


Dynamic Stochastic Scheduler for Integrated Arrivals and Departures

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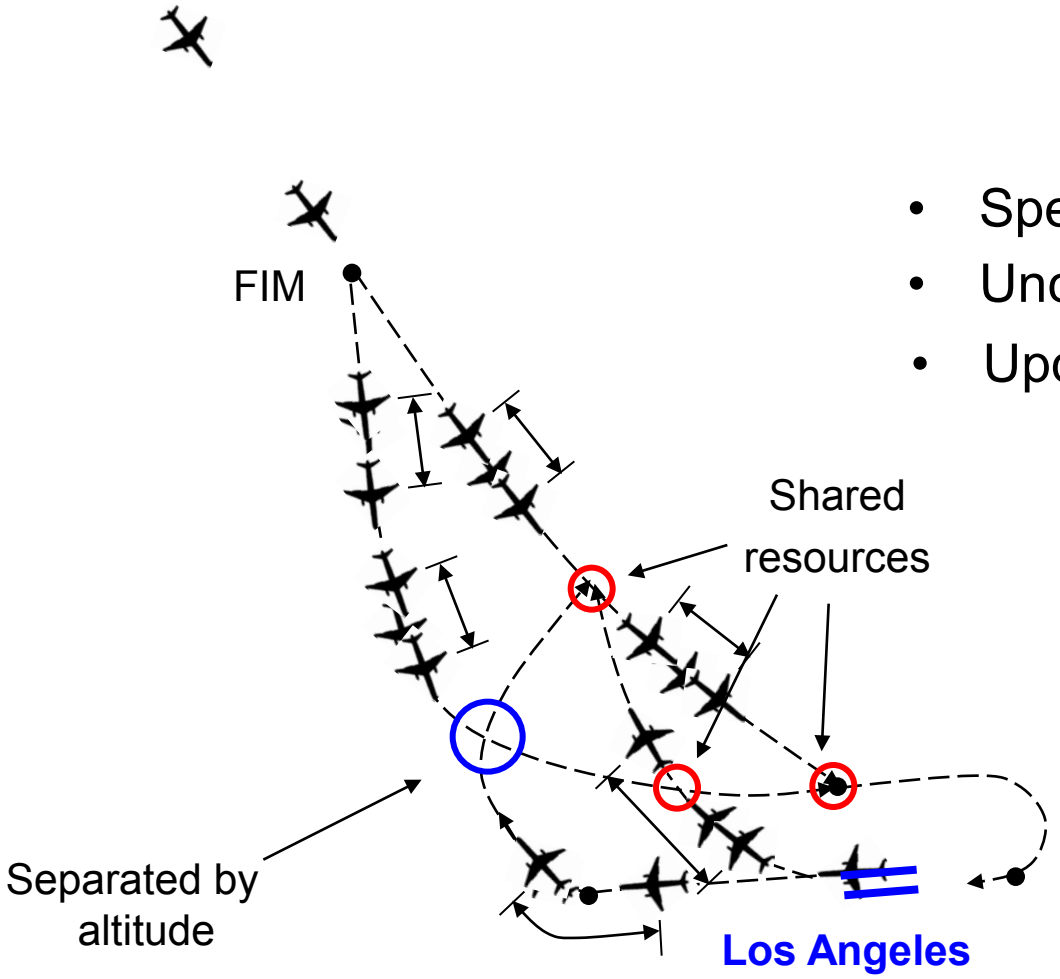

- Speed & routing
- Uncertainty
- Update frequency

Outline

- Background & motivation
- Problem
- Method
- Results
- Conclusions

Background

- Arrival or departure scheduling algorithms
  - Constrained Position Shifting (CPS)
  - CPS with Dynamic Programming
  - Mixed Integer Linear Programming (MILP)
  - Basic Genetic Algorithm (BGA)
  - Heuristic Constraint based FCFS method
- Surface scheduling algorithms
  - MILP [Gupta et al 2009, Malik et al 2012]
  - Generalized Dynamic Programming [Montoya et al 2011]
- Integrated arrival and departure scheduling with shared resources
  - MILP [Capozzi et al 2009 & 2010]
  - Multiple-point scheduling [Chen et al 2011]
  - Non-dominated Sorting GA [Xue et al 2012, 2013]

Motivation

Dynamic & stochastic scheduler is needed

for finding robust and beneficial schedules and routes for continuous traffic under uncertain environment

