LaGuardia Airport Systems Operations Study:

Impact of Airport System Operations in the Presence of Airline Aircraft Upguaging

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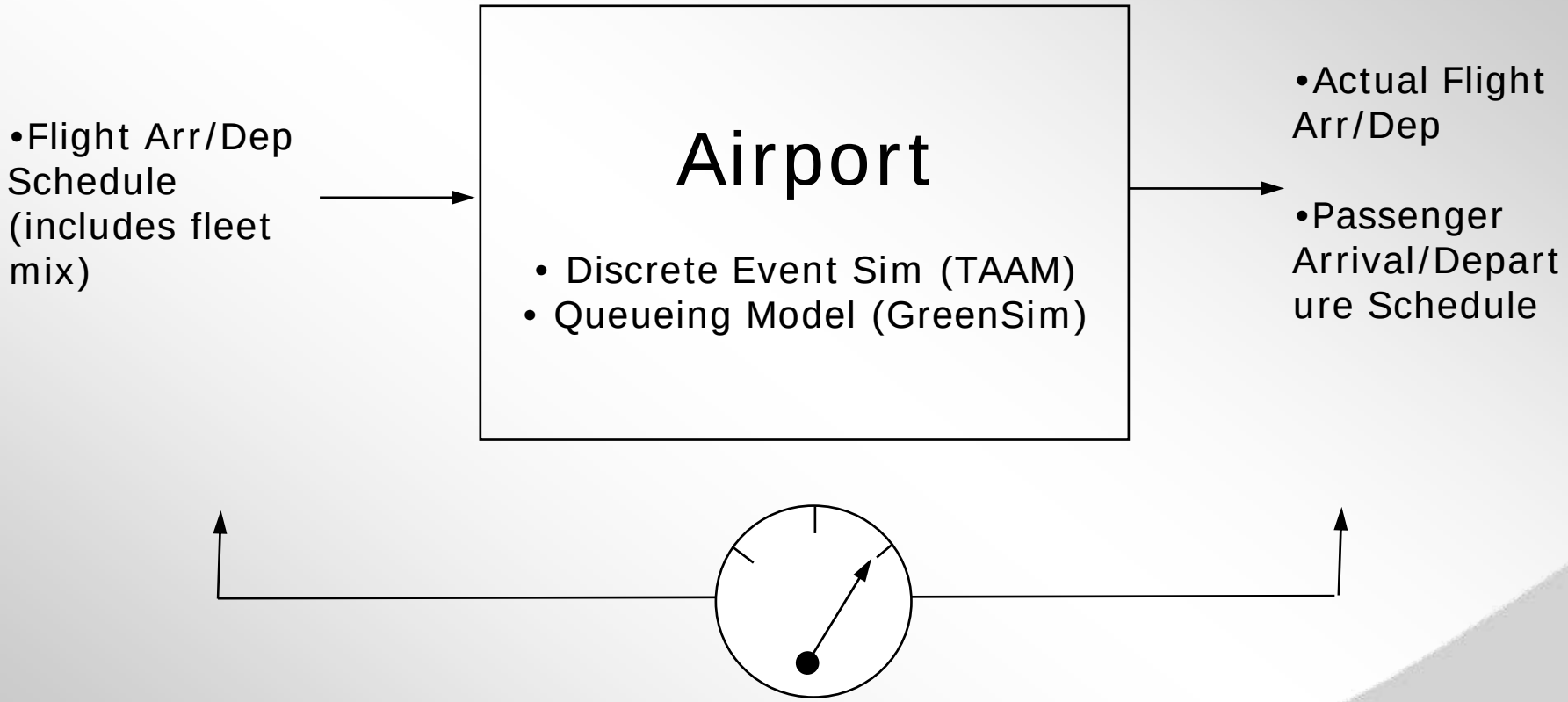
Terry Thompson (Metron Aviation)

Annotated Briefing (View menu, Notes to see text)

Airport "System" Operations



- Seat Capacity, Flight Capacity
- Delays (Taxi-in, Taxi-out, Departure Queue)
- Gate Utilization
- ADOC
- Fuel, Emissions, Noise

Overall Results

1. Airport pax throughput can improved by upguaging
   - Marginal impact on Flight Delays
     - under assumptions of capacity lists, schedule "bunching" and fleet mix
   - Impact on Emissions and Noise
     - Not proportional to schedule or delay reduction
     - Highly dependent on fleet-mix (engine-type)
2. Future regulations should consider
   - Manage schedule to avoid schedule "bunching"
     - Multiple capacities throughout day (buffer for delays)
   - Manage fleet-mix
     - Arrival/Departure separation distance determines capacity
     - Emissions and Noise impact determined by engine-type

Objective

- Assess the overall impact on “airport system” performance (e.g. available seats, delays)
  - in the presence of a nominal high demand schedule (e.g. total scheduled flights of 1125 between 0700 and 2159 local time)
  - with a fleet mix containing increased levels of narrow-bodied aircraft and fewer regional jets
- “Airport System” Performance Metrics:
  - Pax throughput, Flight Delays, Fuel-burn, Emissions, Noise

Organization

- Study 2.1
  - Delays & Gate Utilization
  - Discrete Event Simulation (TAAM)
- Study 2.2
  - Delays, Fuel, ADOC, Emissions, Noise
  - Queueing Simulation (GreenSim)

LaGuardia Airport Systems Operations Study:
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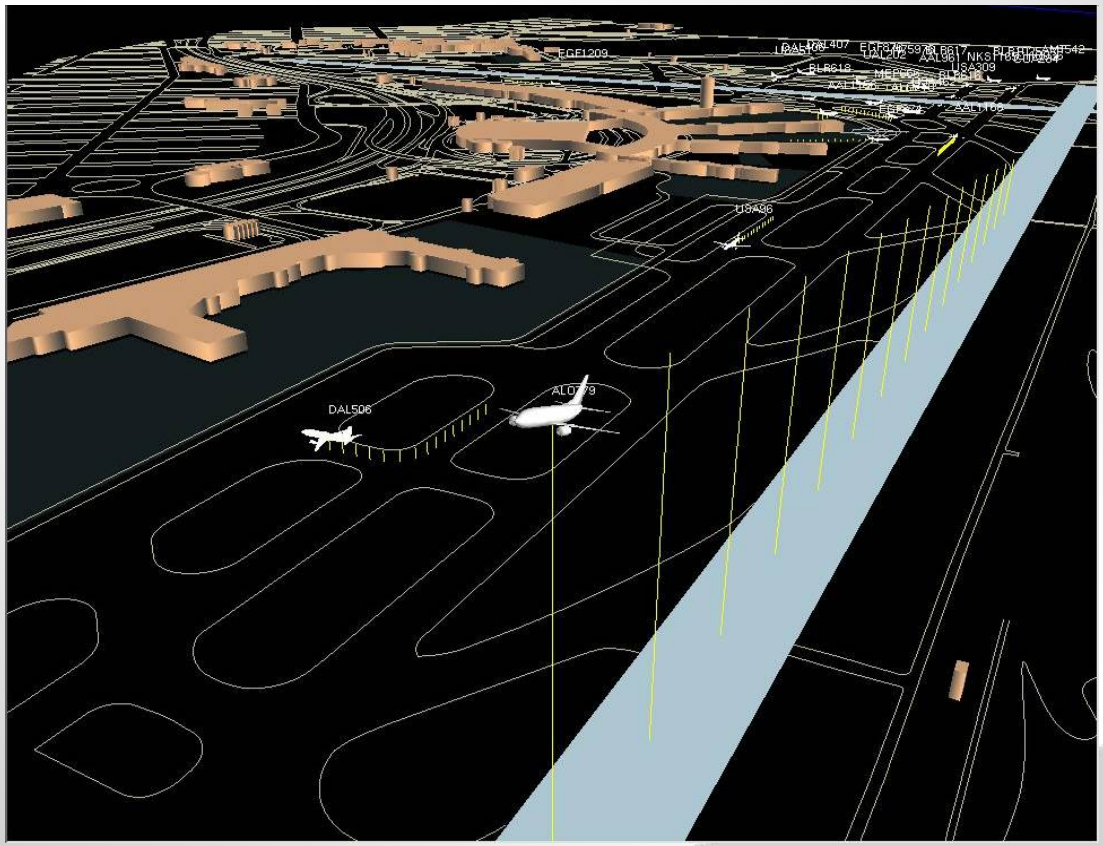
Phase 2.1 (Delays, Gate Utilization)



