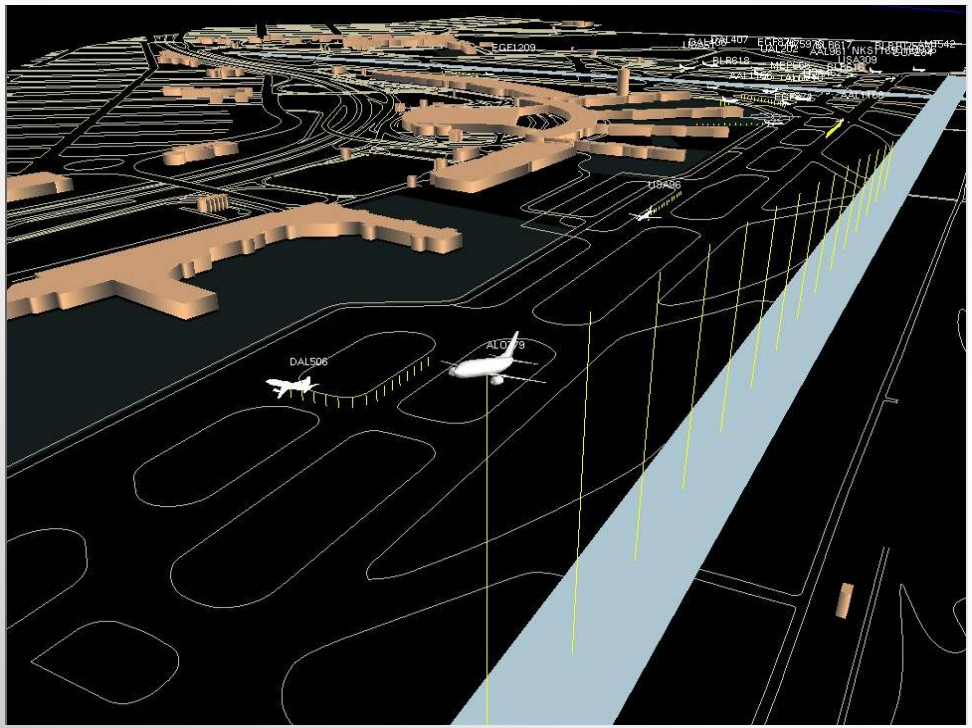
Airport Operations Analysis
Using Fast-Time Simulation Models



Dr. Alexander Klein

Jianfeng Wang

Stephen Szurgyi

CENTER FOR AIR TRANSPORTATION SYSTEMS RESEARCH

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GMU Airport Operations Research

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Capacity

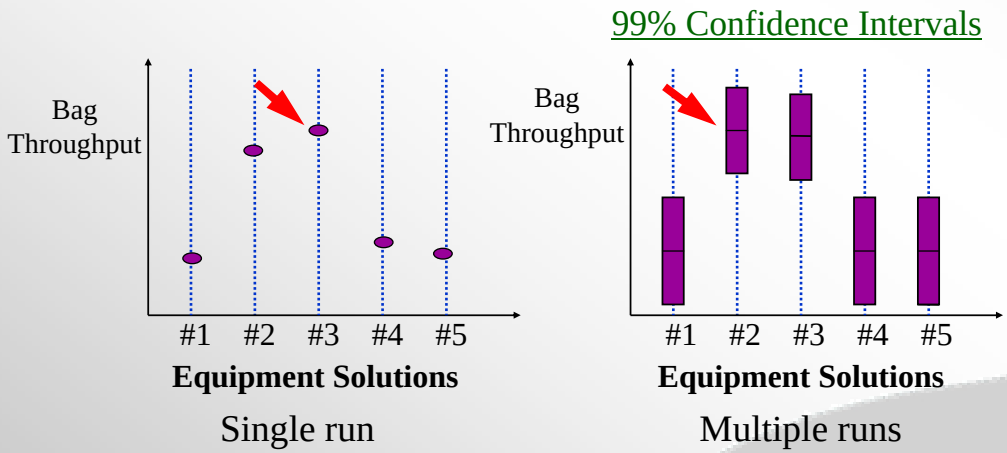
Safety

Economic Analysis

Wide range of models & tools

Stochastic Simulation

- Identifying best solution in a fastest way



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LaGuardia Airport – “Upgauging”

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Problem

- One of nation’s most congested airports
- Slot controlled
- Large proportion of regional jets (RJs)
- FAA and NYPA looking for ways to increase pax throughput from 25 to 30M / year without increasing congestion

Proposed action

- Incentivize air carriers to “upgauge” to larger aircraft

Question posed to research community

- Would upgauging negatively affect LGA operations/delays?

Must look at Runway, Taxiway and Gate capacity

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Simulation Scenarios

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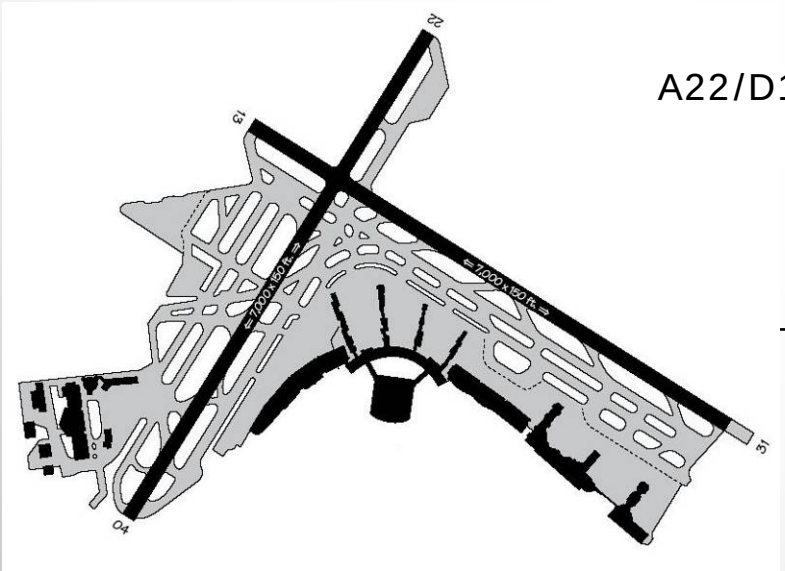

