Benefits Estimates for Mid-Term and Far-Term Wake Concepts at U.S. Airports

Clark Lunsford

(Laurence Audenaerd, Jeff Tittsworth, Jillian Cheng, Chris Devlin, Ralf Mayer, Michael Mills, Joe Sherry, Art Smith, Ken Lamon)

November 29, 2005

MITRE

Mid-Term CSPR Departures (Joint FAA/NASA Effort)

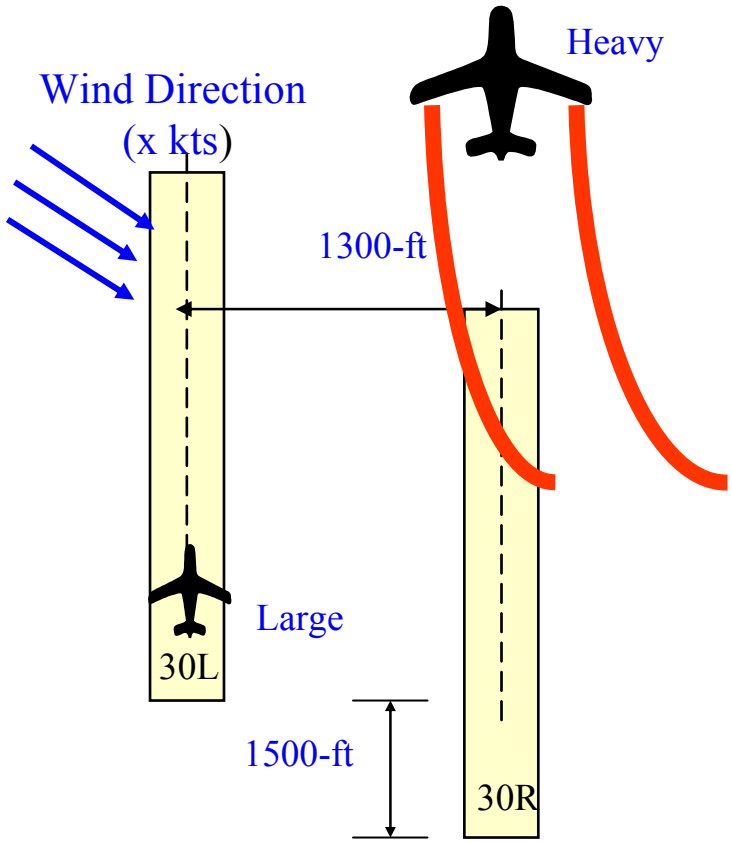
Under current rules a Large departing on 30L has to be spaced 3 minutes (intersection departure rule) behind a Heavy departing 30R since the CSPR are a single runway in IFR conditions.

Under certain wind conditions, like these depicted in this situation, the wake is obviously not a factor and closer spacing could be allowed