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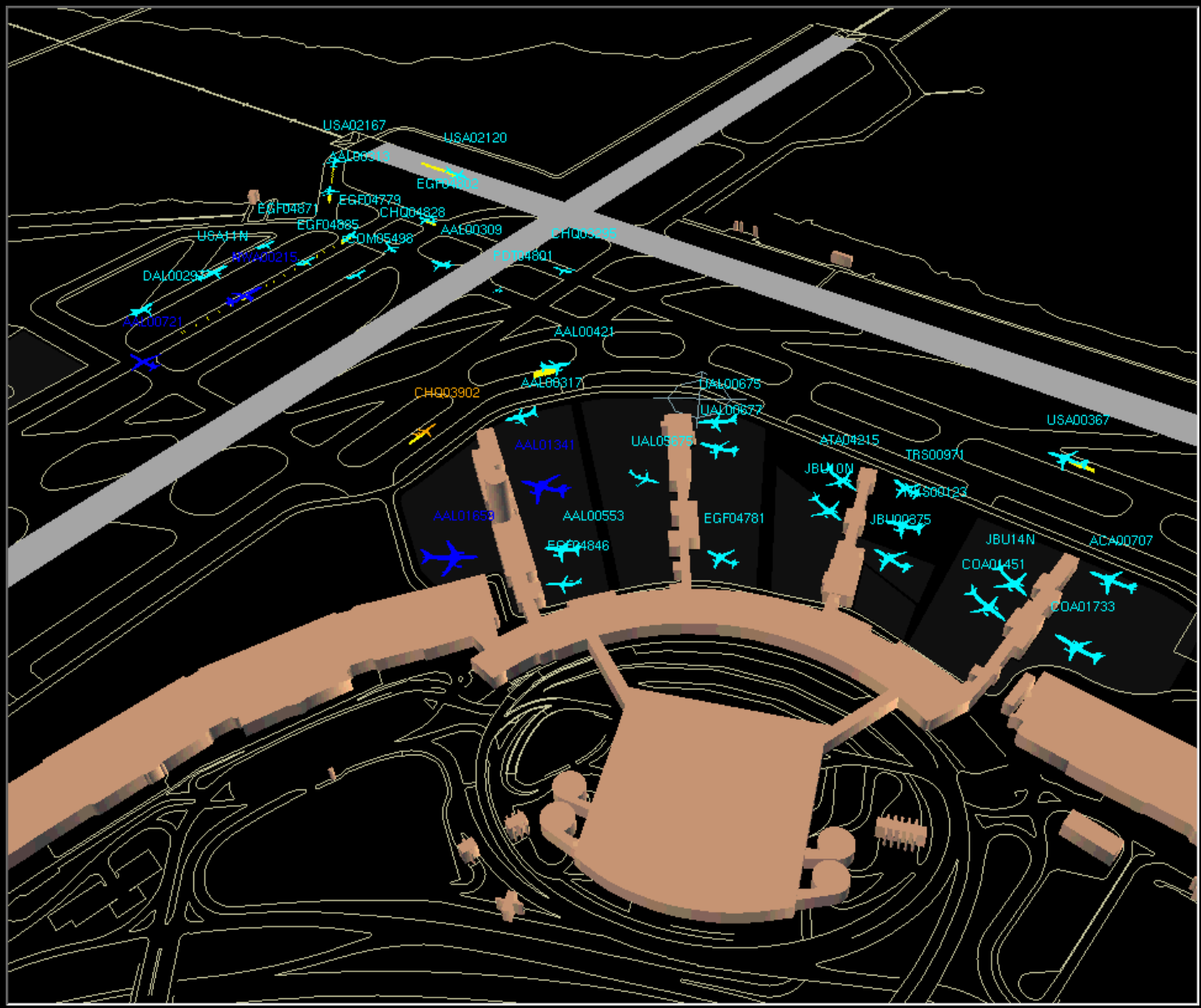
Method

- Analysis was conducted running simulation experiments
- Used Total Airport & Airspace Modeler (TAAM)
- LGA airport model for TAAM provided to GMU/CATSR by the PANYNJ and Leigh-Fisher Associates.
- LGA airport model was enhanced to support this study
- Complete set of data files is available to all parties on request.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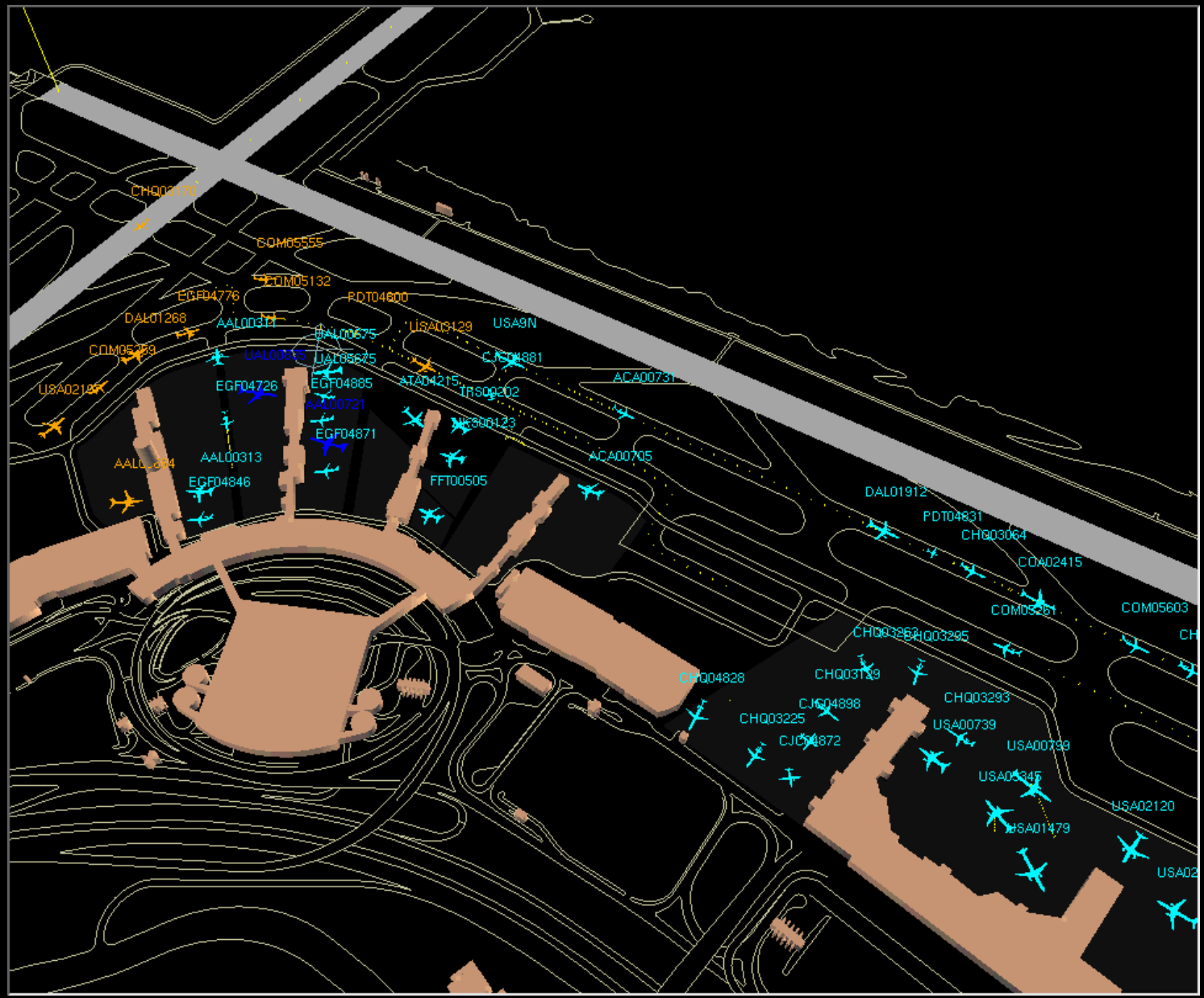
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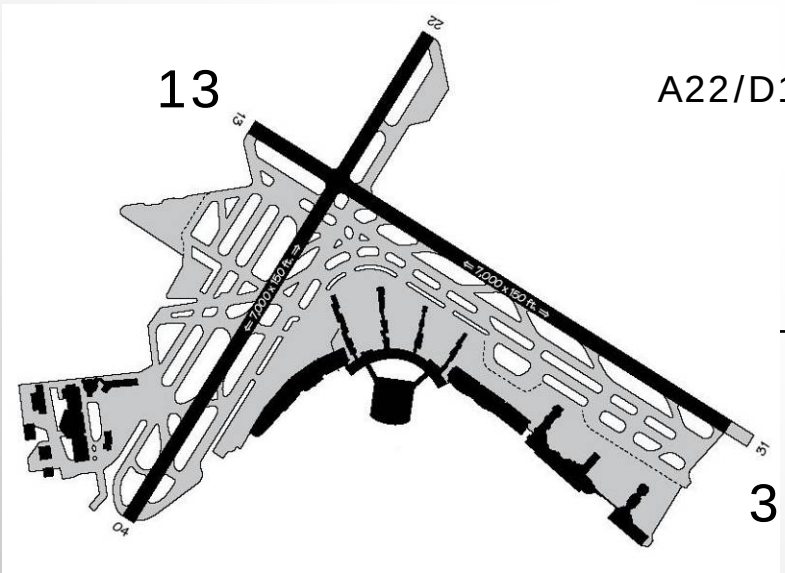
Method - Simulation Scenarios