RWY Config	Day	Fleet mix
A22/D13	061404 (ETMS)	Baseline
		12% less RJs
		25% less RJs
	041905 (GRA)	Baseline
		Upgauged (50% less RJs)
		Upg (757s to A321s)
	081105 (ETMS)	Baseline
		12% less RJs
		25% less RJs
A22/D31	061404 (ETMS)	Baseline
		12% less RJs
		25% less RJs
	041905 (GRA)	Baseline
		Upgauged (50% less RJs)
		Upg (757s to A321s)
	081105 (ETMS)	Baseline
		12% less RJs
		25% less RJs

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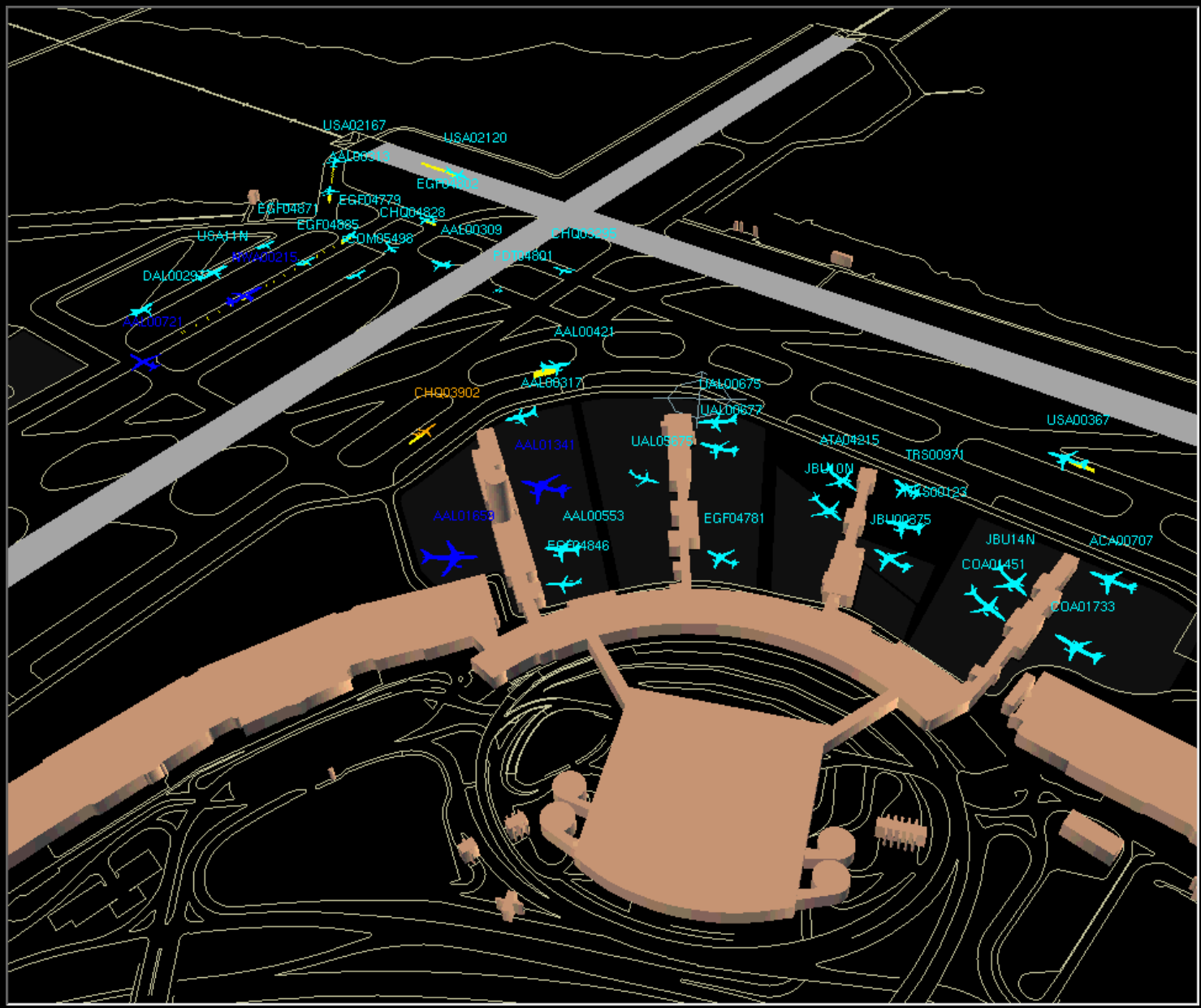
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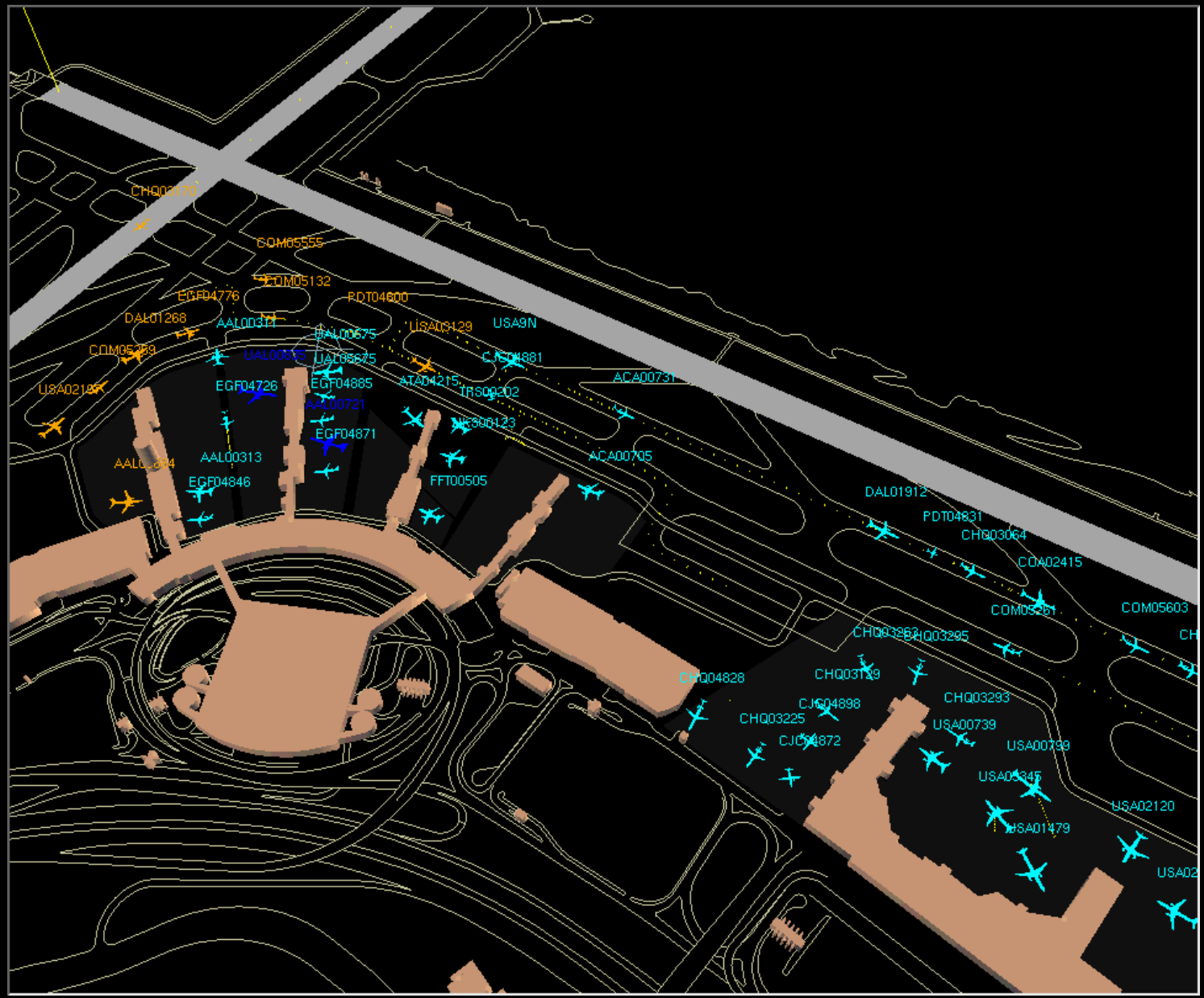
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EGF04871
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CHQ04828
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CHQ03293
CJC04898
CHQ03225
USA00739
CJC04872
USA00739
USA02120
USA01479