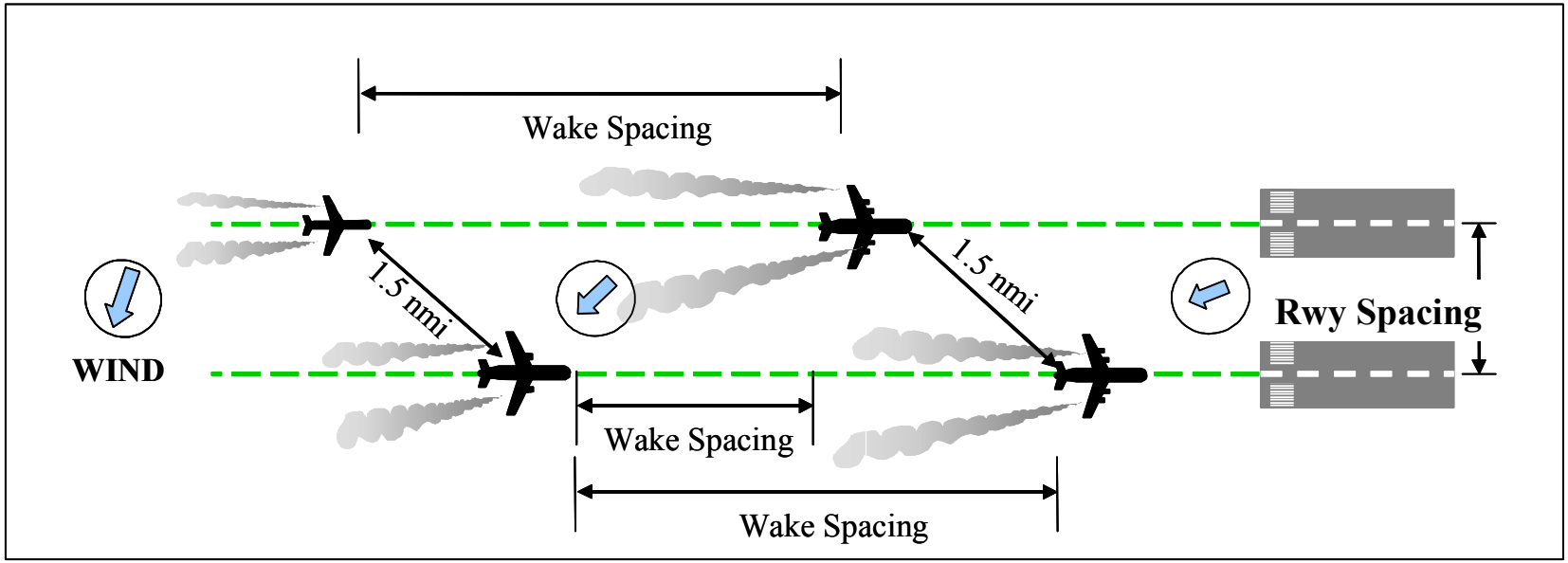
An operational solution requires:

- Tactical Wind Prediction and Monitor function (for next departure)
- Strategic Weather function (for planning horizon)
- Stability of operation to ensure usability/reliability

STL Example



CSPR Wind-Dependent Arrivals (NASA Lead)