RWY Config	Day	Fleet mix
A22/D13	061404 (ETMS)	Baseline
		12% less RJs
		25% less RJs
	041905 (GRA)	Baseline
		Upgauged
		Upg (757s to A321s)
	081105 (ETMS)	Baseline
		12% less RJs
		25% less RJs
A22/D31	061404 (ETMS)	Baseline
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		25% less RJs
	041905 (GRA)	Baseline
		Upgauged
		Upg (757s to A321s)
	081105 (ETMS)	Baseline
		12% less RJs
		25% less RJs

Summary of Results (a)

CATSR

Run	Config	Schedule	Number of Flights in TAAM	Fleet Mix	Total Available Seats per Day	Avg Seats per Flight	Est'd Annual Pax *excluding* GA	Avg Delay per Flight	Avg Delay per Seat	Average Standoff Time per Flight	Est'd Peak-Time Gate Shortage	Carriers Most Affected by Gate Shortages
								Minutes				
1	**A22/D13** (Peak sustained AAR/ADR = 39.5)	ETMS **6/14**/2004 (filled to 75 ops/hr)	1206	Baseline	111279	92	24,795,807	16.0	15.4	0.9	1	None
2			1208	12% RJ to NB	114456	95	25,461,499	17.8	17.6	0.9	1	None
3			1208	25% RJ to NB	118192	98	26,292,597	16.9	16.8	0.7	1	None
4		**GRA** 0419	1178	Baseline	113142	96	25,810,172	11.4	10.5	1.0	1	None
5			1190	Upgauged	135165	114	30,523,169	15.2	14.9	1.5	2	COM, EGF, USA
6			1190	Upg, 757to321	133075	112	30,051,202	13.0	12.9	1.6	2	COM, EGF, USA
7		ETMS **8/11**/2005	1222	Baseline	113851	93	25,036,751	19.0	17.8	2.6	4	USExp, COM
8			1222	12% RJ to NB	117305	96	25,796,314	17.5	16.6	2.7	4	USExp,EGF,COM
9			1222	25% RJ to NB	122567	100	26,953,470	18.6	18.0	2.6	4	USExp,EGF,COM
10	**A22/D31** (Peak sustained AAR/ADR = 38)	ETMS **6/14**/2004 (filled to 75 ops/hr)	1206	Baseline	111279	92	24,795,807	23.5	22.4	1.7	2	COM, EGF
11			1208	12% RJ to NB	114456	95	25,461,499	25.1	23.8	1.5	2	COM, EGF
12			1208	25% RJ to NB	118192	98	26,292,597	27.0	26.1	2.2	3	COM, EGF
13		**GRA** 0419	1178	Baseline	113142	96	25,810,172	16.0	14.2	0.9	1	None
14			1190	Upgauged	135165	114	30,523,169	23.0	21.8	2.5	4	COM, EGF, USA
15			1190	Upg, 757to321	133075	112	30,051,202	21.2	20.0	2.5	3	COM, USA, EGF
16		ETMS **8/11**/2005	1222	Baseline	113851	93	25,036,751	27.8	25.1	3.0	4	USExp,EGF,COM
17			1222	12% RJ to NB	117305	96	25,796,314	27.3	25.0	2.9	4	USExp,EGF,COM
18			1222	25% RJ to NB	122567	100	26,953,470	24.8	22.7	2.4	3	USExp,EGF,COM

Summary of Results (b)

CATSR

Run	Config	Schedule	Number of Flights in TAAM	Fleet Mix	Total Available Seats per Day	Avg Seats per Flight	Est'd Annual Pax *excluding* GA	Avg Delay per Flight	Avg Delay per Seat	Average Standoff Time per Flight	Est'd Peak-Time Gate Shortage	Carriers Most Affected by Gate Shortages
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Gate Activity (TAAM Simulation) - excerpt

Example: A22/D13, 04/19 (GRA) Upgauged

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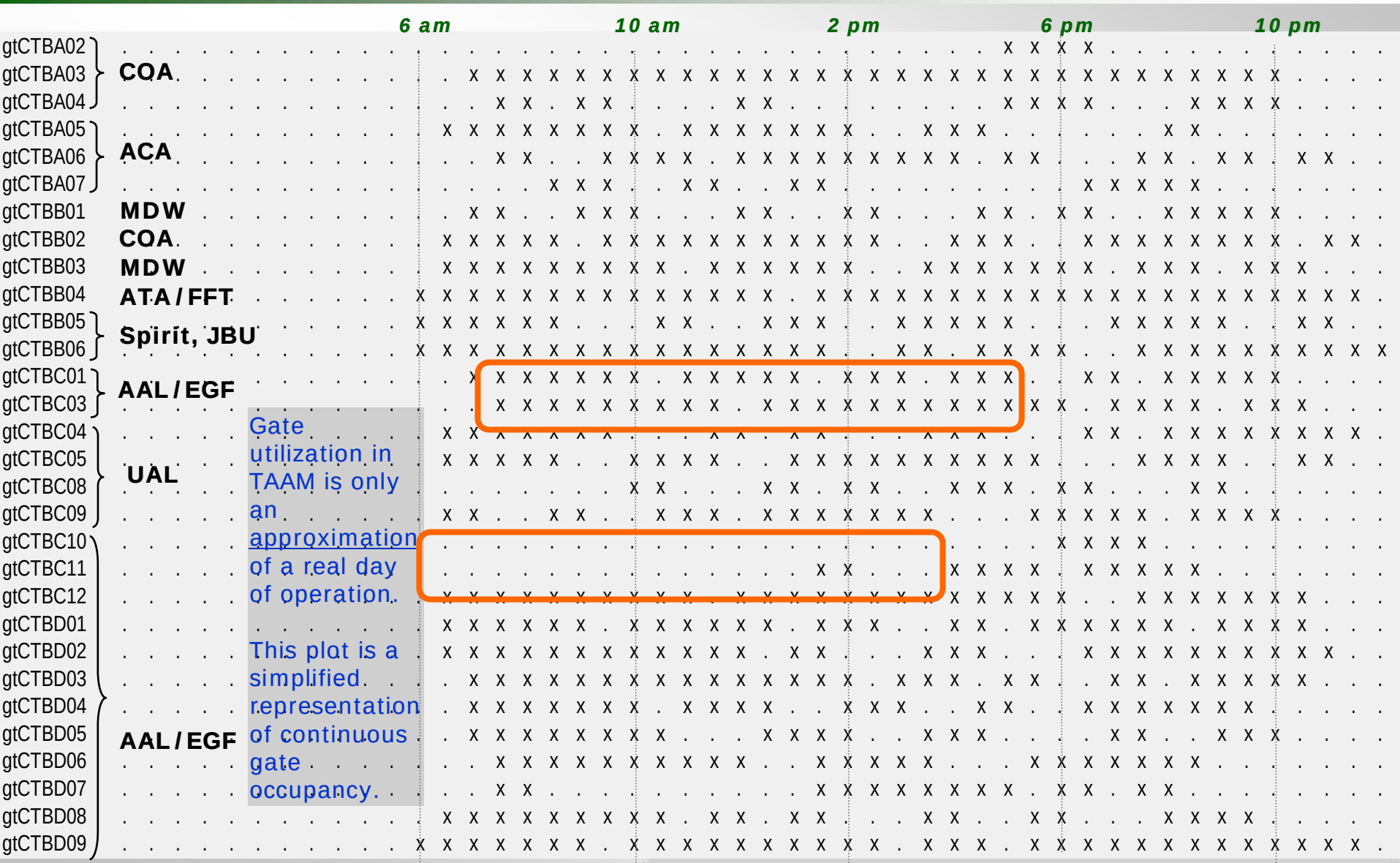
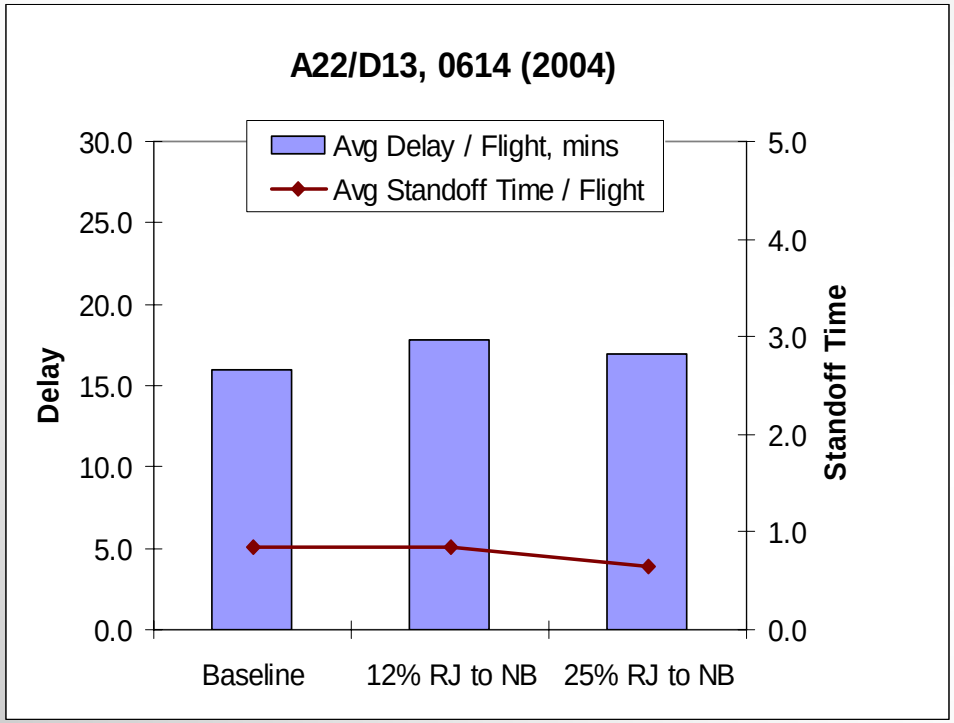
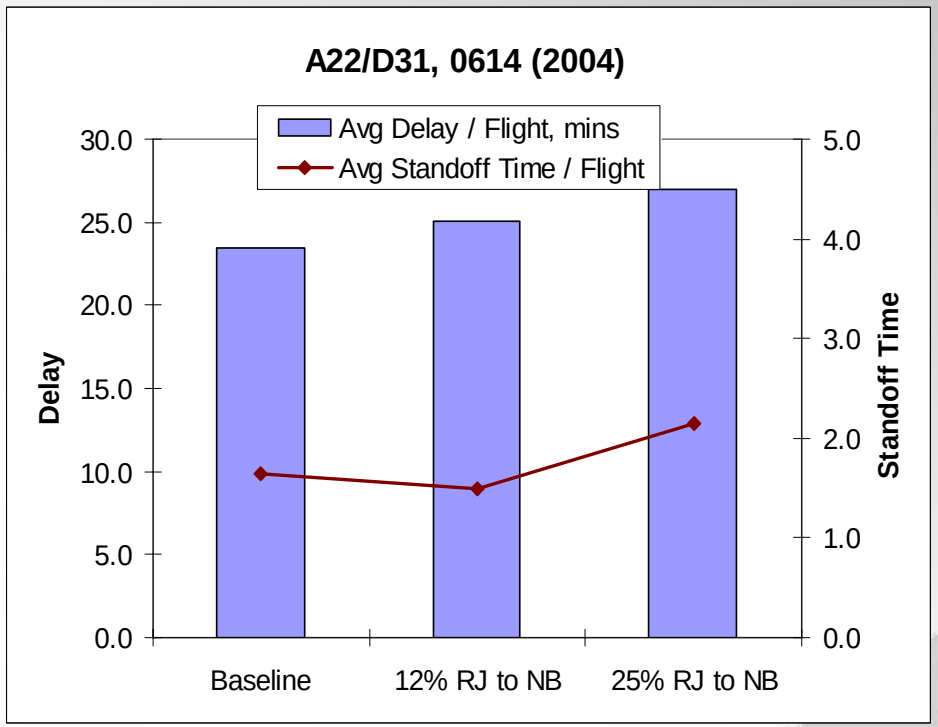