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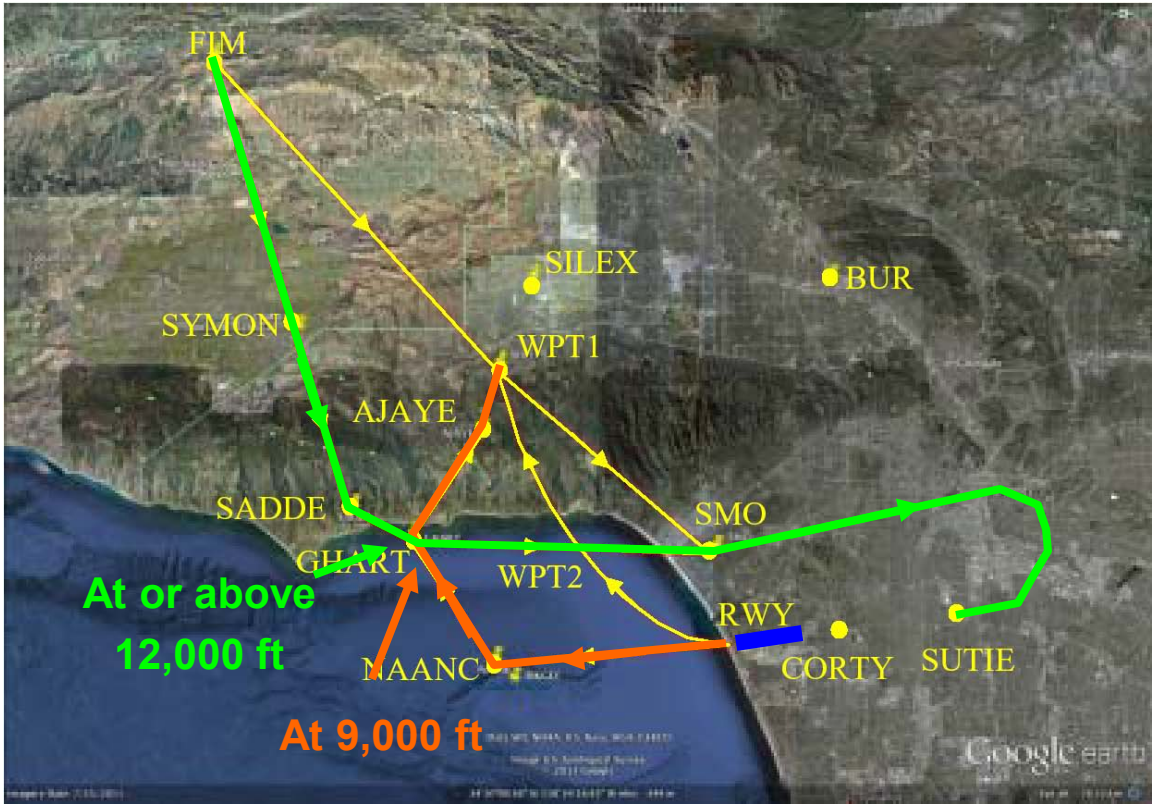
Interactions in LAX Terminal

- SADDE6: 28% of LAX arrivals or ~220 flights/day
- CASTA2: 10% of LAX departures or ~80 flights/day



- Total delay in a day due to the interaction is 380 minutes.