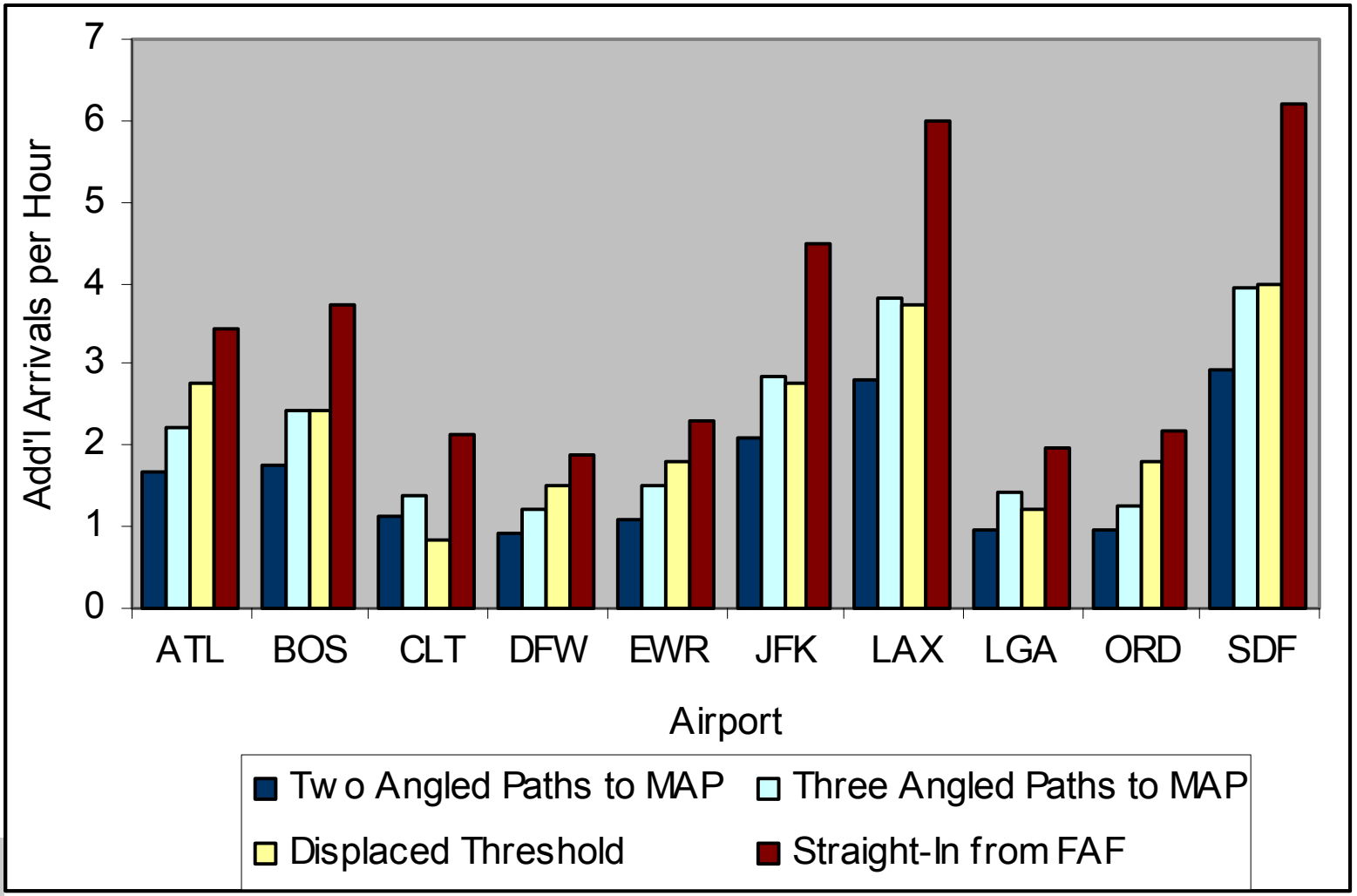
- Concept options include
  - Straight-in
  - One straight-in, one 3 degree angled approach
- Leader of pair is downwind (any weight category)
- Separation
  - 1.5 nm stagger within pair
  - Current wake separation applied between pairs
  - Current wake separation applied in-trail to same runway