Summary of Results

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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

Gate Activity (TAAM Simulation) - excerpt

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

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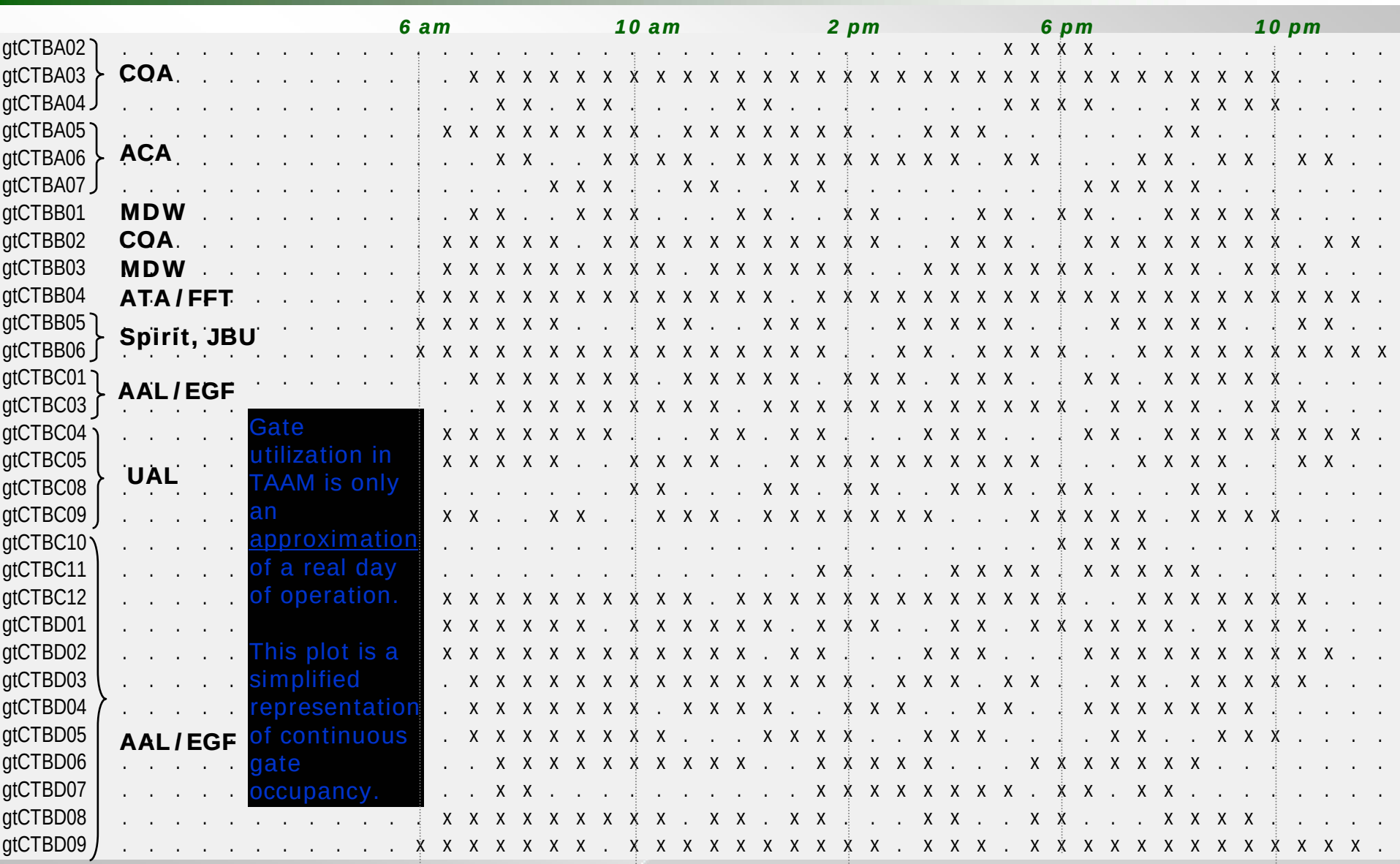