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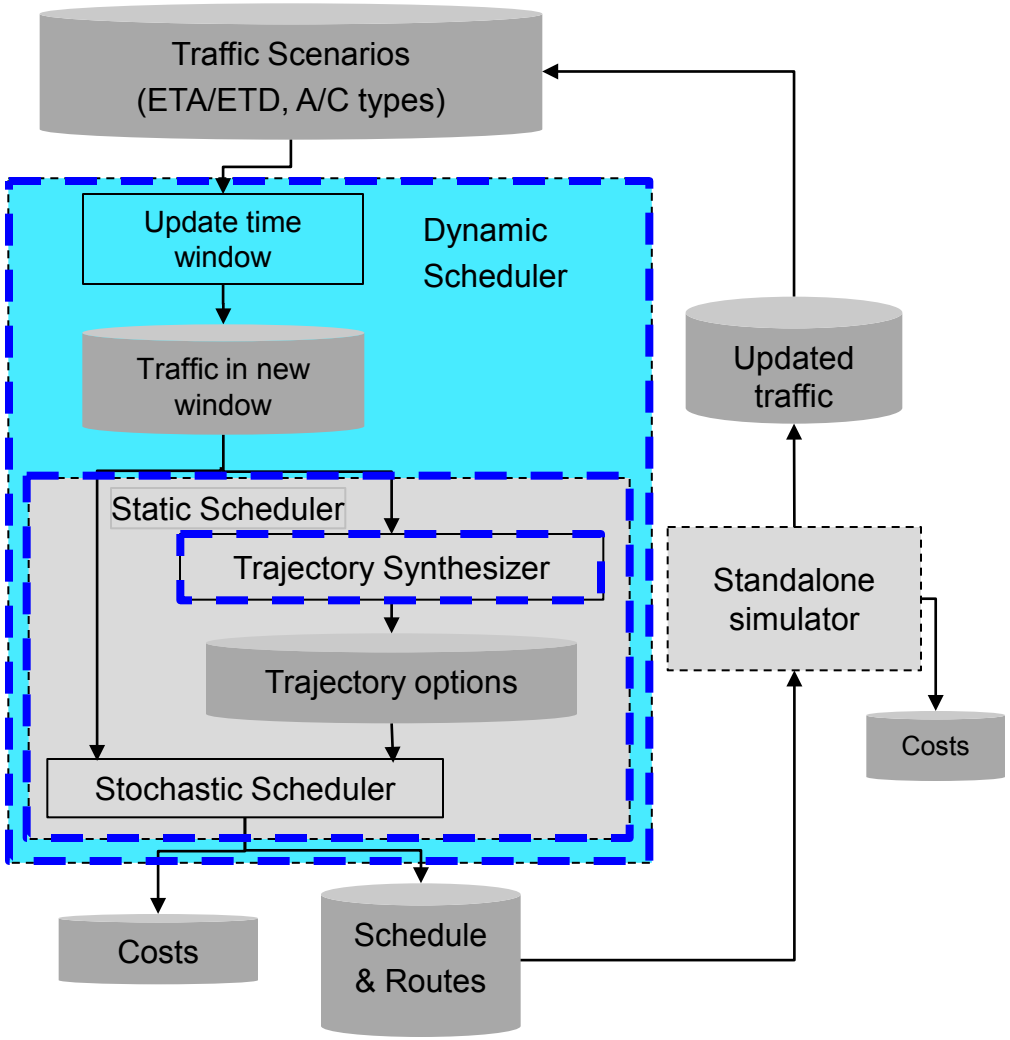
