

Collaborative Airport Surface Metering for Efficiency and Environmental Benefits

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May 2, 2007

2007 Integrated Communications Navigation and Surveillance (ICNS) Conference

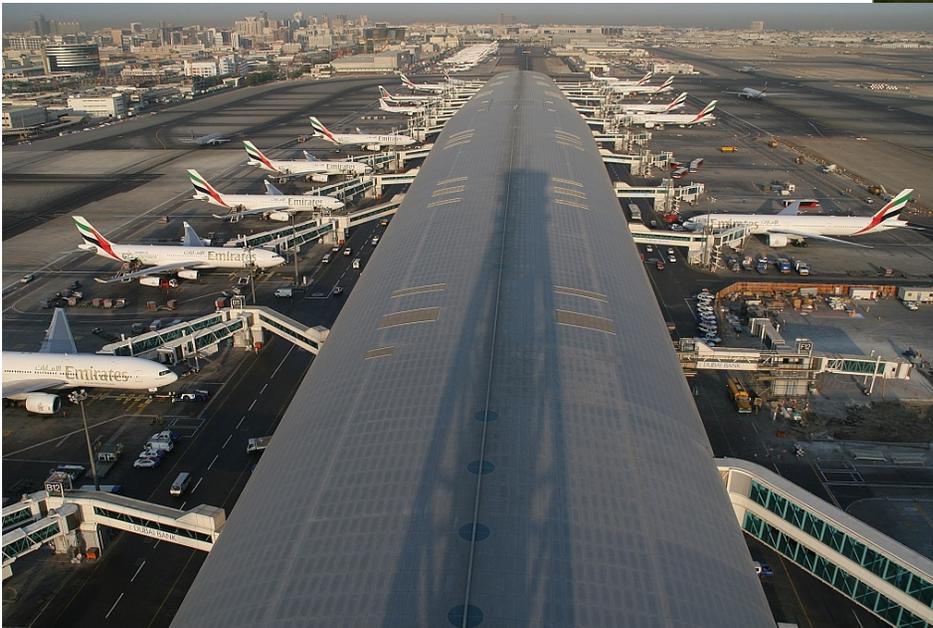


Presentation Outline

- Collaborative Airport Surface Metering (CASM) Concept Overview
- Analysis Approach
- Results
- Conclusions and Future Work

Collaborative Airport Surface Metering

- Plan Departure Operations to Take Required Delay at the Parking Gate
- Take Delay Here Not Here →

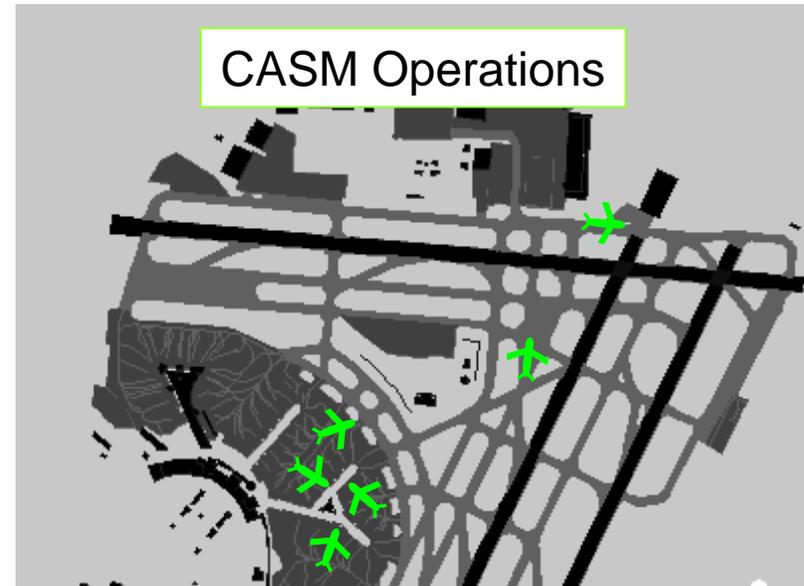
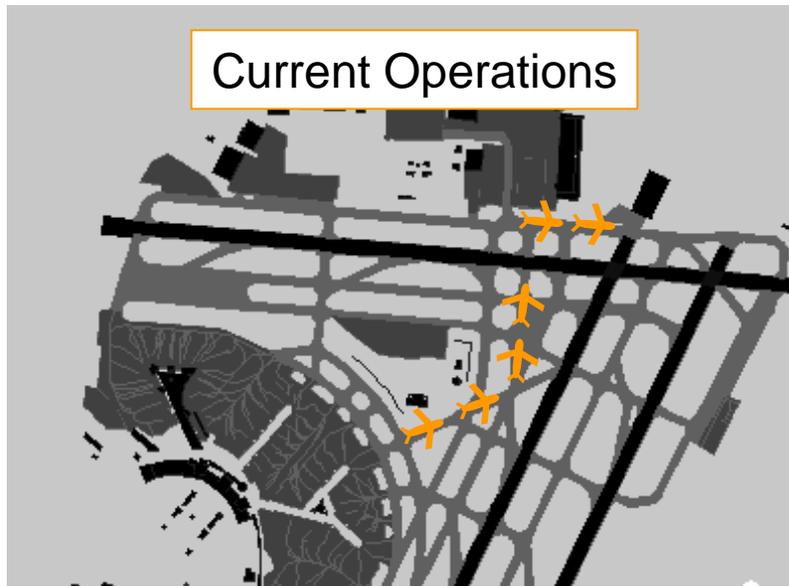