Average Delay & Standoff Time / Flight

06/14/04 Sample (ETMS)

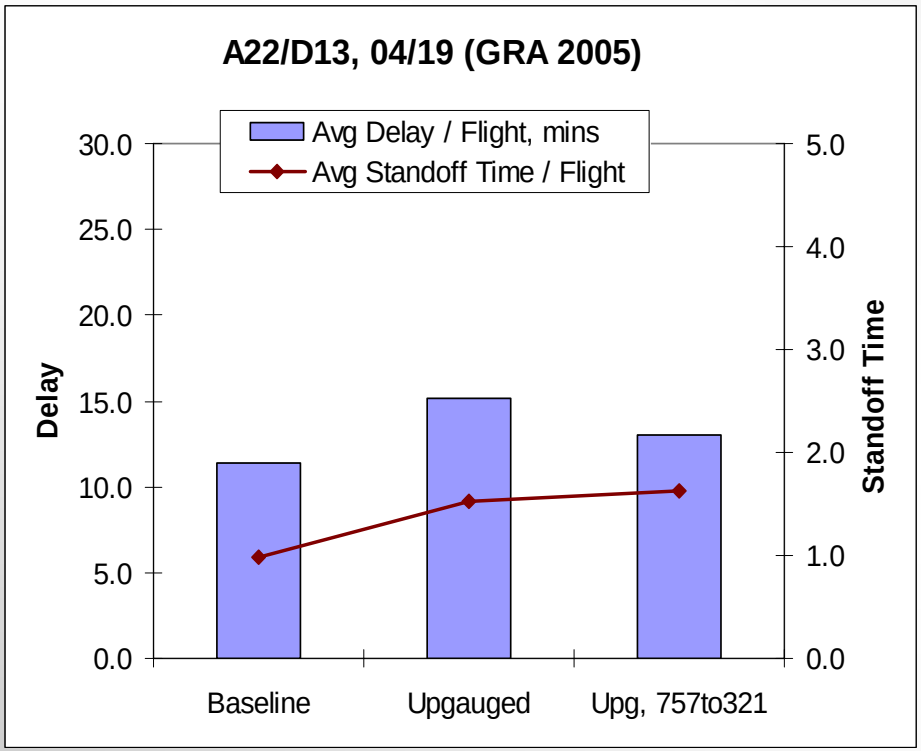


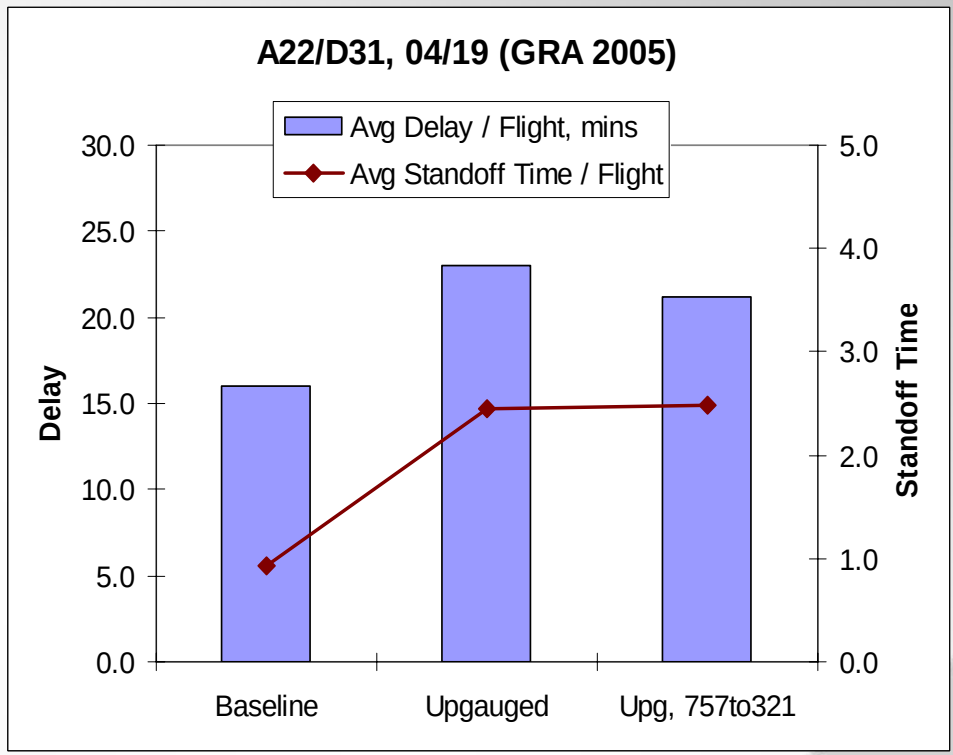


Runway configuration, impacts taxiway, and gate utilization

Average Delay & Standoff Time / Flight

04/19 Sample (GRA)