Average Delay & Standoff Time / Flight

04/19/05 Sample (GRA)

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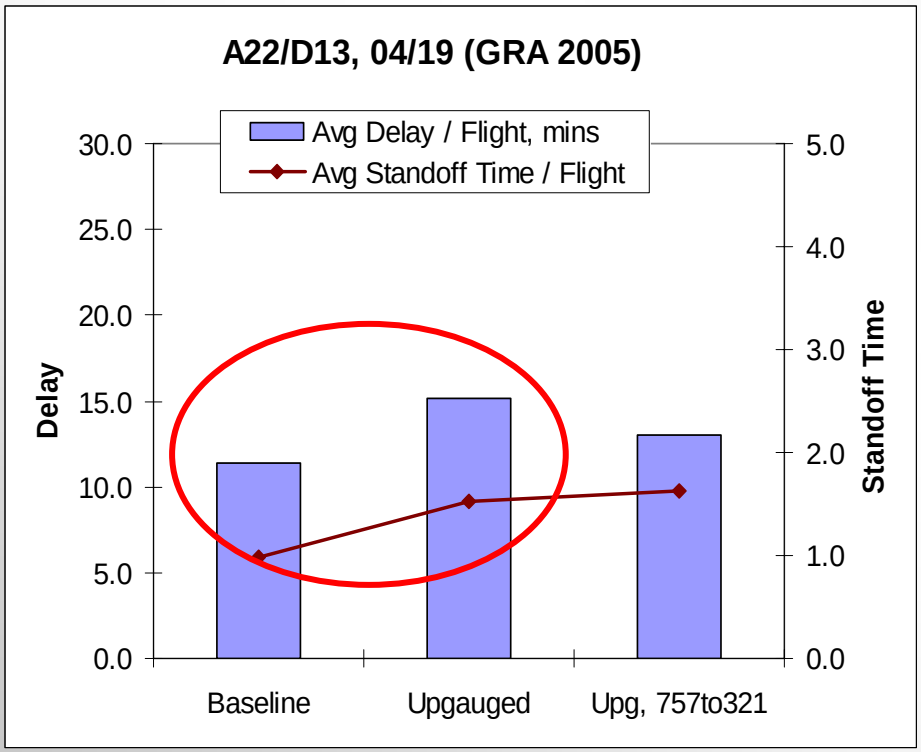

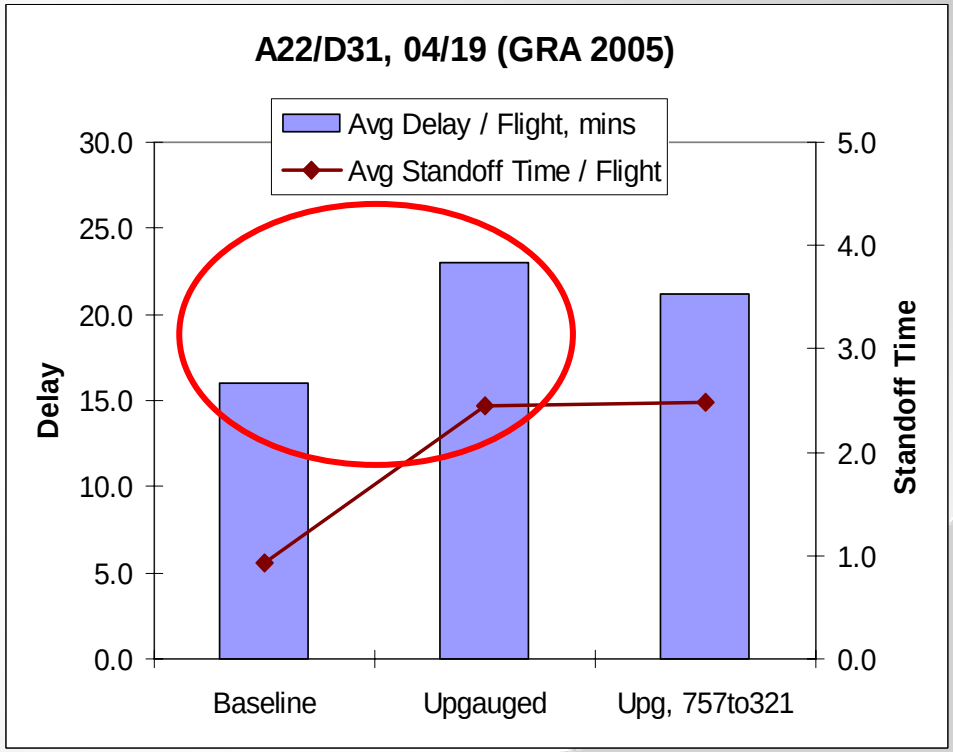

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Understanding Differences in Delays

Impact of Schedule Lumpiness (1 of 2)

