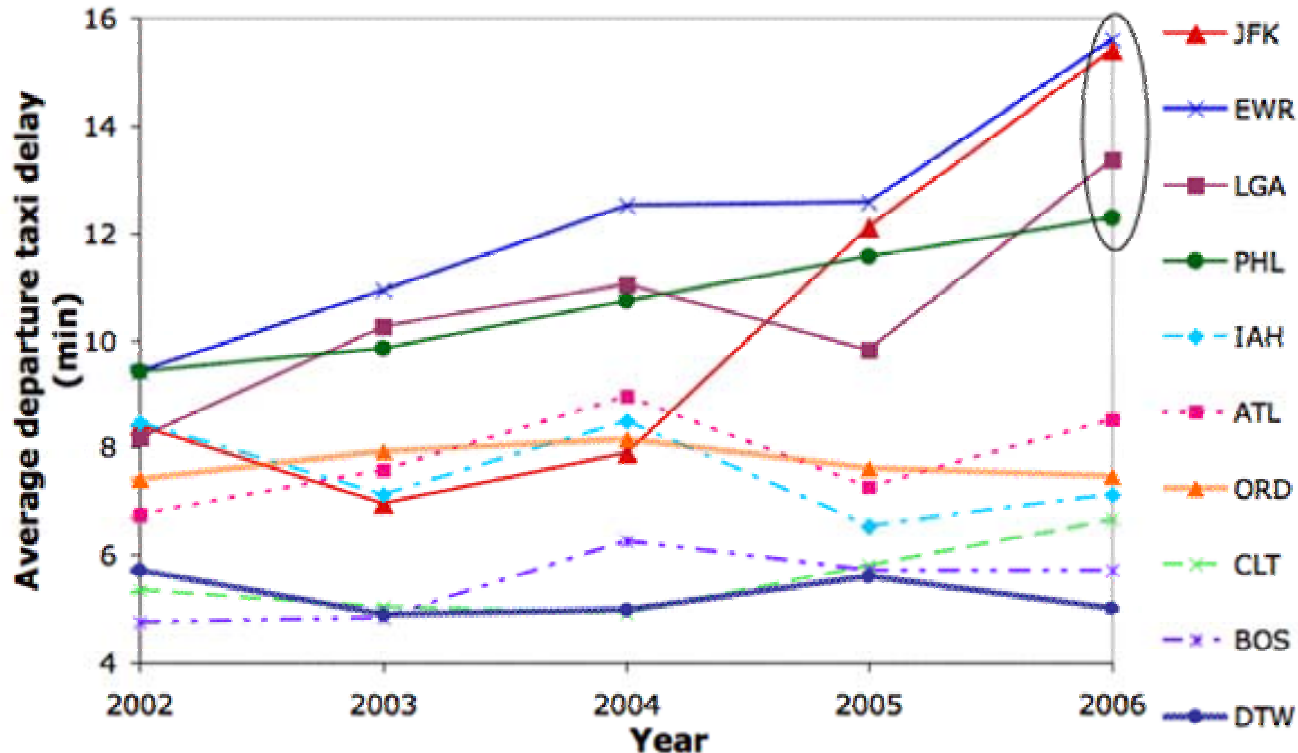
Terminal A
Delta
Delta Connection/
Comair
Delta Shuttle

Terminal B
Air Canada
Alaska Airlines
America West
American/American Eagle
Spirit Airlines
US Air/US Air Express/
US Airways Shuttle

Terminal C
AirTran Airways
Cape Air
Continental
JetBlue Airways
Midwest
United
United Express

Airports for a pilot study

- We would like to engage with airports for a pilot study



For example, the ten major airports with the largest taxi times?



Approach

1. Identification of inefficiencies/opportunities for improvement in current surface operations
We would really welcome and appreciate your ideas and input!
2. Analysis of different surface movement optimization strategies, and their potential benefits
3. Identification of potential barriers to the adoption of promising surface movement optimization strategies
4. Development of a plan for the field trials of promising concepts
5. Determination of factors influencing candidate airports for field trials
6. Description of an initial plan for a pilot airport study on reducing emissions through improved surface traffic management



Summary

- Optimized surface movement planning is a promising approach to decreasing surface emissions
 - Early studies seem to suggest that controlling pushback (“gate-holding strategies”) can help reduce taxi times
 - Other approaches?
 - Plan to introduce environmental factors into objective function
- Implementation barriers need to be identified and addressed
 - Gate usage and ownership
 - Infrastructure issues: taxiway layout, availability of tugs
 - Interactions between surface and airspace operations
 - Airline concerns
- Factors influencing candidate airports for field tests
 - Taxi times
 - Gate ownership/lease procedures
 - Ramp control by airlines
 - Stakeholder interest
 - Non-attainment areas
 - Availability of surface surveillance