- Reduce
 - Fuel Burn
 - Operating Costs
 - Emissions
 - Congestion

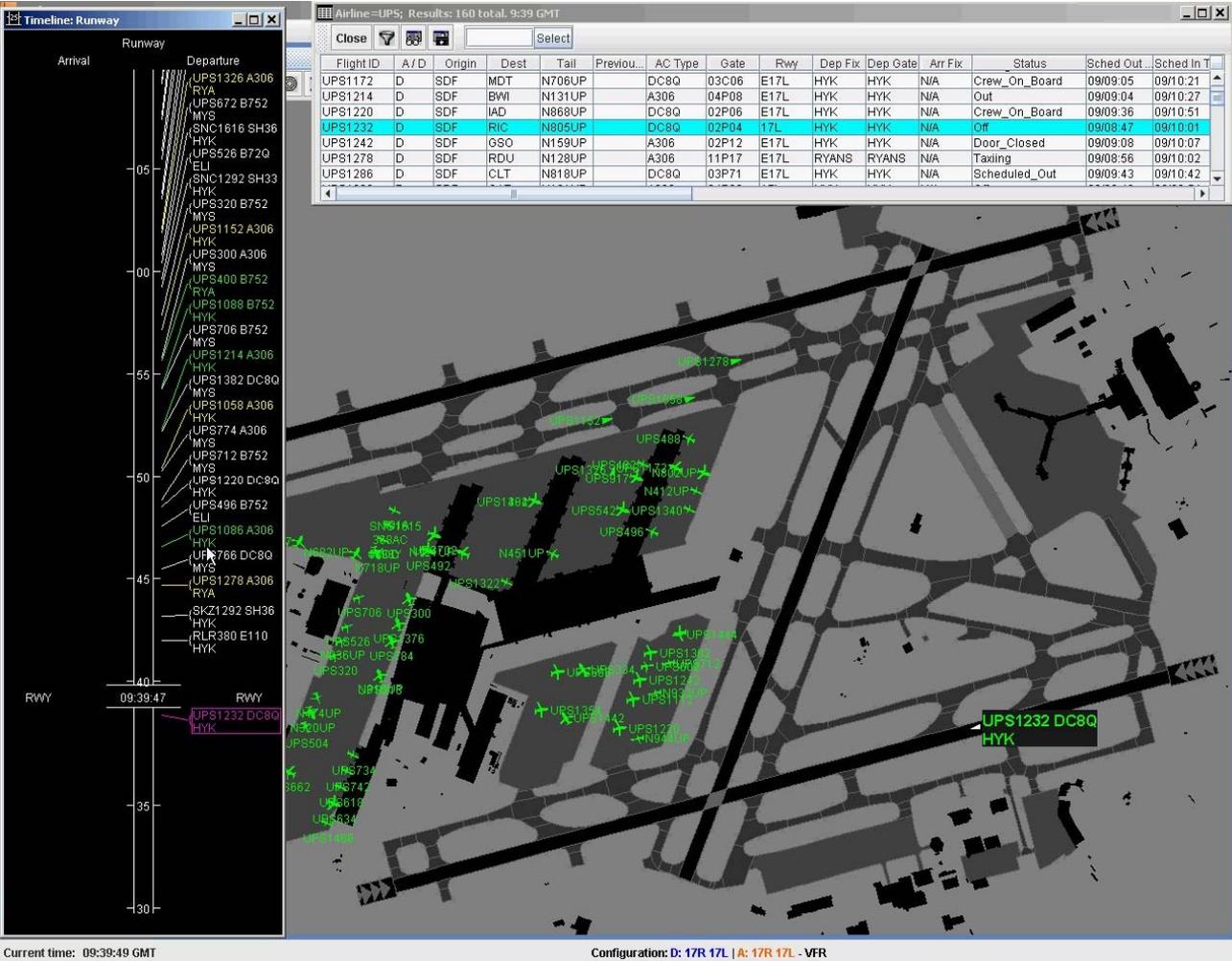


Collaborative Surface/Departure Metering

- Just-in-Time Delivery of Departure Flights to Runway
 - Initial Steps Toward 4-D Trajectory Operations on the Airport Surface
- Environmental and Efficiency Benefits
 - Reduced Queuing Time, and
 - Reduced Fuel Burn => Reduced Emissions



Operational Experience



- UPS Meters Push-Backs During Overnight Launch
- To Save Fuel
- And Reduce Congestion