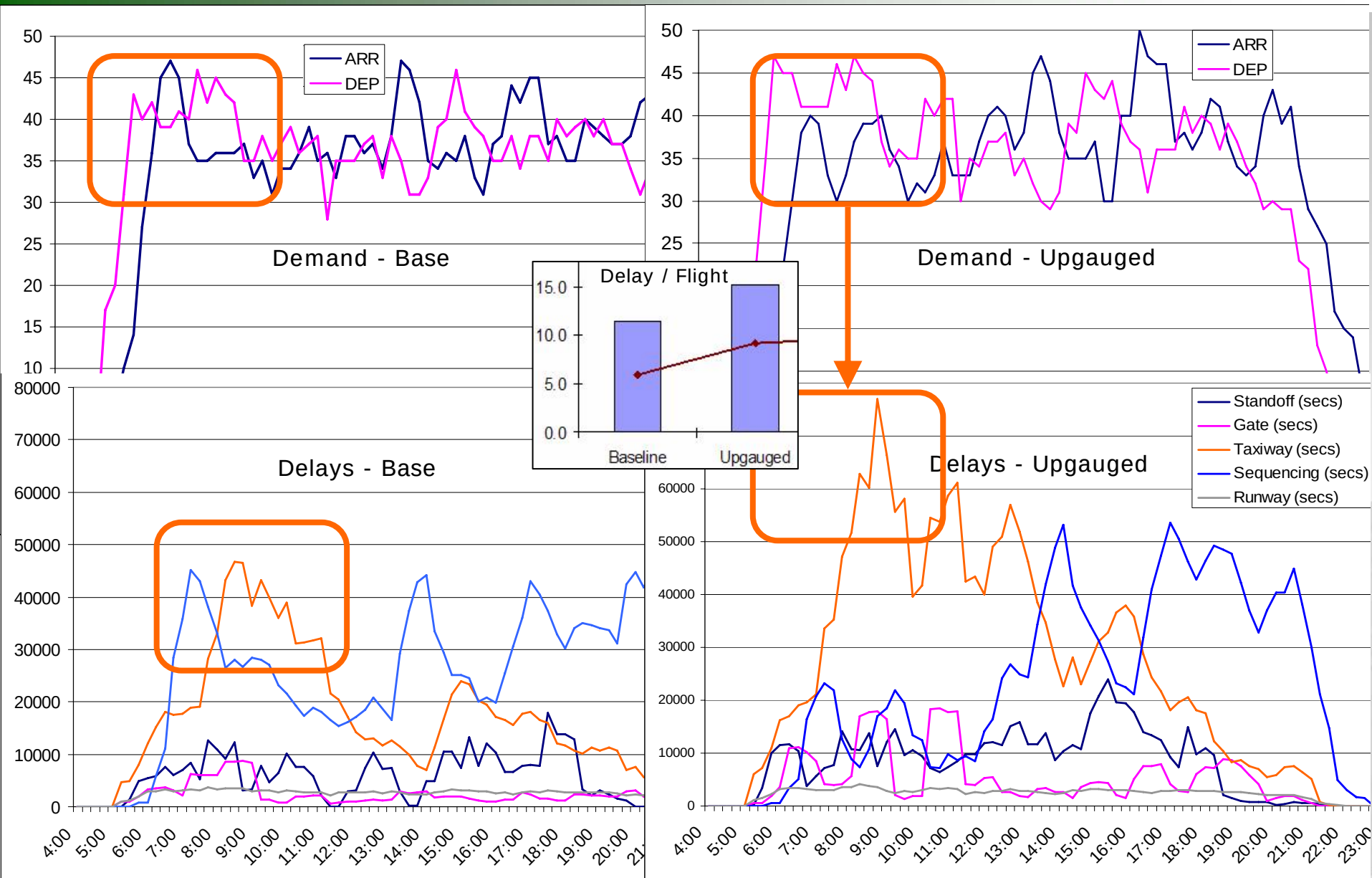


Runway configuration and Fleet-mix, impacts taxiway, and gate utilization

Understanding Differences in Delays

04/19 (GRA) Timetable, Baseline vs. Upgauged

CATSR



Randomized Simulations

20 Runs per scenario (ATD, acft perf randomized)

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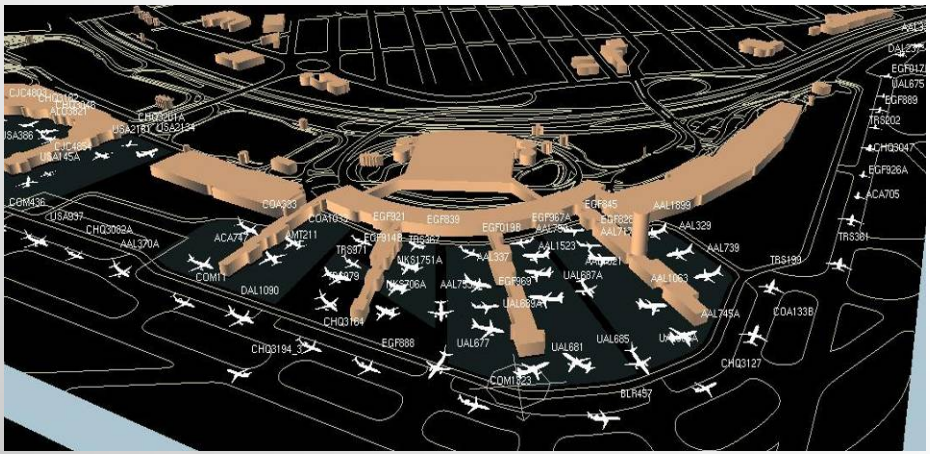
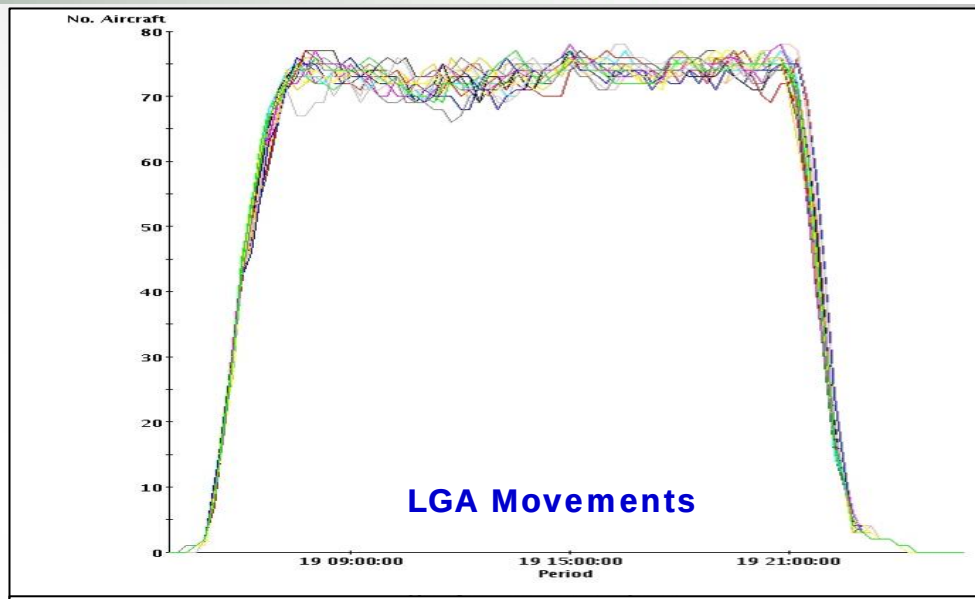
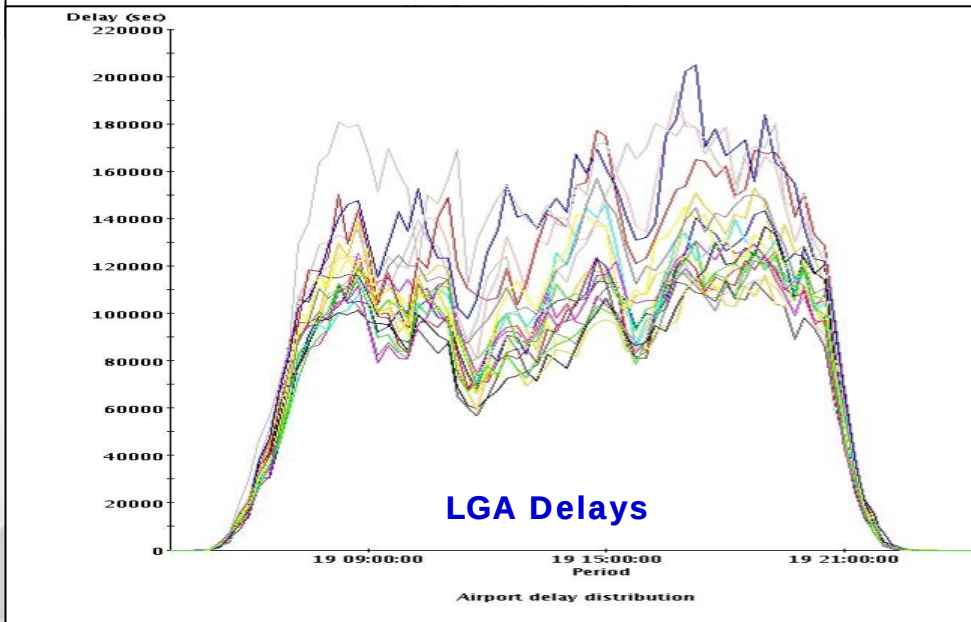
At congested airports like LGA, small variations in traffic demand or throughput can lead to large fluctuations in delays