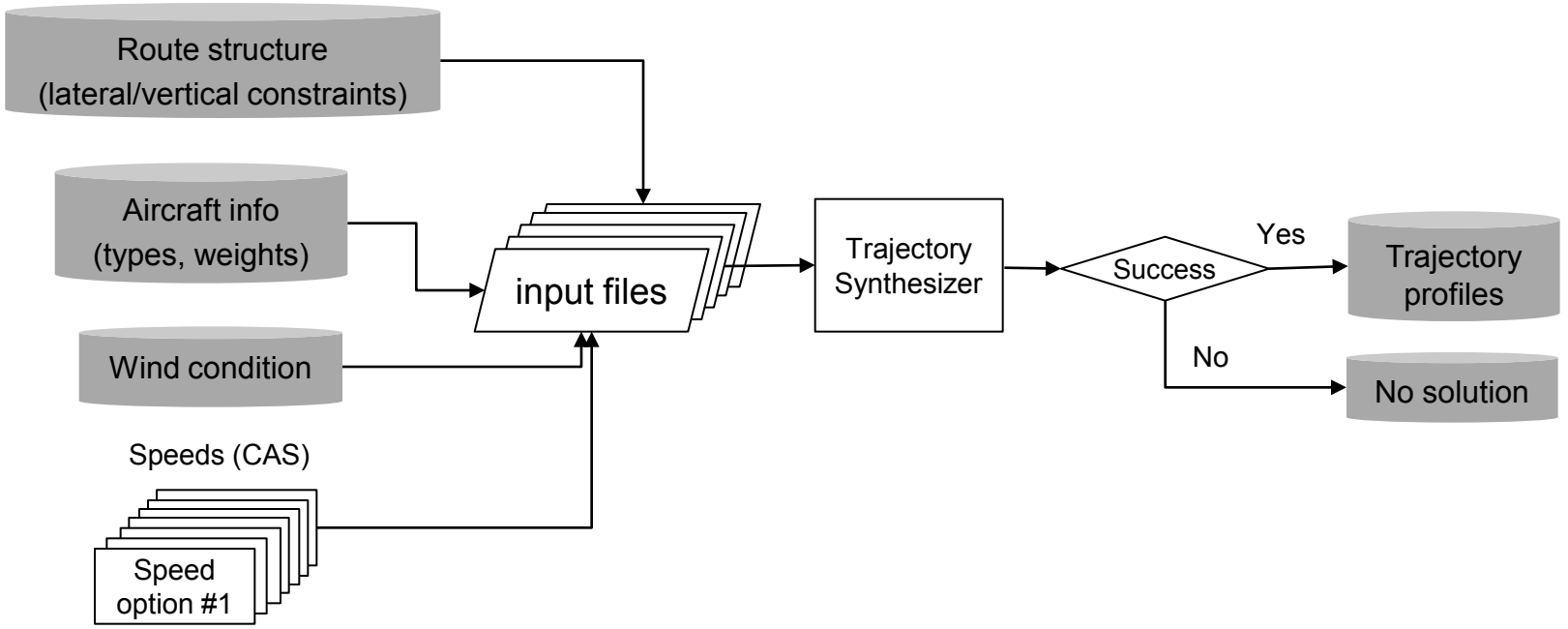
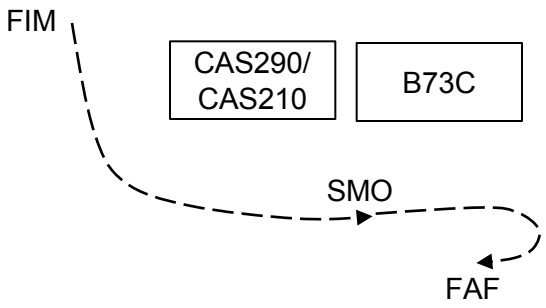
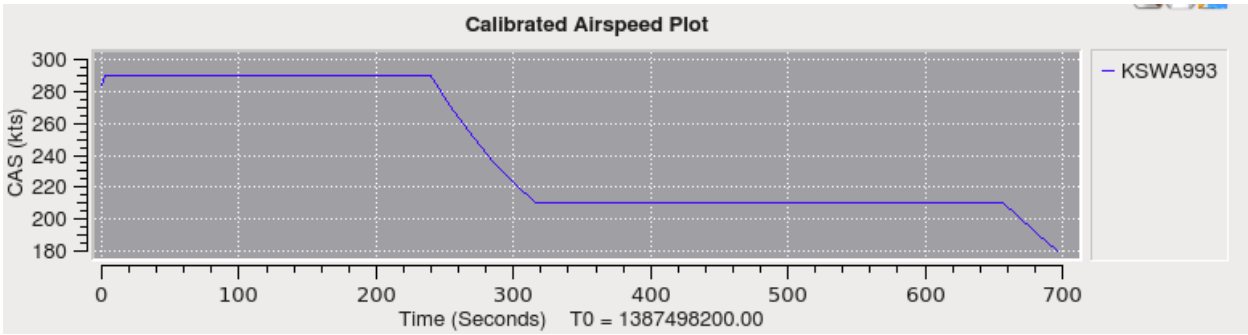
Procedure