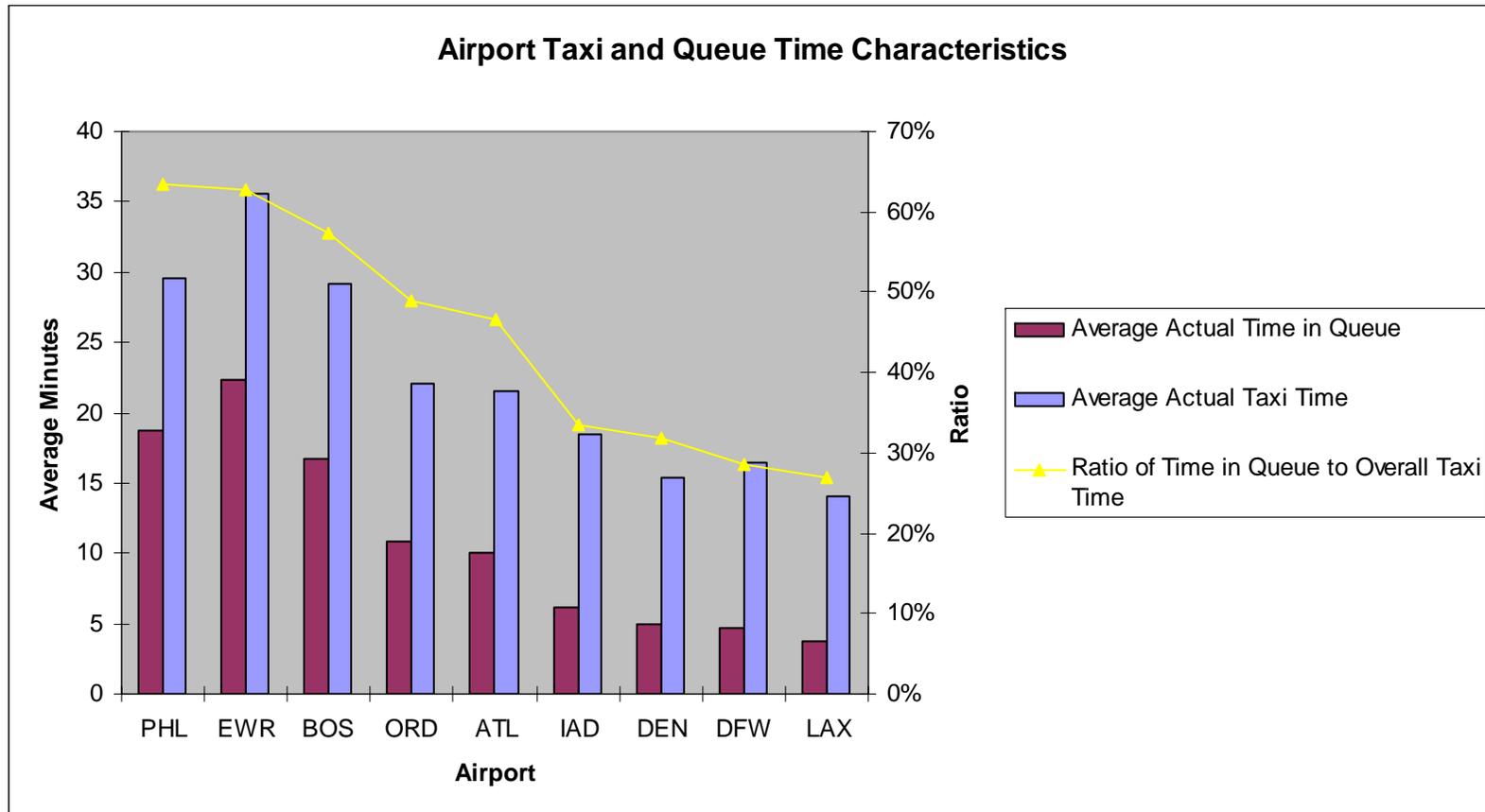
Operational Concept Issues

- Participation
 - Pre-Assigned Take-Off Sequence Must Be Established and Guaranteed
 - Even With Non-Participating Flight Operators
- Parking Gate Conflicts
 - Parking Gate May Be Needed for Another Flight
 - Gate Holding May Not Be Possible
- CASM Includes Establishment of ‘Virtual Departure Queues’
 - Tools for ATC Tower to Track Departure Sequence without Requiring Spatial Line-Up
 - Handles Gate Conflict Issues
 - Some Flights Can Push-Back and Wait Away from the Gate
 - If the Parking Gate is Needed for Another Flight

Data Used for Analysis

- June 19, 2006 data used
- Bureau of Transportation Statistics
 - Airline On-Time Performance Data
 - Contains actual gate and runway time, and taxi times
 - Includes tail number for determining line of flight
 - Only includes passenger carriers who account for at least 1% of domestic scheduled passenger revenues (no cargo carriers)
 - Only includes domestic carriers and flights
 - Enhanced Traffic Management System
 - Provided aircraft type for contributing to line of flight determination
- Aviation System Performance Metrics
 - Provided unimpeded taxi times

9 Airports Studied



The higher the ratio, the more amount of the overall taxi time is spent in a queue. For example, flights at PHL spend on average 63% of the taxi time waiting in a queue