MITRE

Conops Capacity, Availability, and Delay Impact Analysis

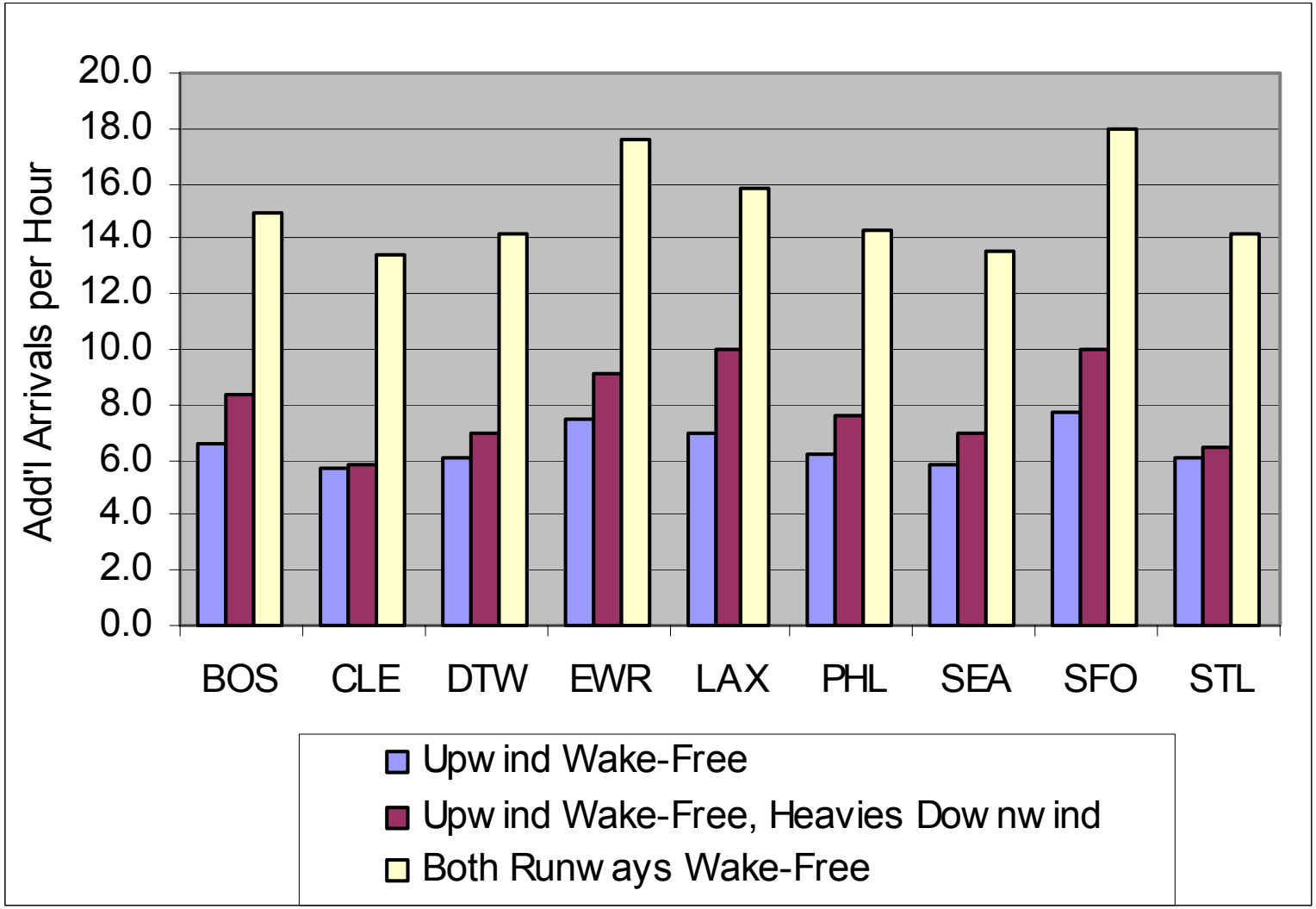
- Model the arrival (or departure) throughput for each conop
  - Monte Carlo simulations using distributions derived from operational data
    - Traffic mix, Approach speeds, Final approach spacing, Spacing uncertainty buffer
    - 50,000 aircraft operations modeled for each conop
- Calculate crosswind requirement for each conop geometry and airport
  - APA derived wake transport by crosswind and wake life
  - Conop geometry factors: flight technical error, alternate separation zone height and width, CSPR separation
  - Aircraft factors: worst case wing span for leader and trailer, wake radius
- Estimate when the required crosswinds existed for a sample year
  - Analyze historical winds for satisfying crosswind requirements at all levels up to ASZ height for each conop geometry
- Estimate delay savings using one year of actual demand
  - Model delay impact using CAASD Capacity Benefit Analyzer