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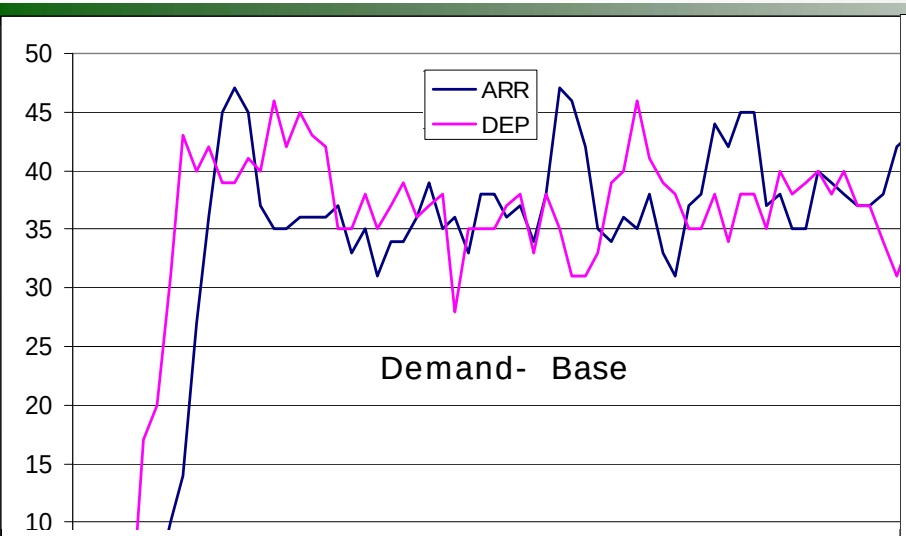