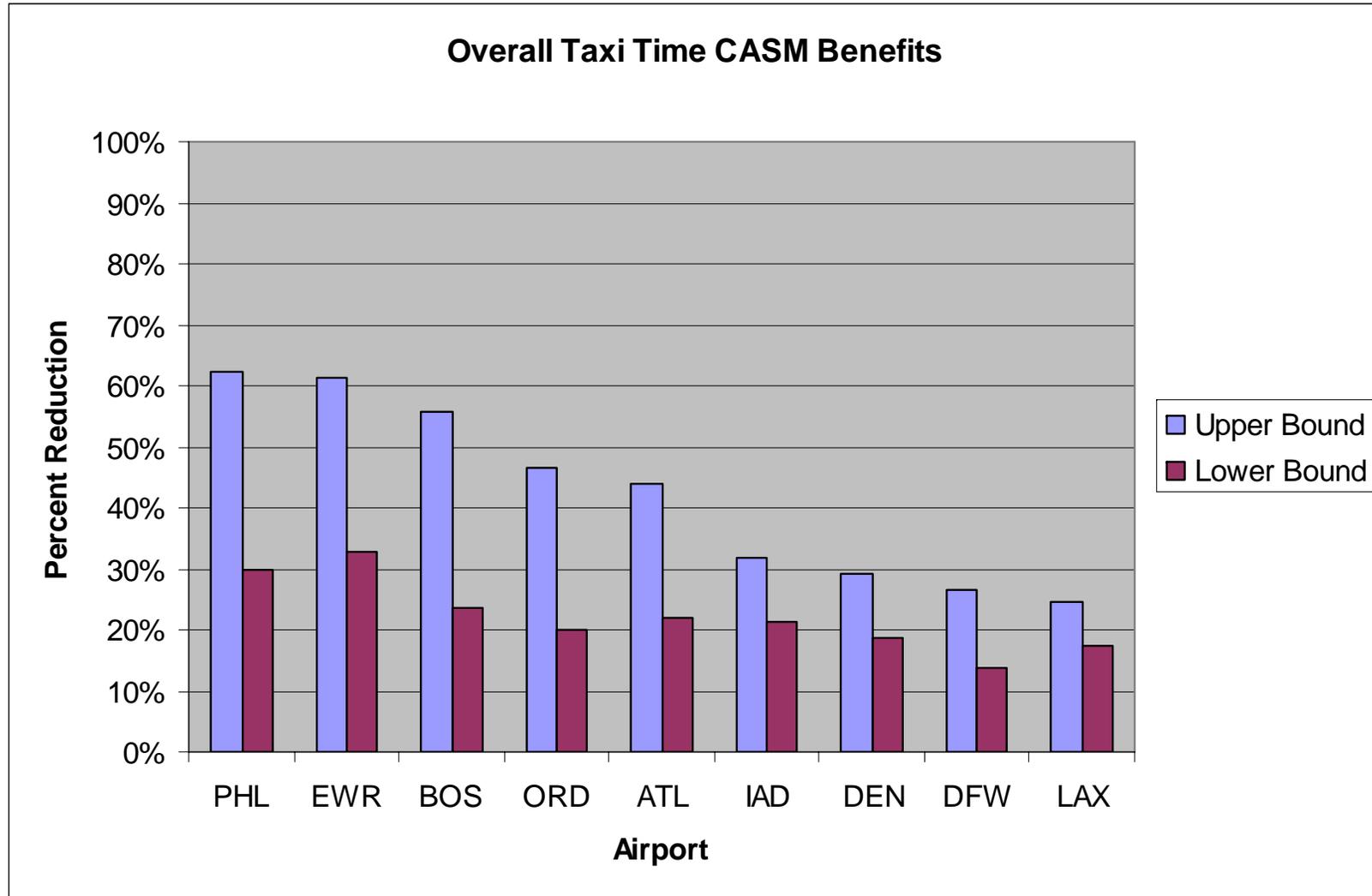
Approach – Upper Bound on Benefits

- With CASM, flights will not push back from the gate until necessary to meet runway departure time.
- In order to make sure runway capacity is not wasted, require flights to push back 30 seconds early which will result in only a 30 second wait at the runway queue.
- Use the unimpeded taxi time for the airport as the taxi time for flights under CASM.
- Actual Time in Queue = $\text{Max}(0, \text{Actual Taxi Time} - \text{Unimpeded Taxi Time})$
- CASM Time in Queue = $\text{Min}(\text{Actual Time in Queue}, 30 \text{ seconds})$
- Reduced Time in Queue = $\text{Actual Time in Queue} - \text{CASM Time in Queue}$

Approach – Lower Bound on Benefits

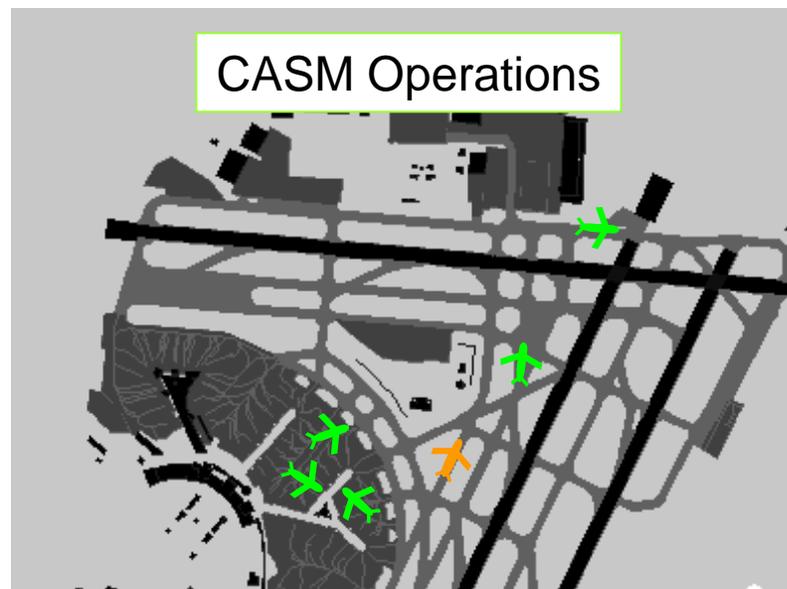
- Some flights will not be able to hold at the gate prior to departure because an arriving flight needs the gate
- Benefits in reduced runway queue time will be reduced due to early gate push backs to accommodate arriving flights
- Estimation Approach:
 - Assign each aircraft to a gate as efficiently as possible, minimizing the number of gates
 - Adjust the actual push back times for departures to the gate push back time under CASM
 - If the new departure time is later than the arrival time of the next aircraft at that gate, then
 - Assign departure to push back before arrival flight gets to gate
- Lower bound due to aircraft being scheduled to gates as efficiently as possible. In actuality, gate capacity could be higher.