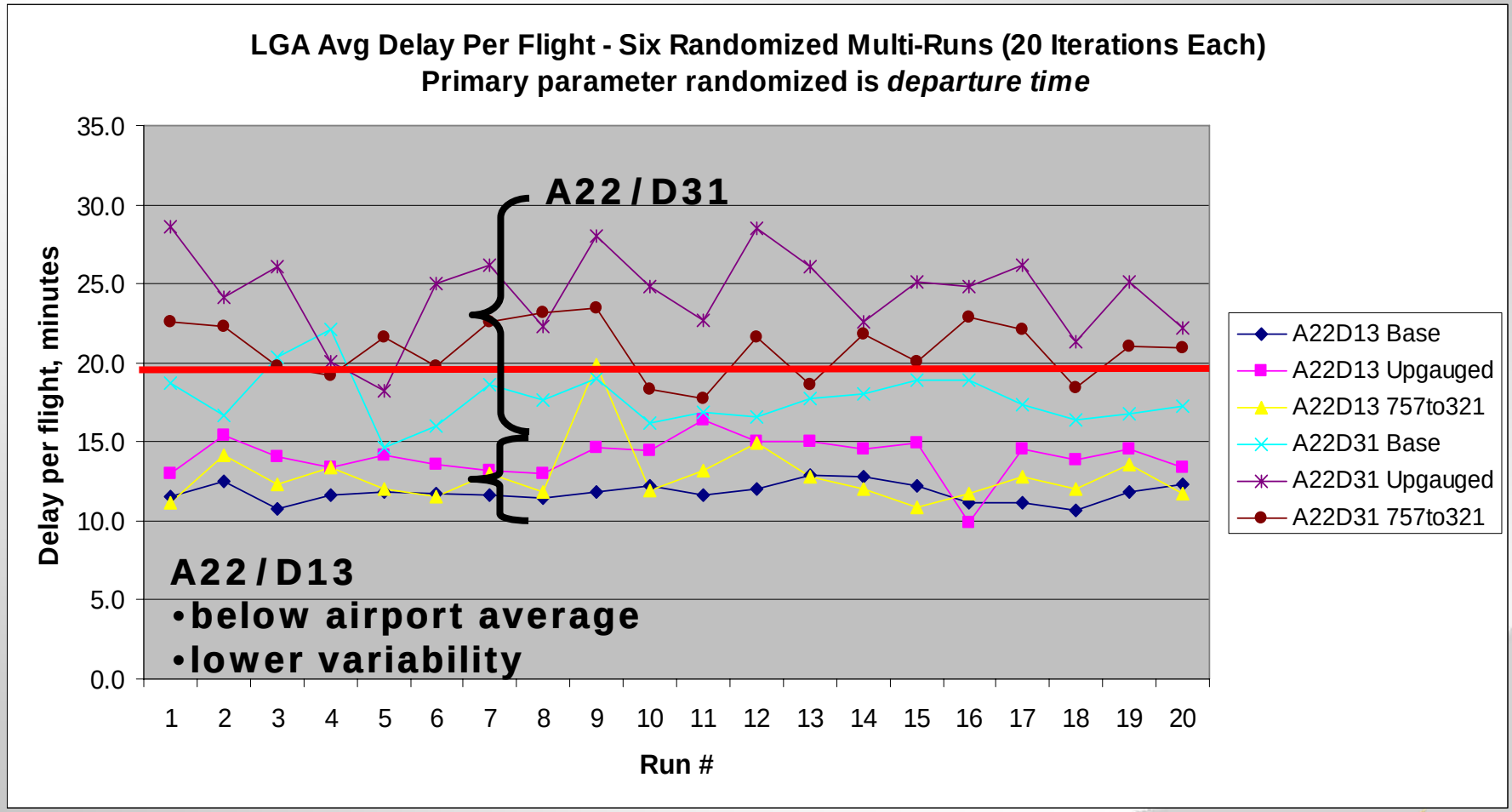


Example for 04/19 schedule, upgauged, A22/D31 runway configuration, is shown →





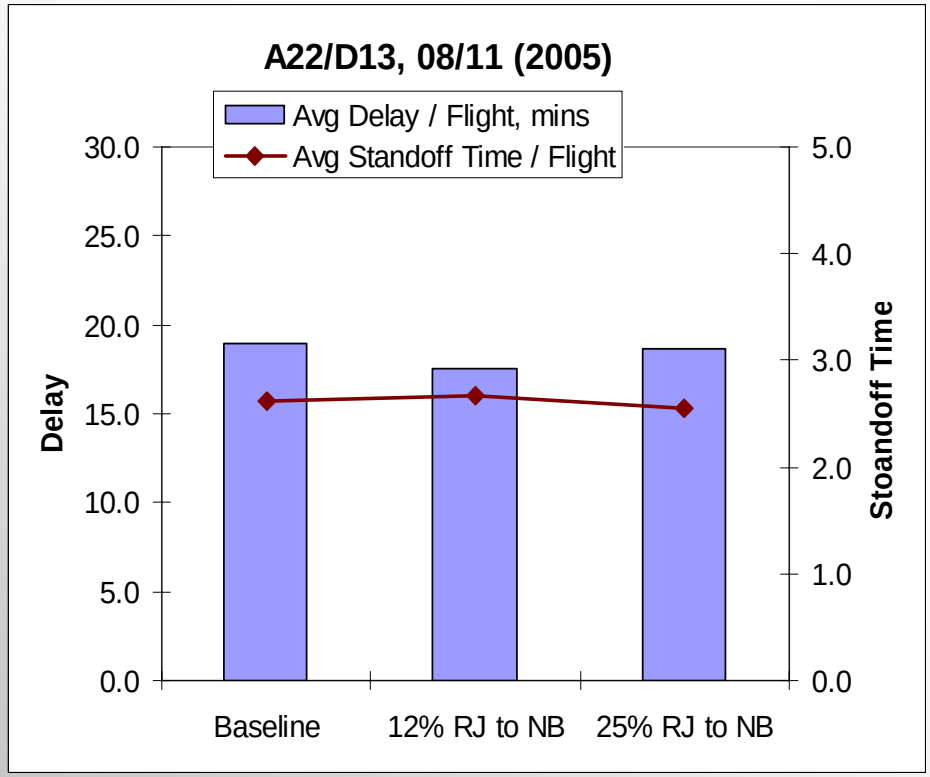
Effect of Randomization on Delays

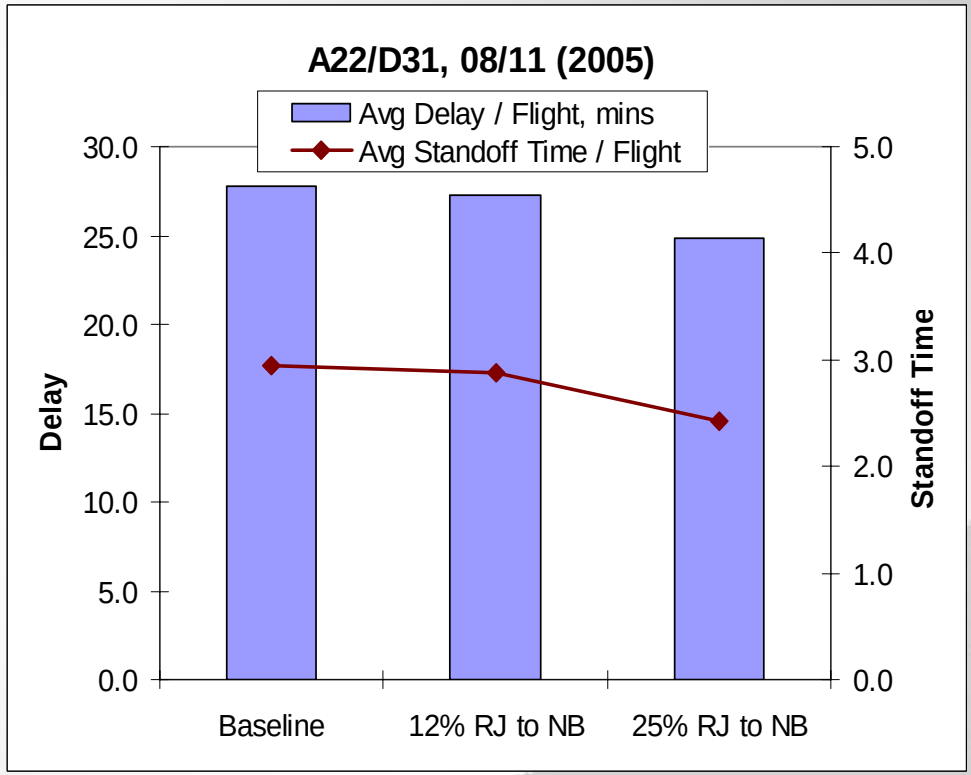


- Average Delay Per Flight for *20 Randomized TAAM Runs for the 6* (04/19, GRA) *Cases*
- Comparison with actual data: average delay/flight at LGA was 19.5 min in Aug 2005

Average Delay & Standoff Time / Flight

08/11/05 Sample (ETMS)





Summary of Results (Delays)