Traffic Scenarios
(ETA/ETD, A/C types)
Update time window
Dynamic Scheduler
Traffic in new window
Static Scheduler
Trajectory Synthesizer
Trajectory options
Stochastic Scheduler
Costs
Schedule & Routes
Updated traffic
Standalone simulator
Costs

Speed options



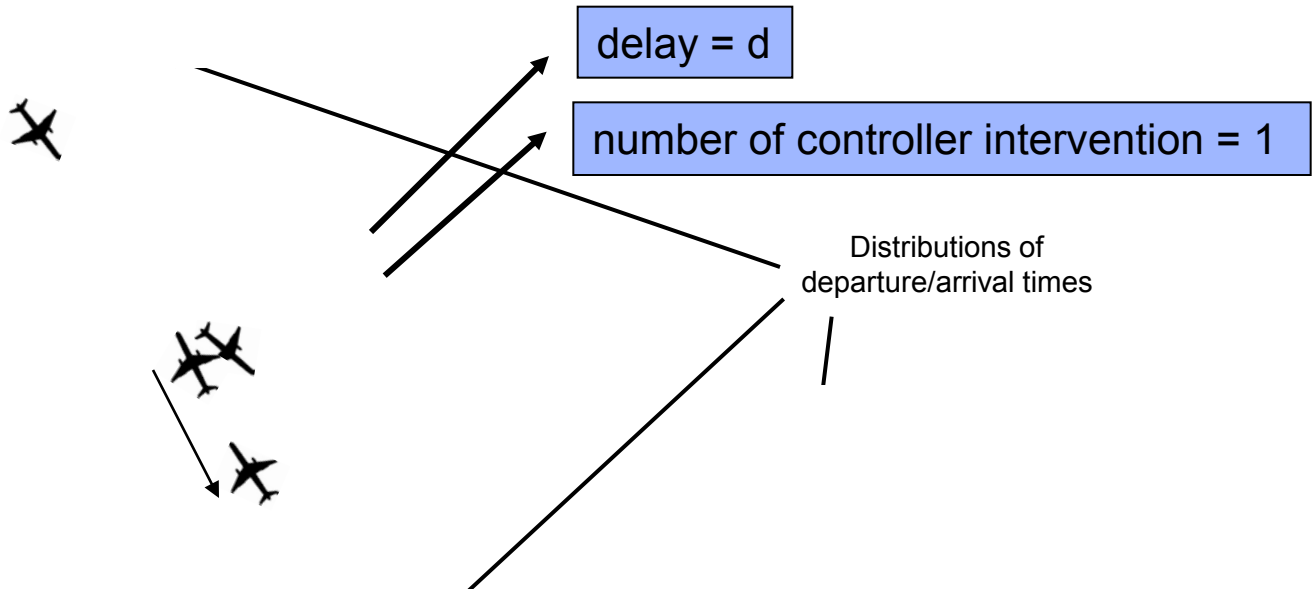




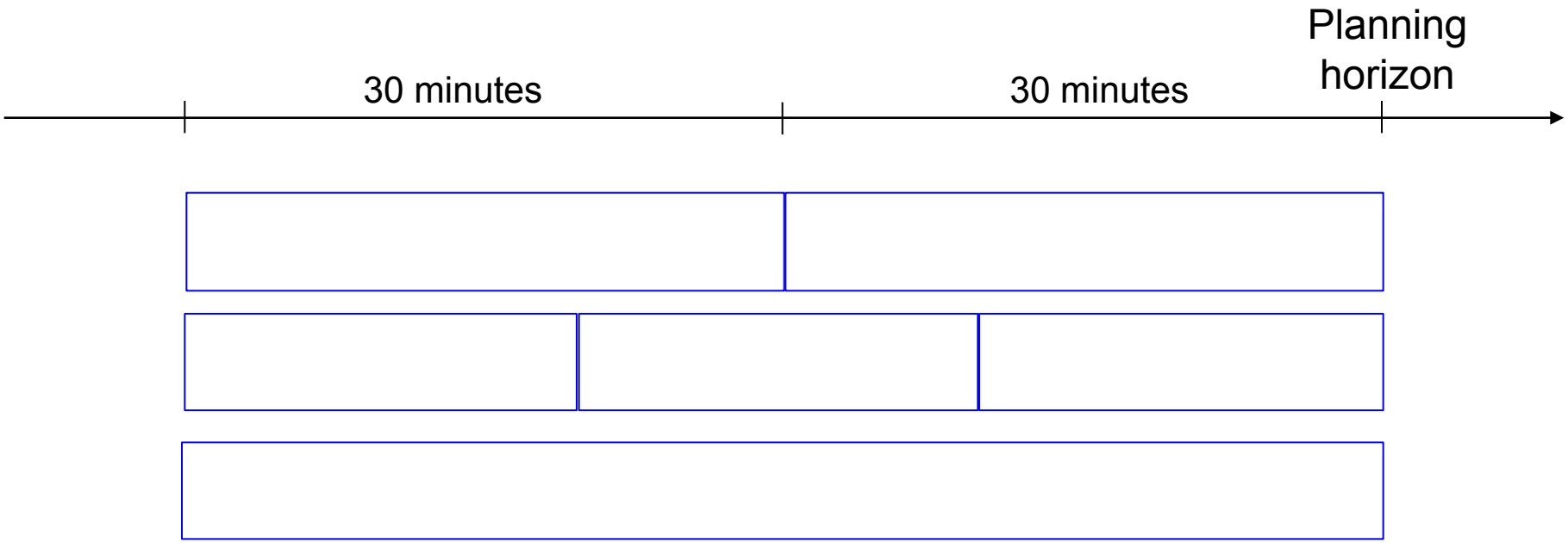
Stochastic scheduler

J_1 = deterministic delay + stochastic delay (mean value)

J_2 = controller interventions (mean value)



Scheduling window (update frequency)



- Window size can be varied
- Windows can overlap with each other
- Some flights are included in multiple windows