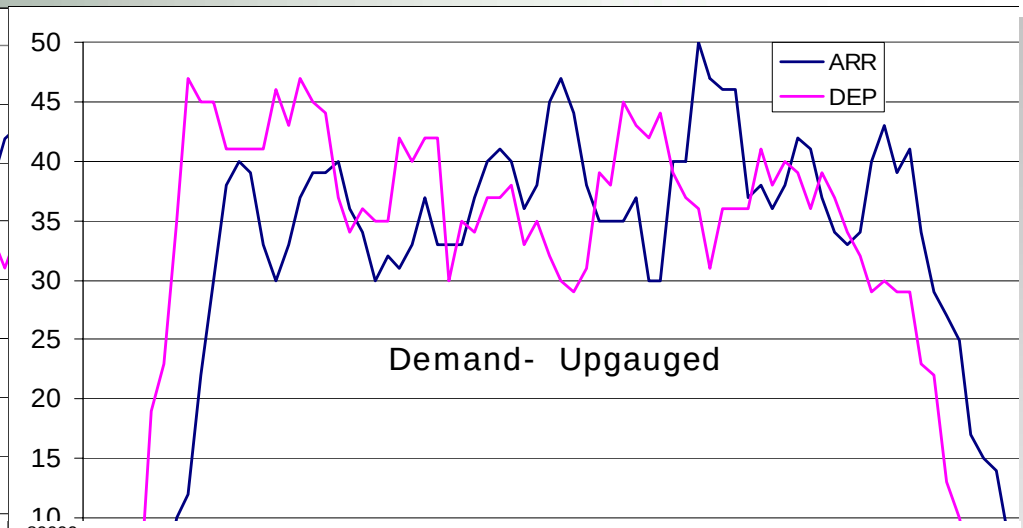

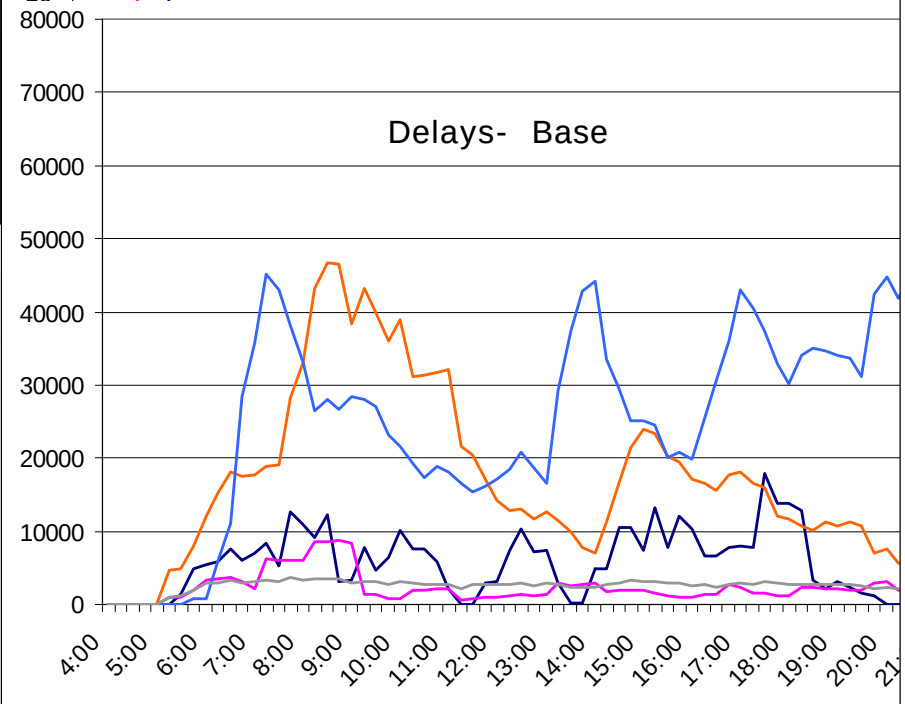

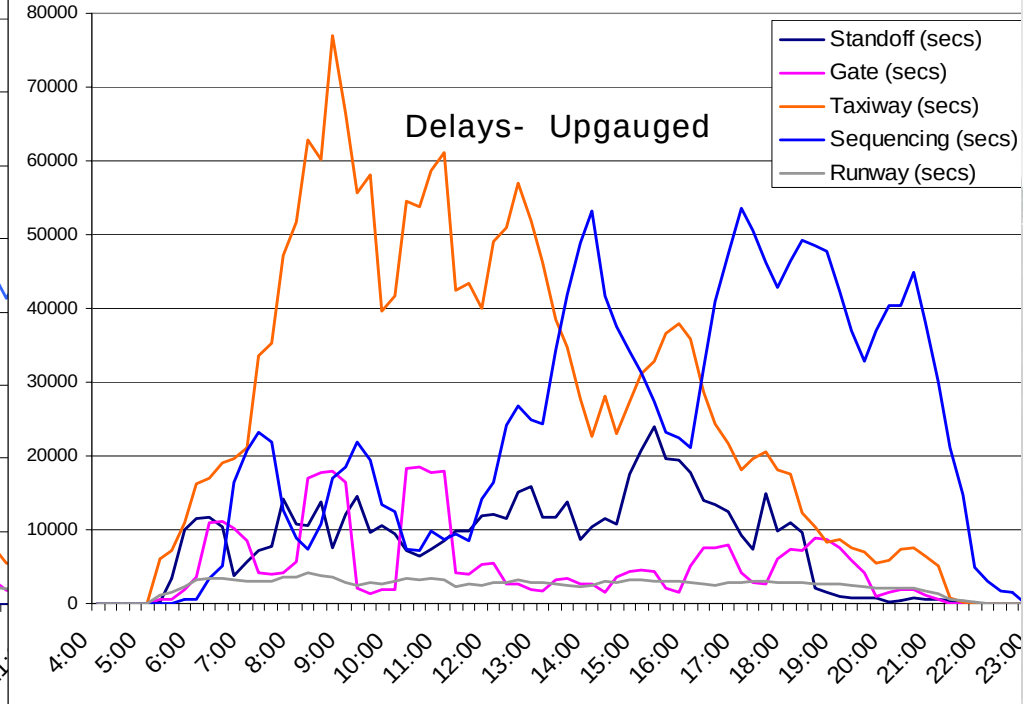

Understanding Differences in Delays

Impact of Schedule Lumpiness (2 of 2)

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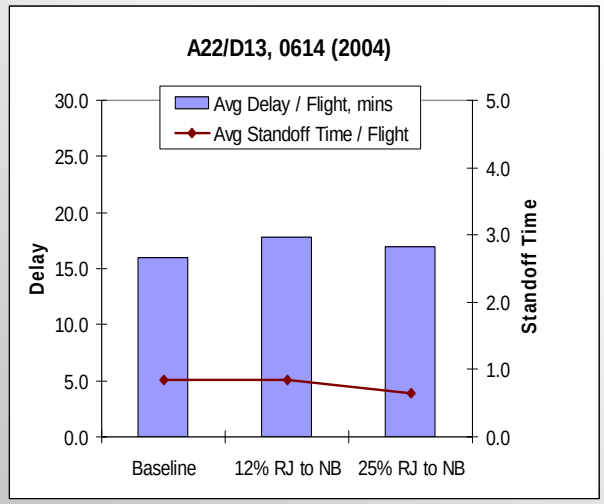
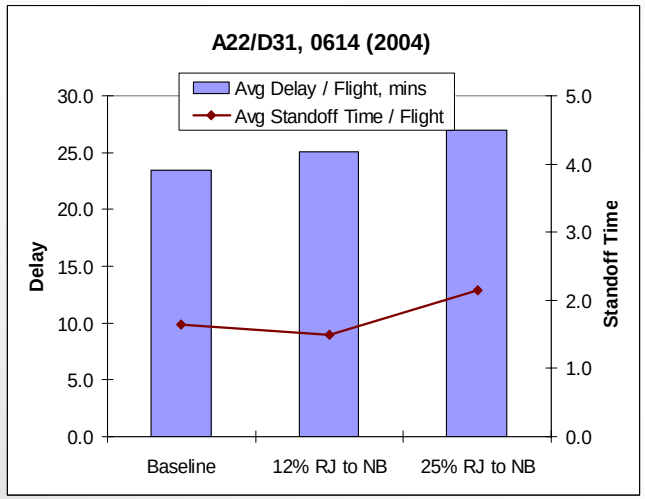
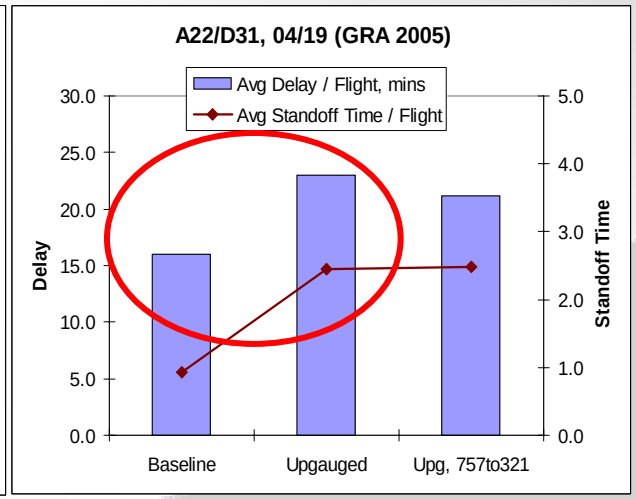
Same schedule, larger fleet: delay increase is small