CATSR

- Upgauging could raise LGA's annual Pax throughput by about 3-4M
  - Equivalent to increase of about 15-20 seats per aircraft (92-96 to 110-114)
- Moderate upgauging does *not* lead to increased delays
  - And, gate utilization would improve slightly
- More aggressive upgauging *may* lead to some increase in delays
  - Could be mitigated in part if 757s were replaced by B737-900, A321
  - Could also be mitigated by better scheduling of flights

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Summary Results (Gates)

At peak-demand times, LGA can be short of about 3-4 gates

- Gate shortages are highly “local” (carrier and time specific)
- Some un-used gates are always present, even at peak-demand times

Some carriers appear to have occasional overscheduling issues

- Comair, American Eagle, USAirways Express

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Phase 2.2 (Fuel, Emissions, Noise)

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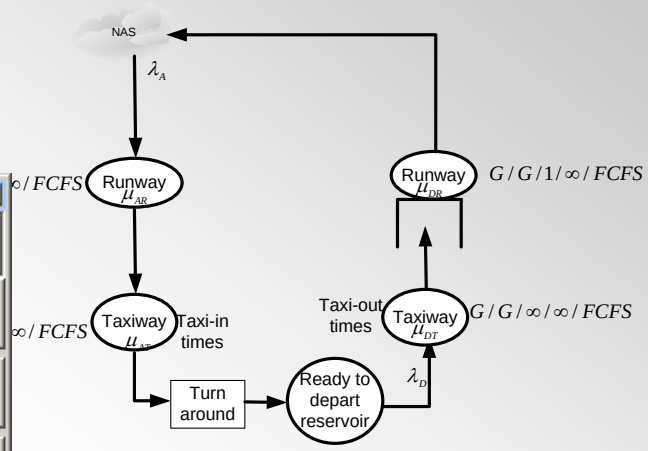

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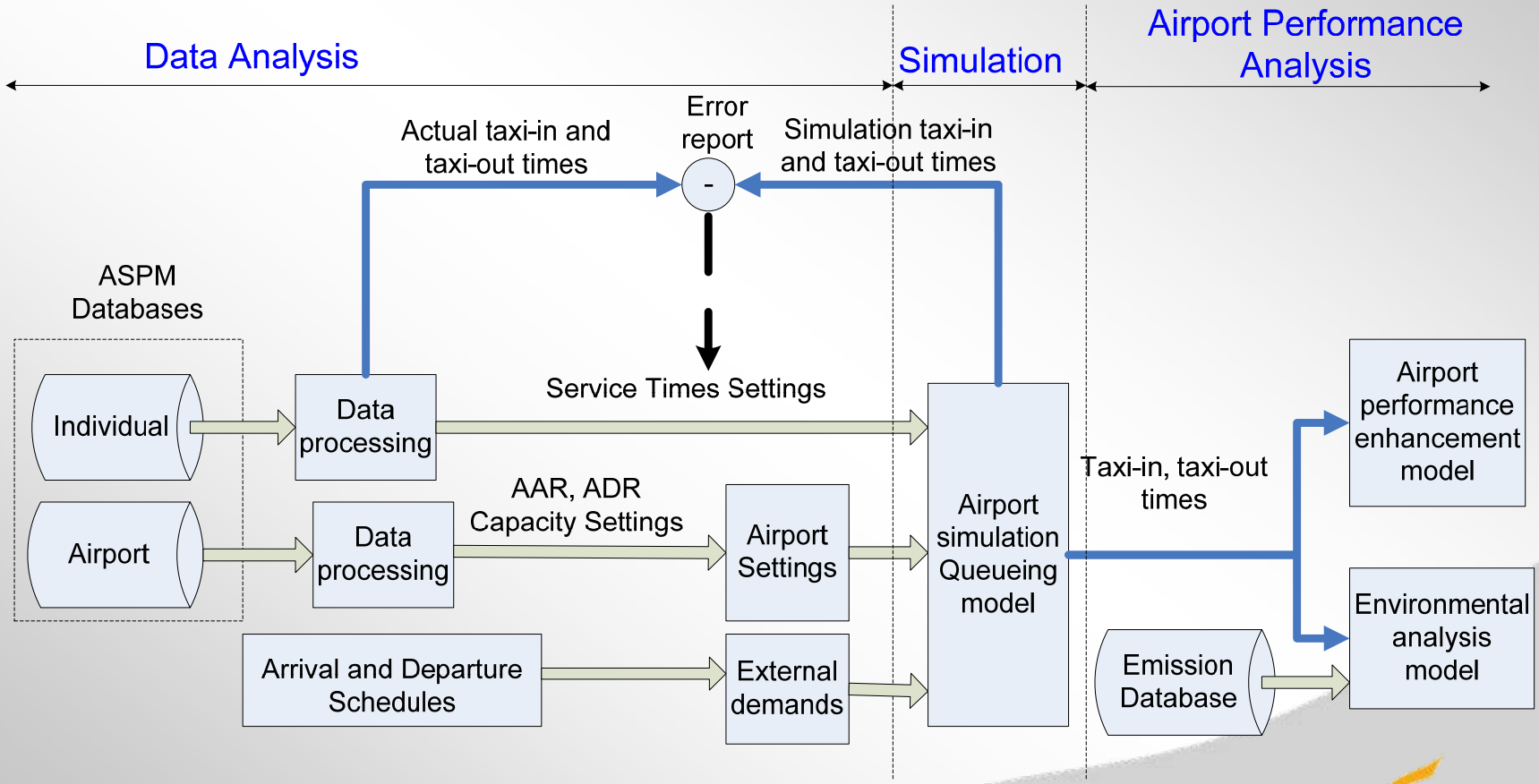
GreenSim


Data Analysis
Simulation
Airport Performance Analysis
Actual taxi-in and taxi-out times
Error report
-
Simulation taxi-in and taxi-out times
ASPM Databases
Individual
Airport
Data processing
Data processing
Service Times Settings
AAR, ADR Capacity Settings
Airport Settings
Arrival and Departure Schedules
External demands
Airport simulation Queueing model
Taxi-in, taxi-out times
Airport performance enhancement model
Environmental analysis model
Emission Database

Design of Experiment

- 3 Scenarios
  1. ETMS Schedule (4/19/2005 - Baseline)
  2. GRA Schedule (Upguage, no frequency reduction)
  3. Max Efficiency (Upguage with frequency reduction)
- A21/D13
- Avg 500 replications

Results – Schedule & Capacity

	Baseline	Upguage, No Frequency Reduction (GRA)	% Change	Upguage with Frequency Reduction	% Change
Daily Arrival Demand	**597**	**597**	**0.0%**	**492**	**-17.6%**
Departure Demand/day	597	597	0.0%	492	-17.6%
Hourly Arrival Demand	35	35	0.0%	29	-17.6%
Hourly Departure Demand	35	35	0.0%	29	-17.6%
Total Arrival Seats	**57401**	**68362**	**19.1%**	**58150**	**1.3%**
Total Departure Seats	57401	68459	19.3%	58153	1.3%
Total Seats	114802	136821	19.2%	116303	1.3%
AvgSeats/flight	**96**	**114**	**18.8%**	**118**	**22.9%**