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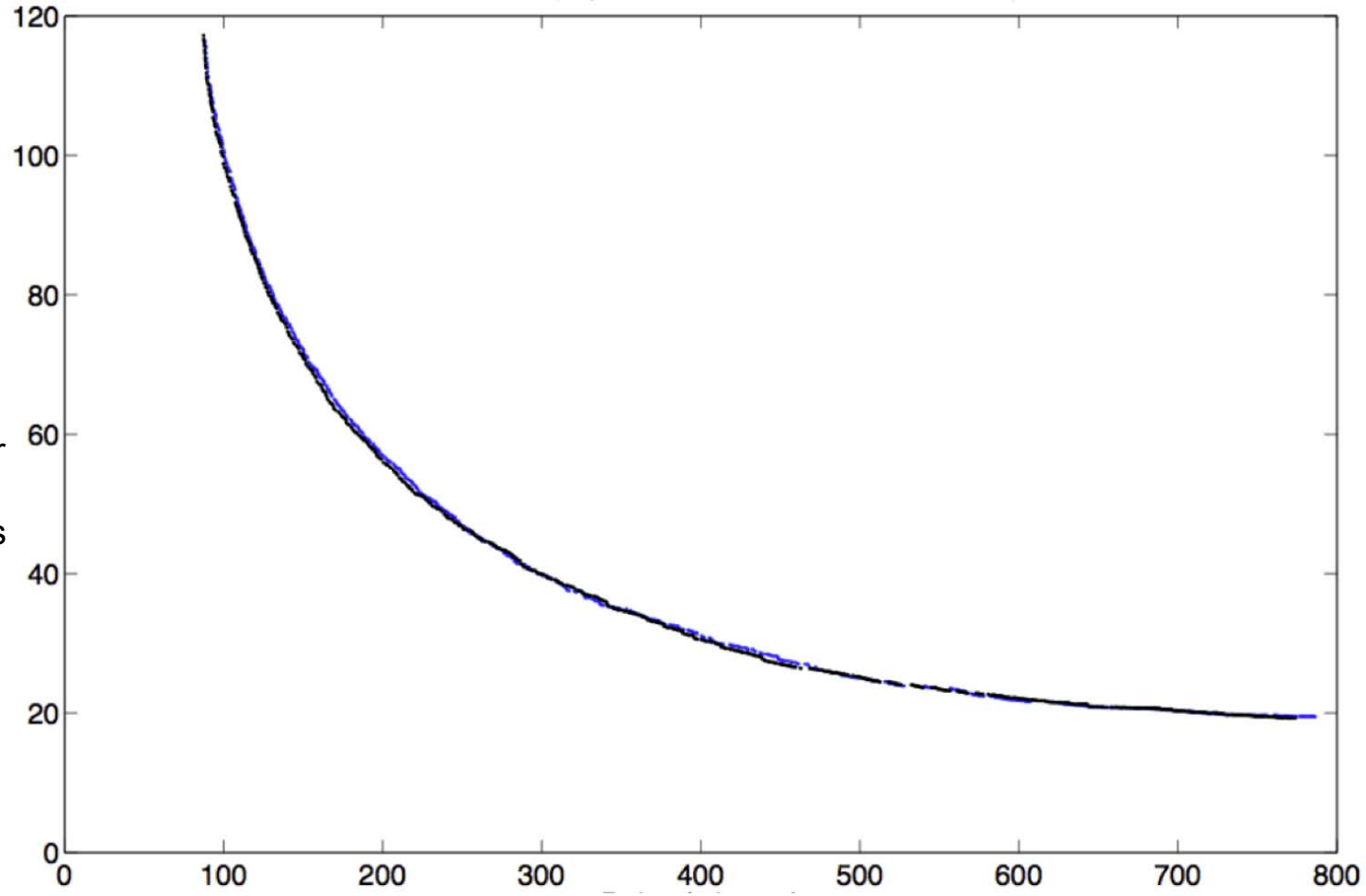
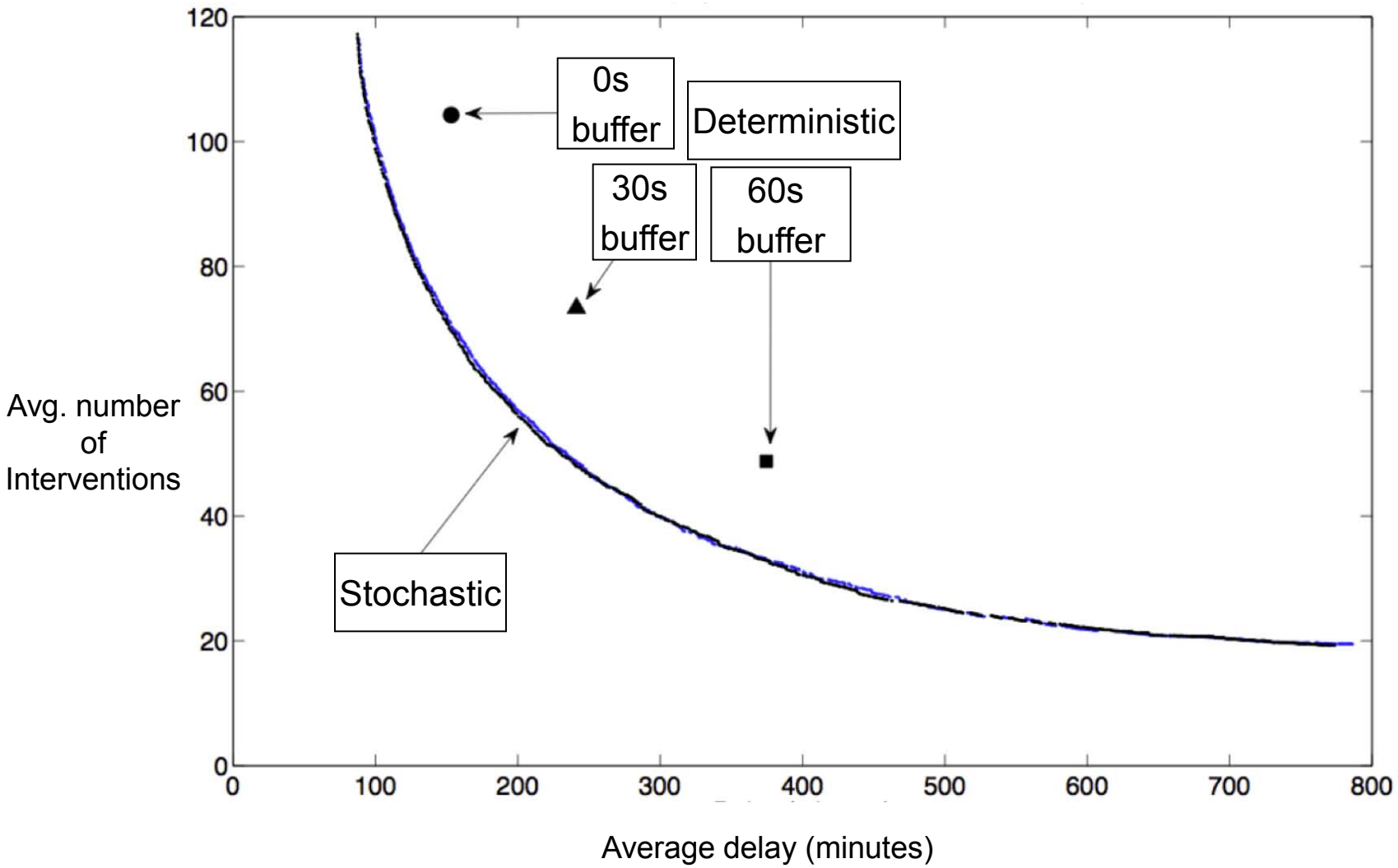
Experiment set-up

- Traffic scenario based on Dec. 4, 2012
- A total of 378 flights, including 290 arrivals & 88 departures
- Separation based on wake category
- Buffers in deterministic cases