Modified, lumpier schedule, larger fleet: delay increase is noticeable







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Stochastic Simulations

Departure time, aircraft performance randomized

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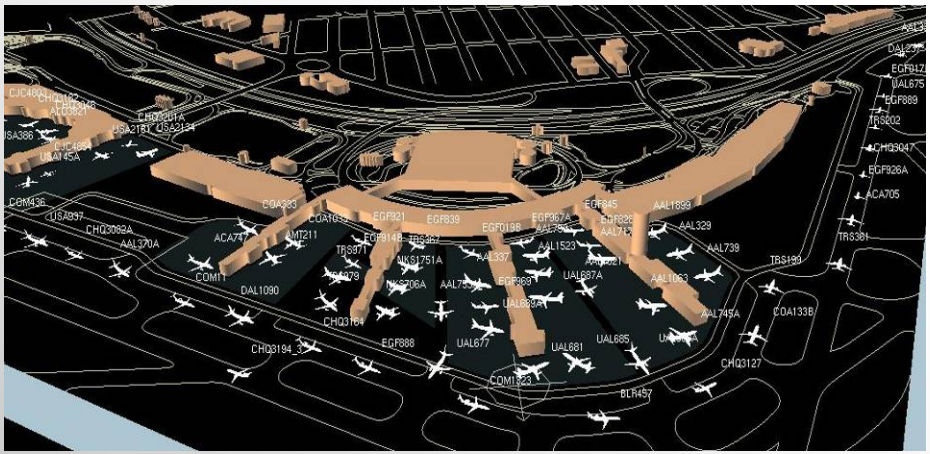
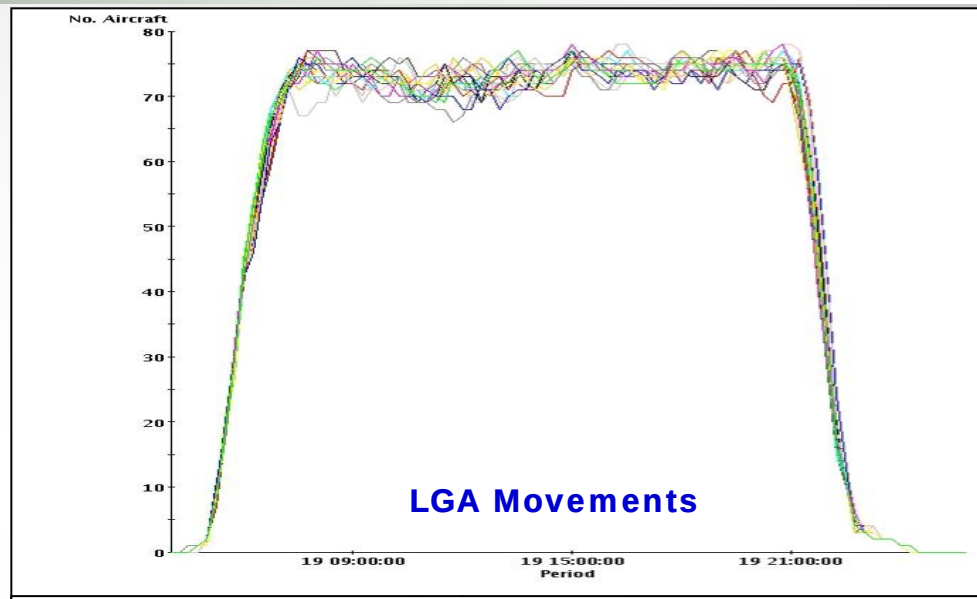
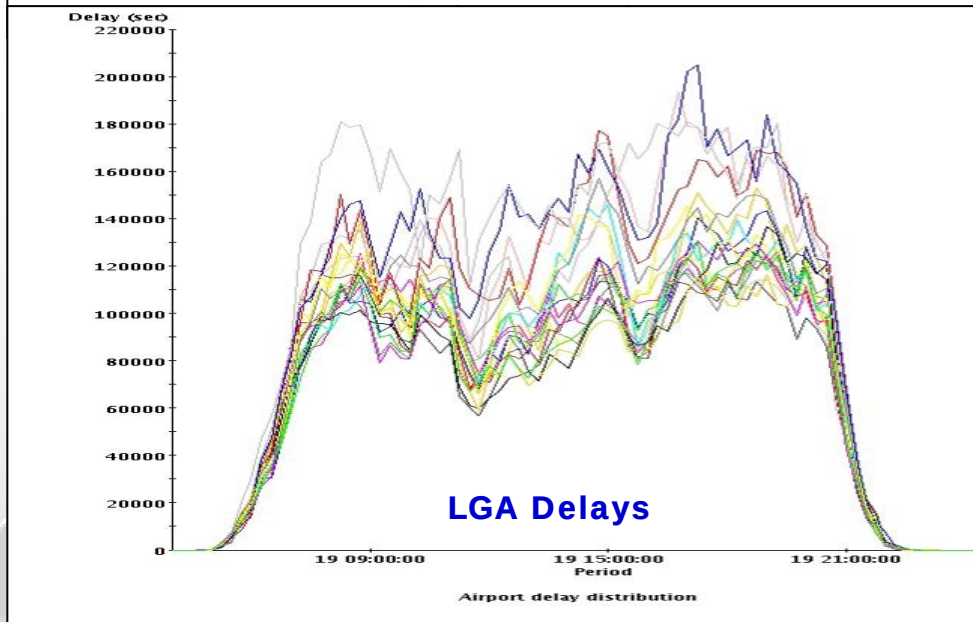
At congested airports like LGA, small variations in traffic demand or throughput can lead to large fluctuations in delays



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





Average Delay Per Flight (04/19, GRA)