Results



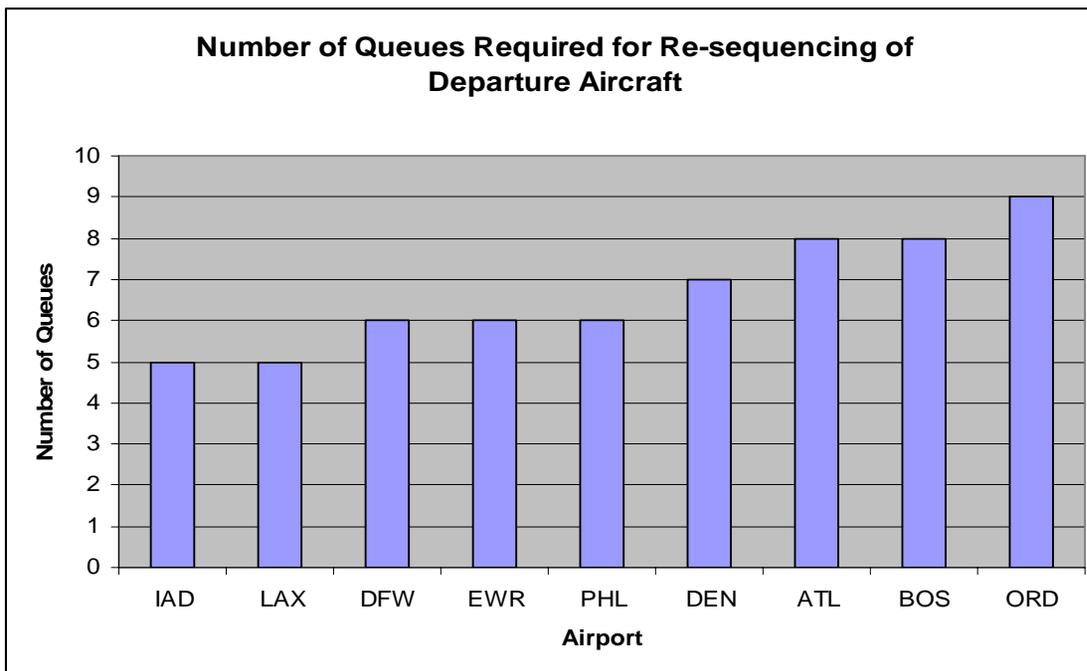
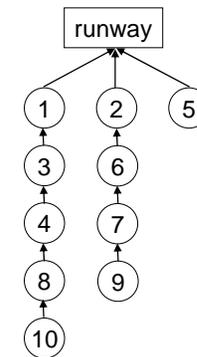
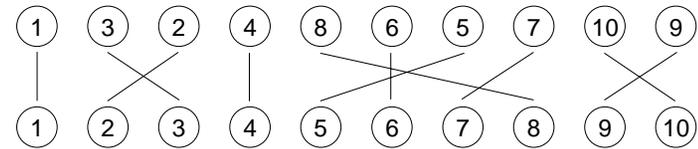
Airport Surface Sequencing

- Under CASM, Departure Flights May Arrive at the Runway Out of Sequence
 - Due to Early Push Backs to Make Gate Available
- CASM 'Virtual Queue' Must Be Realized on the Airport Surface
 - Alternative Taxi Routes
 - Holding Areas