Combined Pareto front



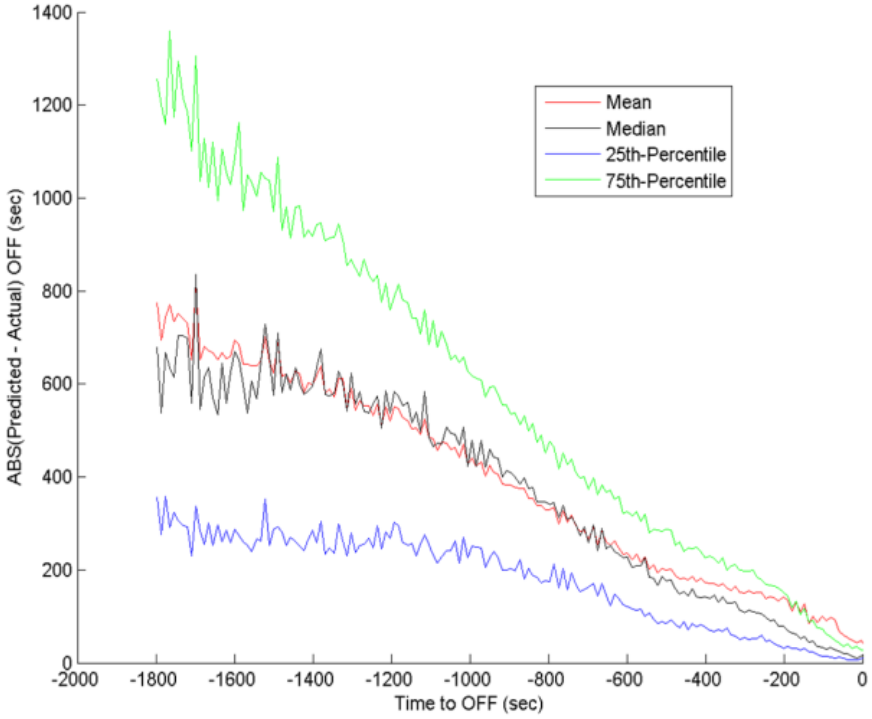
Deterministic vs. Stochastic



Look-ahead time vs. Uncertainty

Surface Decision Support System (SDSS) prediction accuracy at DFW June, 2011
[courtesy picture from Capps et. al. 2011 ATIO]

Time (s)