Single Runway Arrival Results (2.5/3.0 nmi)

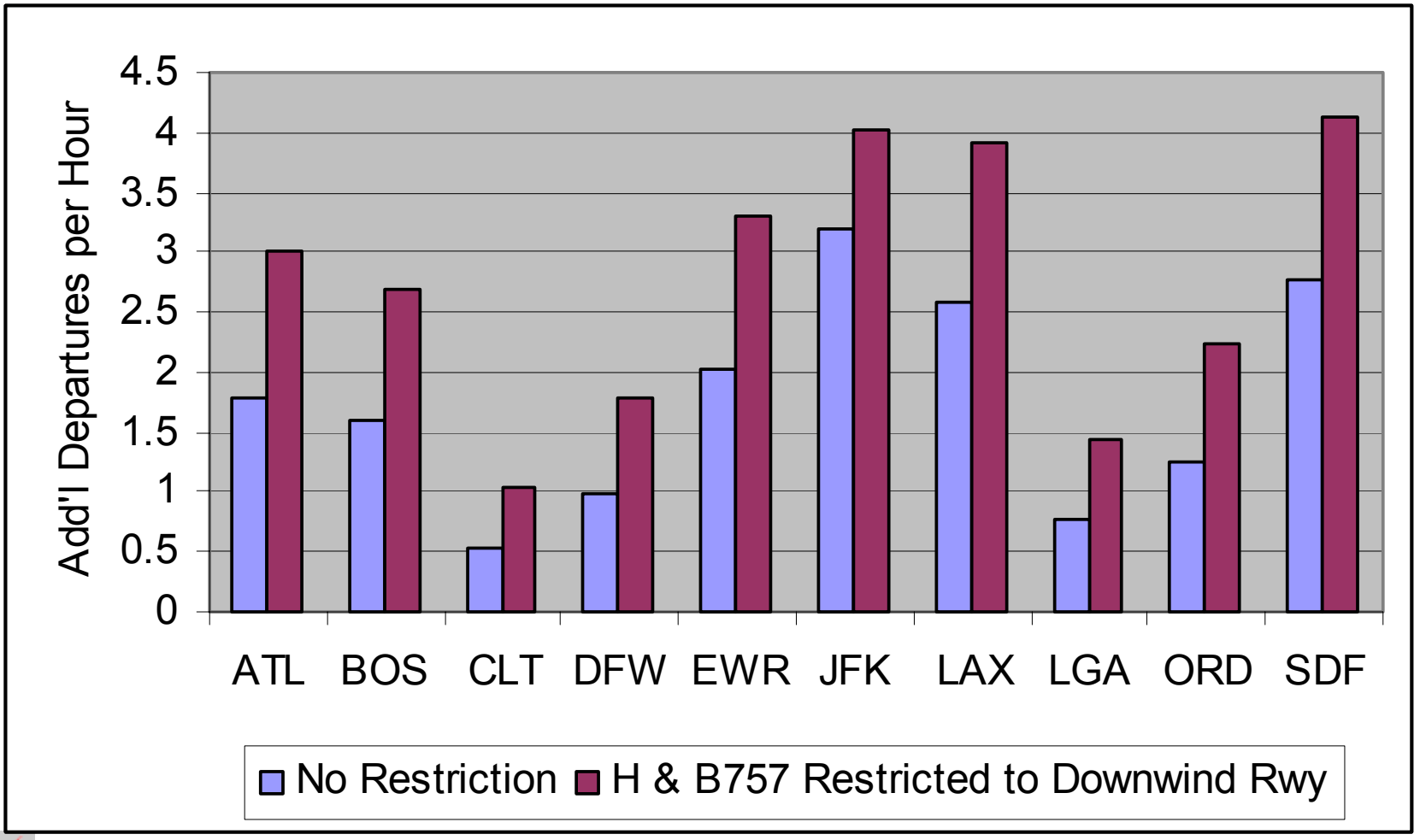


MITRE

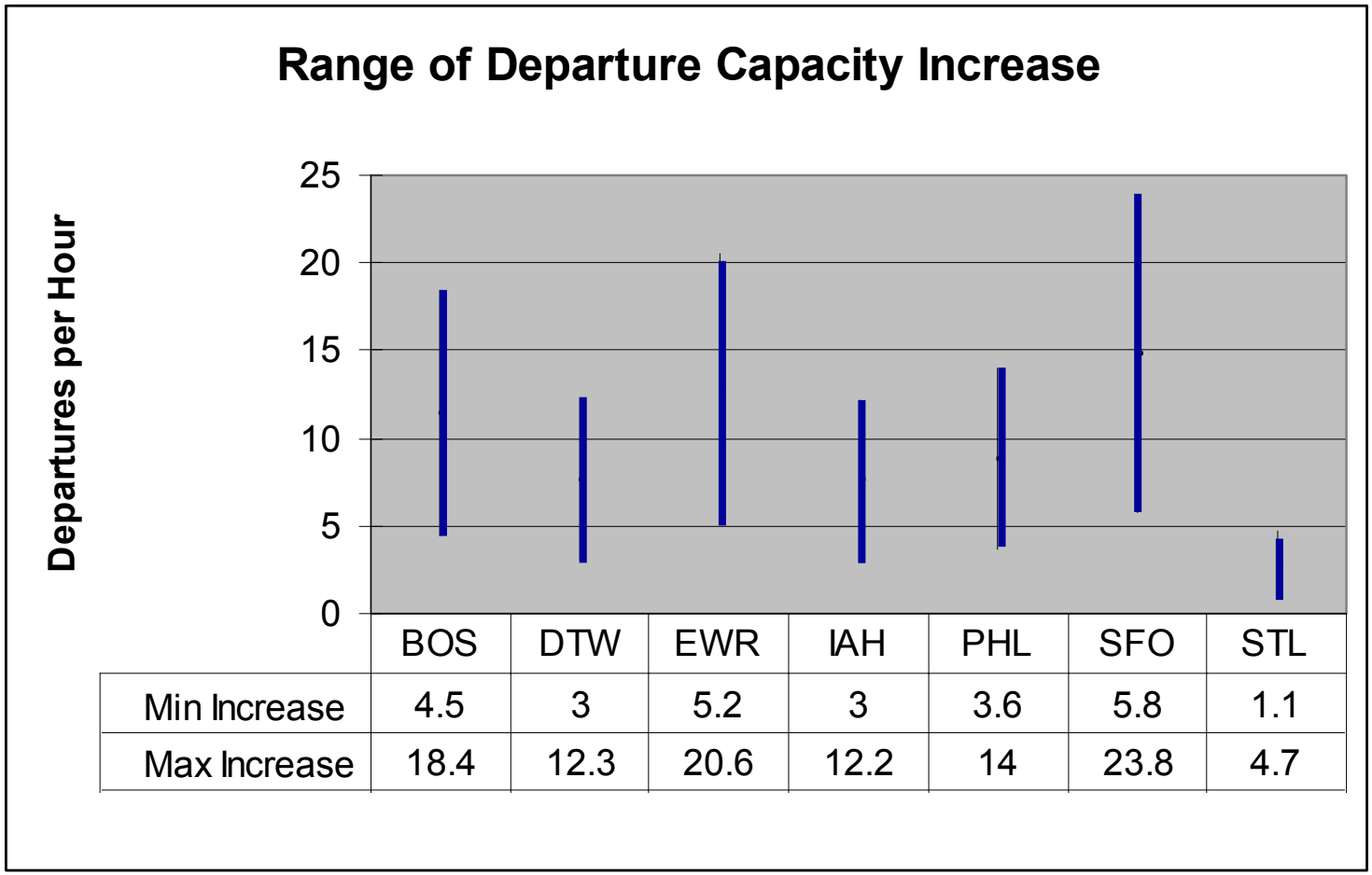
CSPR Arrival Rate Improvement



Single Runway Departure Increases (Visual, Dual Dept Path)



CSPR Departure Capacity Improvement



	BOS	DTW	EWR	IAH	PHL	SFO	STL
Min Increase	4.5	3	5.2	3	3.6	5.8	1.1
Max Increase	18.4	12.3	20.6	12.2	14	23.8	4.7

- **Range over all runway configurations, weather conditions, and Heavy runway assignment**