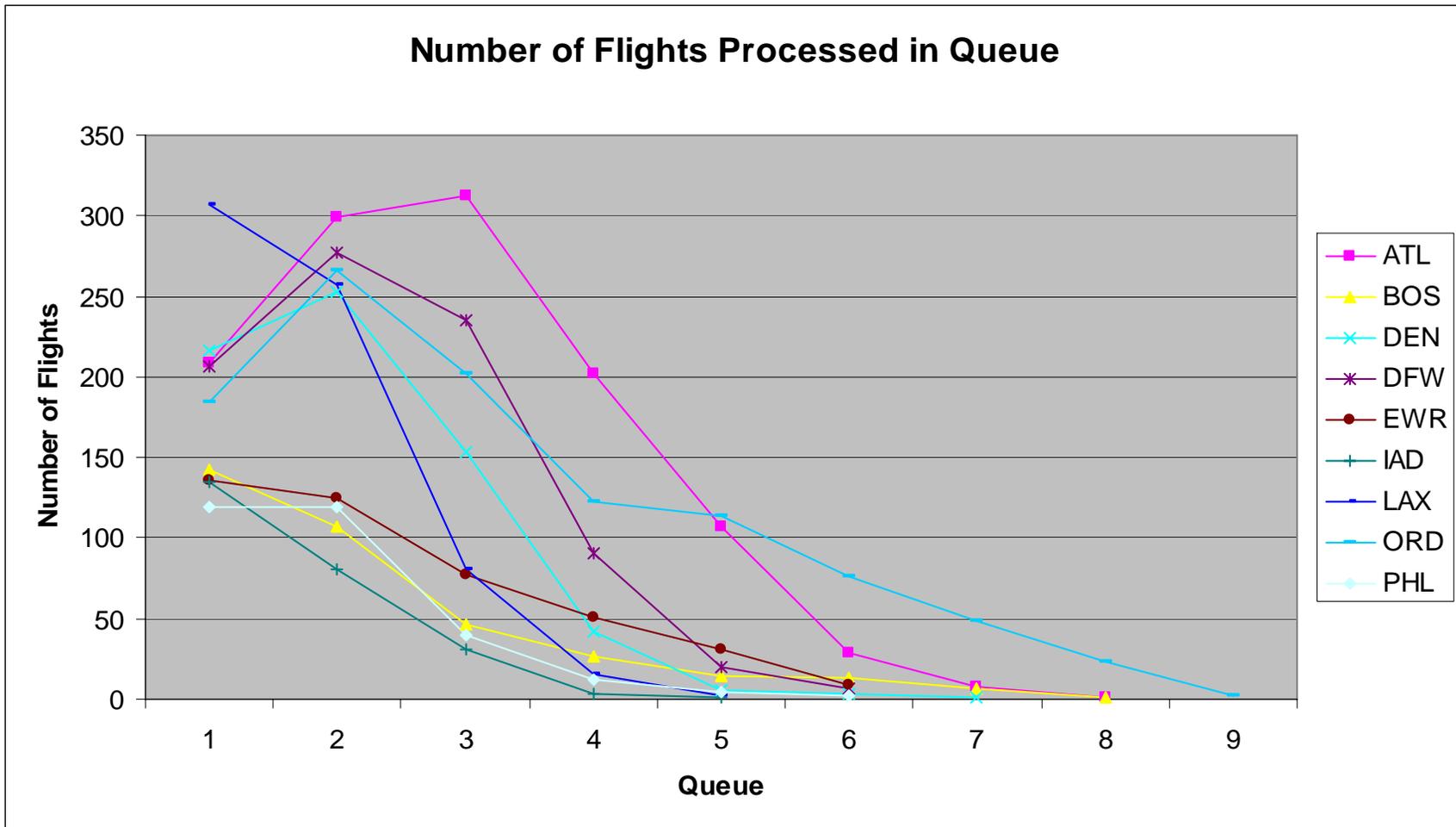


Required Number of Alternative Queues

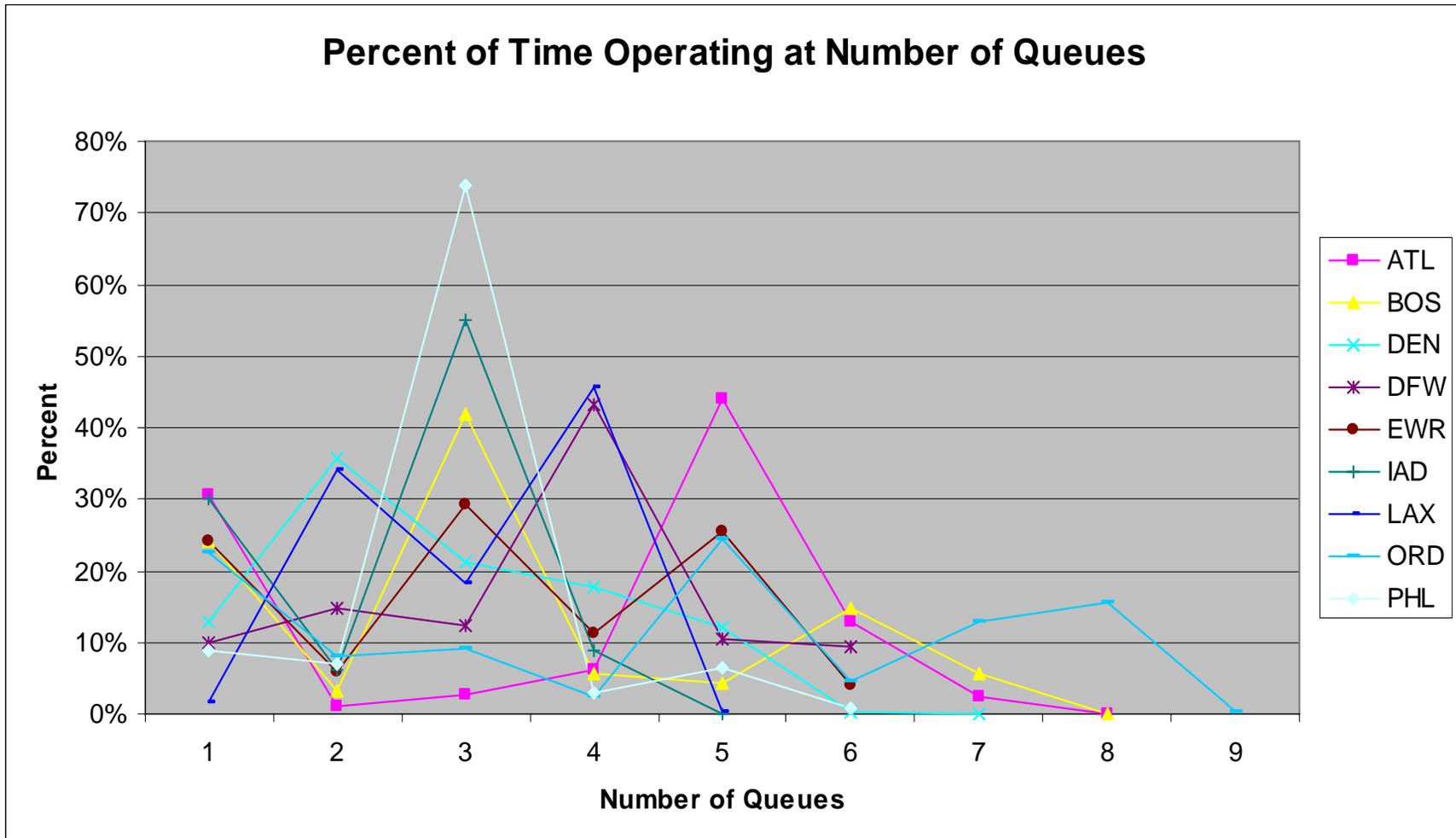
- Analysis of Airport Surface Sequencing Complexity for Departure Flights Under CASM



CASM Complexity (cont.)



CASM Complexity (cont.)



Conclusions

- Collaborative Airport Surface Metering Can Provide Significant Benefits
 - Taxi Time Reduction
 - Fuel Burn / Operating Cost Reduction
 - Emissions Reduction
- Benefits Already Demonstrated in Air Cargo Operations
- To Extend to Air Carrier Operations, New ATC Procedures Are Required
 - To Equitably Allocate Runway Departure Slots
 - To Establish the Take-Off Sequence, and
 - To Manage Push-Backs and Airport Surface Sequencing
- Collaboration Benefits for Flight Operator Through Slot Swapping
 - Analysis to be Conducted in Future Work