e
y

75th percentile

75th percentile

)s

Mean

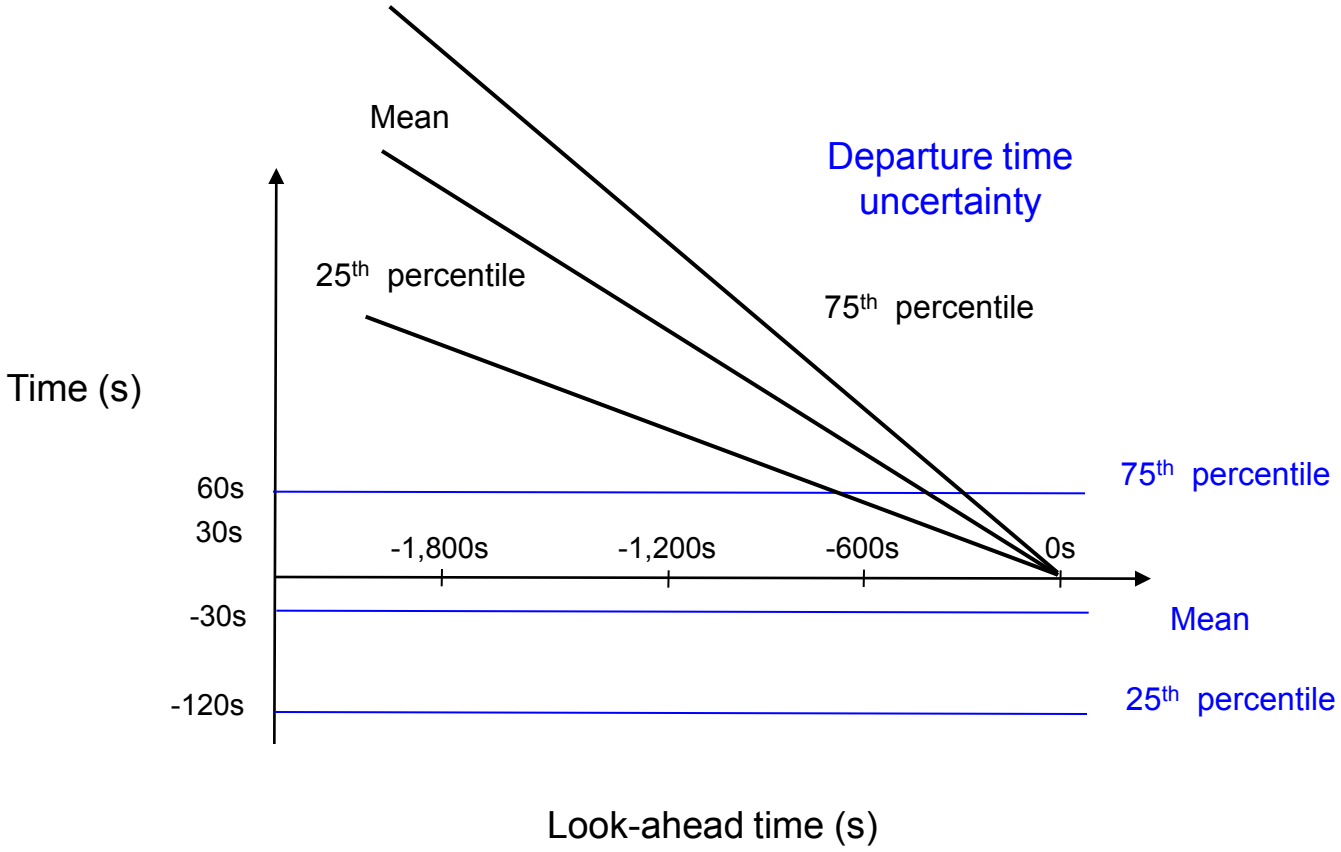
25th percentile

25th percentile

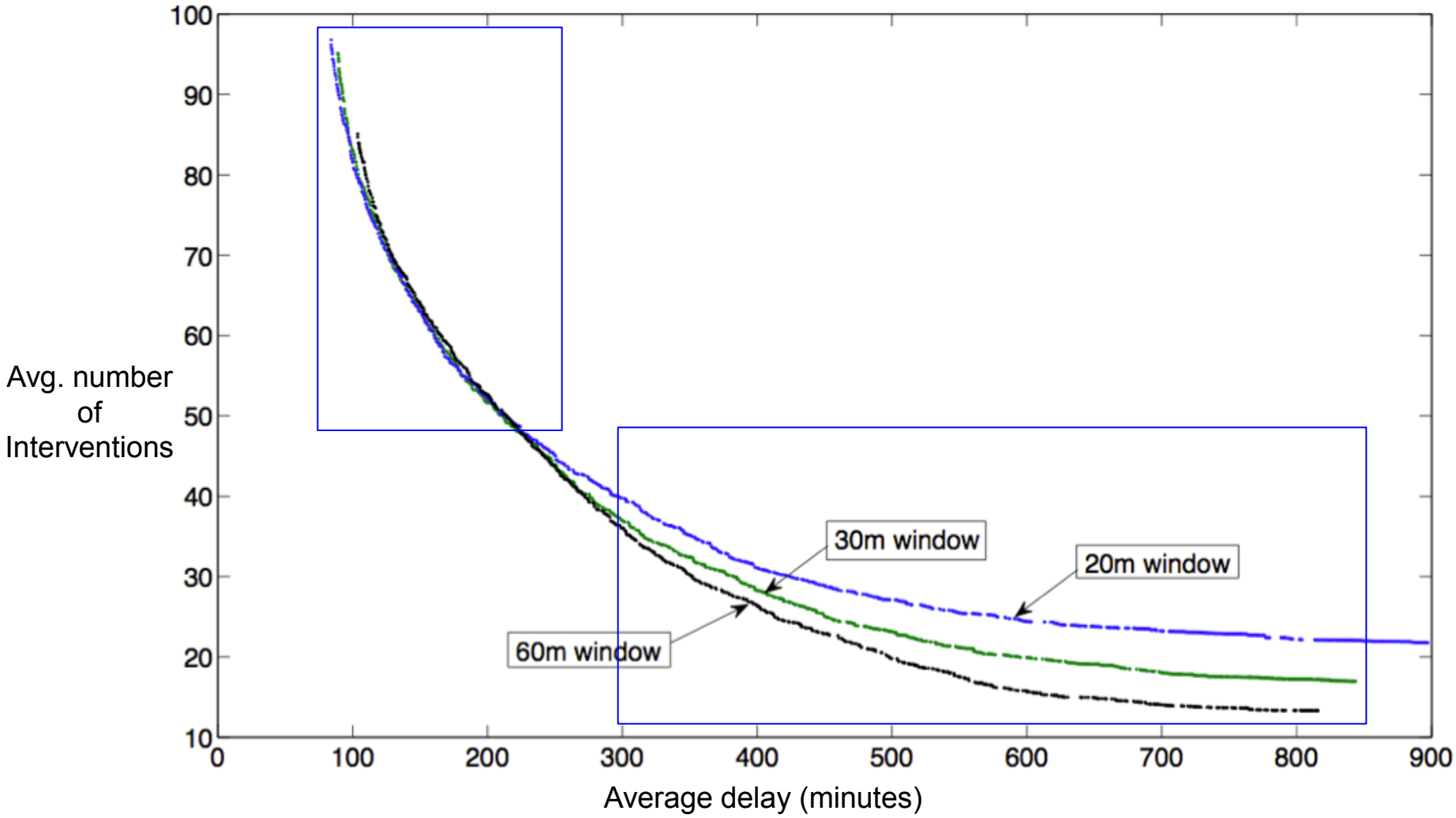
$$\text{Mean} = 0.39 \times T_L \qquad (1)$$

$$\text{Std. dev.} = 0.41 \times T_L \qquad (2)$$

Look-ahead time vs. Uncertainty



Impact of window-size/look-ahead time



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Conclusions

- A sequential/dynamic stochastic scheduler was developed to handle uncertainty and multi-objective for integrated departures and arrivals
- Stochastic scheduler is better than deterministic scheduler with buffers by reducing delay & number of controller interventions
- Large window size is better when the controller intervention is low, and small window size is better when delay is low

Future work:

- Extend the application to all LAX arrivals, departures, and surface operations
- Apply to other multiple airport metroplex like NY