Model Delay Impact Using Actual Demand with Capacity Benefit Analyzer

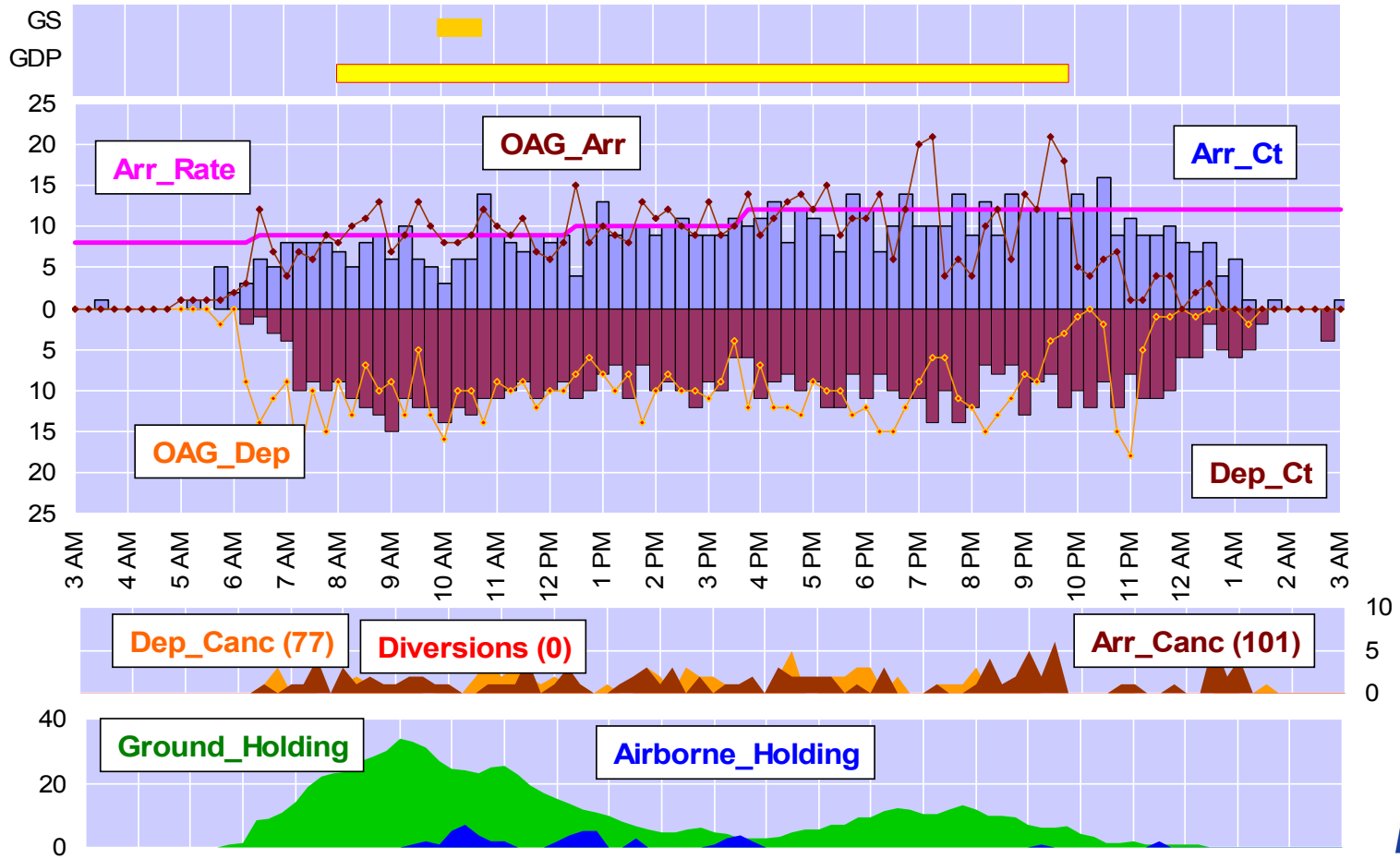
LOW CIGS/VIS

PHL: Monday, Feb 21, 2005

Delays	Departure	Arrival	TMS
288	87	1	200

% Ops delayed = 23%

Average delay = 60 minutes



MITRE CAASD **Sample ASAP output for example of demand**

What Changes in Capacity/Delay Will Result?
Mid-Term CSPR Arrivals

Metric	BOS	DTW	EWR	PHL	SFO	Totals
Percent Increase in Peak Arrival Capacity	17%	17%	23%	19%	34%	
Reduction in Arrival Delay (Hours/Day)	26.5	6.6	44.8	56.6	17.3	
Percent Reduction in Arrival Delay	15%	4%	15%	15%	12%	
Annual Direct Operating Cost Savings ($Million)	$6.2	$1.5	$11.7	$12.6	$5.4	$37.4

Airport	ADOC Airborne** Cost per Minute
BOS	$ 27.05
DTW	$ 26.03
EWR	$ 29.99
PHL	$ 25.50
SFO	$ 35.74

What Changes in Capacity/Delay Will Result?
Mid-Term CSPR Departures

Metric	SFO	DTW	EWR	IAH	PHL	Totals
Percent Increase in Departure Capacity	13.2%	4.3%	10.6%	7.9%	14.6%	
Reduction in Departure Delay (Hours/Day)	2.7	3.1	19.1	8.5	25.1	
Percent Reduction in Departure Delay	5.8%	4.1%	18.3%	8.2%	21.7%	
Annual Direct Operating Cost Savings ($Million)	1.5	1.3	9.1	3.4	10.2	25.5

Airport	ADOC Taxi** Cost per Minute
SFO	$ 25.91
DTW	$ 18.87
EWR	$ 21.74
IAH	$ 18.30
PHL	$ 18.48

Next Steps

- Incorporate Wind Forecast Algorithm performance considerations in CSPR Departure benefits estimates
- Conduct airport visits to
  - Expand set of facility stakeholders
  - Identify airport specific factors related to conops to verify concept applicability and benefits achievability
    - Arrival or departure operations and airport specific techniques
    - Airspace factors
    - Surface management factors
    - Noise abatement
    - Level of region and local support for considering implementation of conop
- Explore operational issues and Decision Support Tool feasibility in Controller-in-the-Loop simulations in CAASD's ATM Lab