Results - Delays

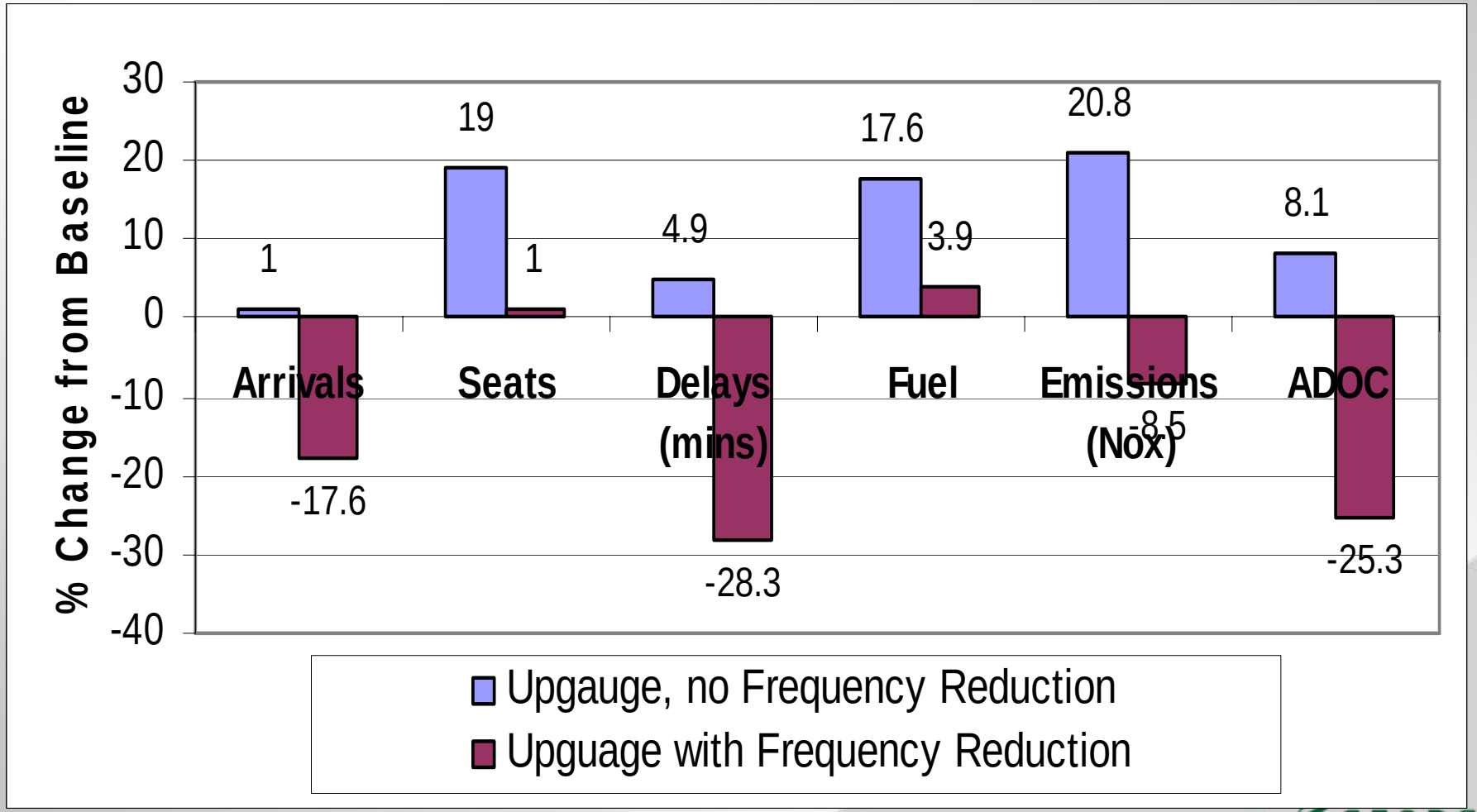
	Baseline	Upguage, No Frequency Reduction (GRA)	% Change	Upguage with Frequency Reduction	% Change
Taxi-in (mean, stdEV)	(6.9, 3.6)	(7.0, 3.6)	--	(6.8, 3.4)	--
Taxi-out (mean, stdEV)	(18.9, 5.8)	(19.4, 6.1)	--	(17.8, 4.9)	--
Total Taxi-in Delays (min)	1430.62	1450.48	1.4%	1109.45	-22.4%
Average Taxi-in Delays (min)	2.40	2.43	1.4%	2.25	-6.2%
Total Taxi-out Delays (min)	4327.11	4586.87	6%	3016.27	-30.3%
Average Taxi-out Delays (min)	7.25	7.68	6%	6.13	-15.4%
Total Delay (min)	**5757.73**	**6037.35**	**4.9%**	**4125.72**	**-28.3%**
Maximum Queue Size	**10.00**	**11.00**	**10%**	**9.00**	**-10.0%**
Mean Queue Size	**2.17**	**2.42**	**11%**	**1.23**	**-43.3%**
Mean Queue Time(min)	**2.49**	**2.77**	**11%**	**1.71**	**-31.3%**

Note: Airport only taxi & gate), not include arrival delays

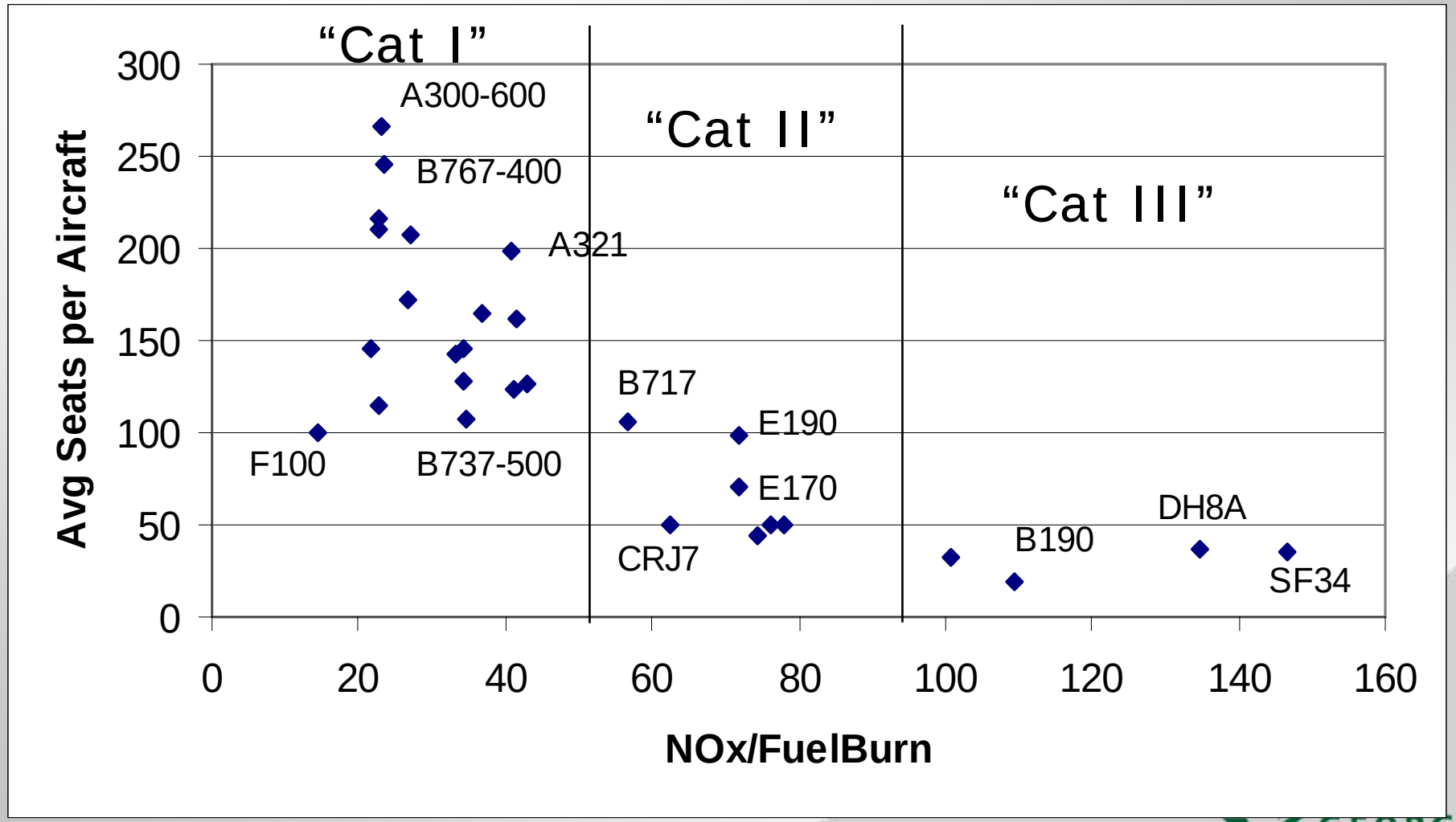
Results – Fuel & Emissions

	Baseline	Upguage, No Frequency Reduction (GRA)	% Chg	Upguage with Frequency Reduction	% Chg
Fuel(ton)	**158.1**	**185.9**	**17.6%**	**152.0**	**-3.9%**
CO(kg)	3733.3	4032.2	8.0%	3700.5	-0.9%
HC(kg)	465.2	433.7	-6.8%	449.5	-3.4%
NOx(kg)	**642.7**	**776.3**	**20.8%**	**588.1**	**-8.5%**
SOx(kg)	158.1	185.9	17.6%	152.0	-3.9%
TotalEm(kg)	4999.3	5428.1	8.6%	4890.1	-2.2%

Results - Summary



Results – NOx & Fleet Mix



Migrating to "Cat I" has Positive Emissions Implications

Conclusions

- Upguaging without Frequency change
  - Proportional increase in seat capacity
  - Marginal impact on delays
    - Fleet mix (i.e. separation distance)
    - Schedule “bunching”
  - Proportional increase in fuel-burn & ADOC
    - Derived from fleet mix
  - Proportional increase in Emissions (NOx)
    - Fleet mix (i.e. engine-type)

- Upguaging with Frequency Reduction
  - Maintain seat capacity
  - Significant reduction in delays
  - Reduced fuel burn and ADOC
    - Derived from delays
  - Marginal reduction in fuel-burn
    - Dependent on fleet-mix

Conclusions

- Airport pax throughput improved by upguaging
  - Marginal impact on delays
    - under assumptions of schedule “bunching” and fleet mix
  - Impact on Emissions and Noise not proportional to schedule or delay reduction
    - Highly dependent on fleet-mix (engine-type)
- Future regulations should consider
    - Multiple capacities throughout day (buffer for delays)
    - Emissions and Noise by fleet mix