20 Randomized TAAM Runs for the 6 Scenarios

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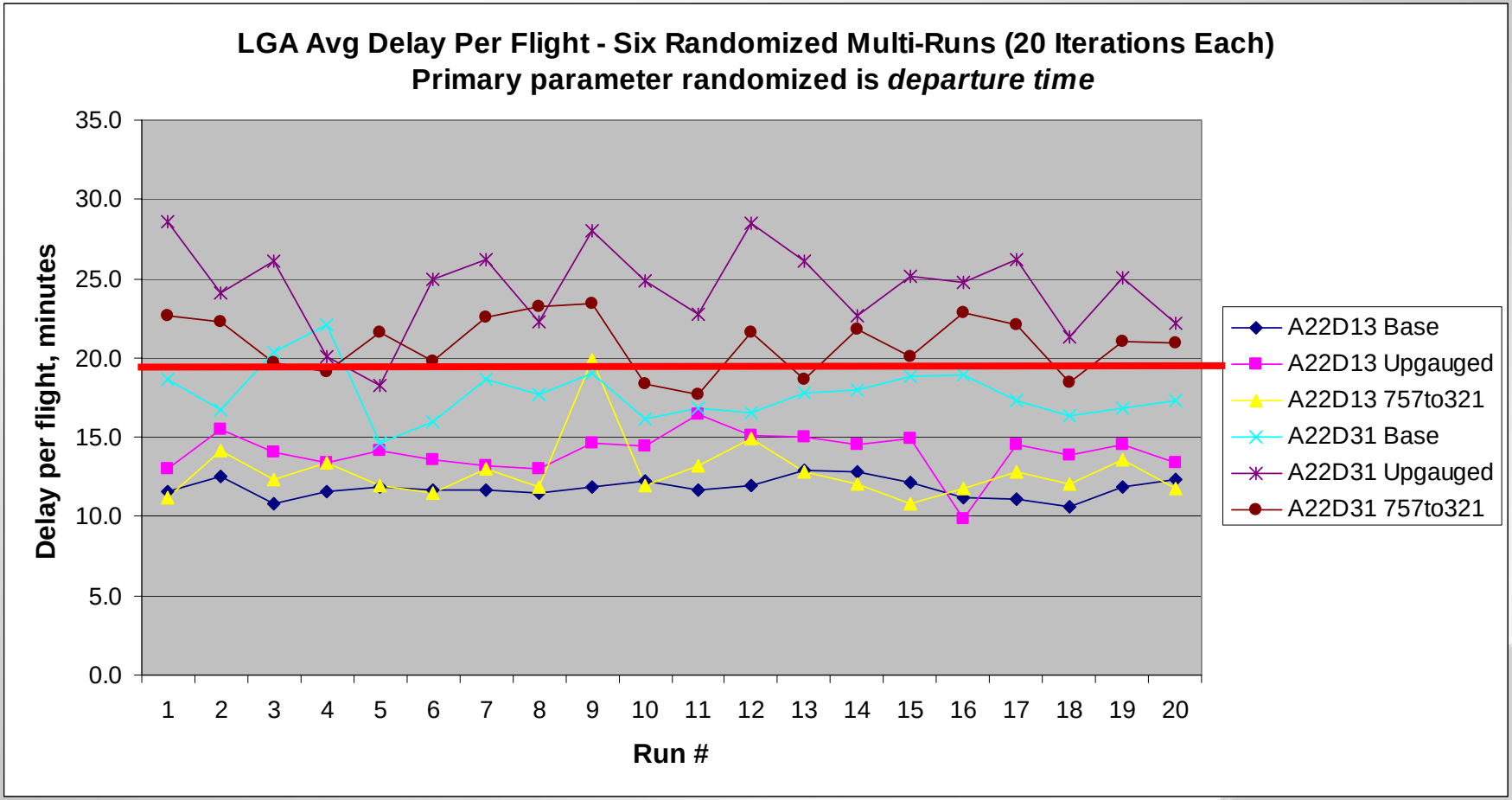

Comparison with actual data: average delay/flight at LGA was 19.5 min in Aug 2005

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LaGuardia Upgauging - Discussion

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Upgauging does not lead to significant delay increase – *if* schedule "lumpiness" can be mitigated

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 times

Optimized scheduling is key to reducing delays at a given demand level

- Fine-tuning through simulation

Combined simulation of aircraft *and* passenger/bag movement at LGA is highly desirable

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Fast-Time Simulation Enables Broader Analyses

E.g. TAAM as a Carrier, Platform for Other Tools & Models

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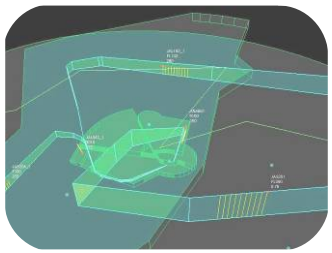
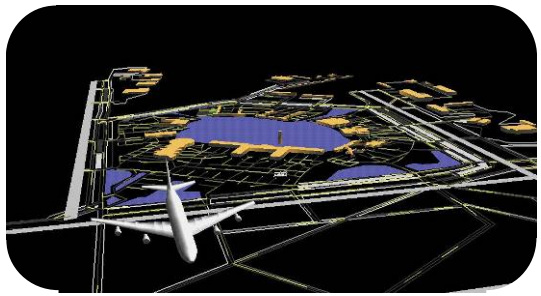
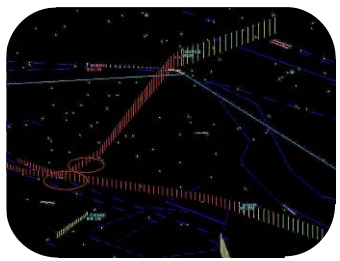
Airport & airspace design tools

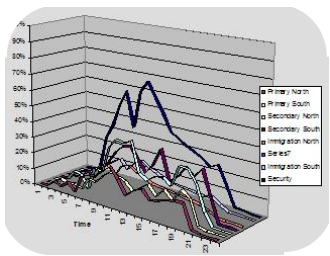


TAAM simulation

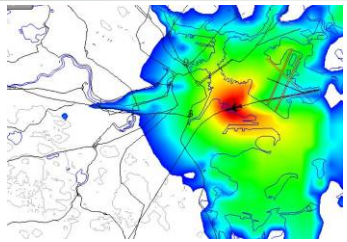




Conflict analysis

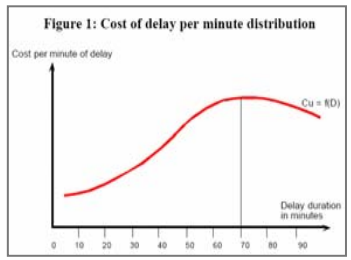


Capacity statistics

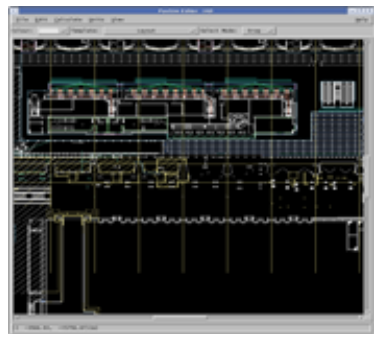


Noise analysis

Scenario generation for real-time simulators



Cost / benefit analysis



Passenger and baggage flow simulation

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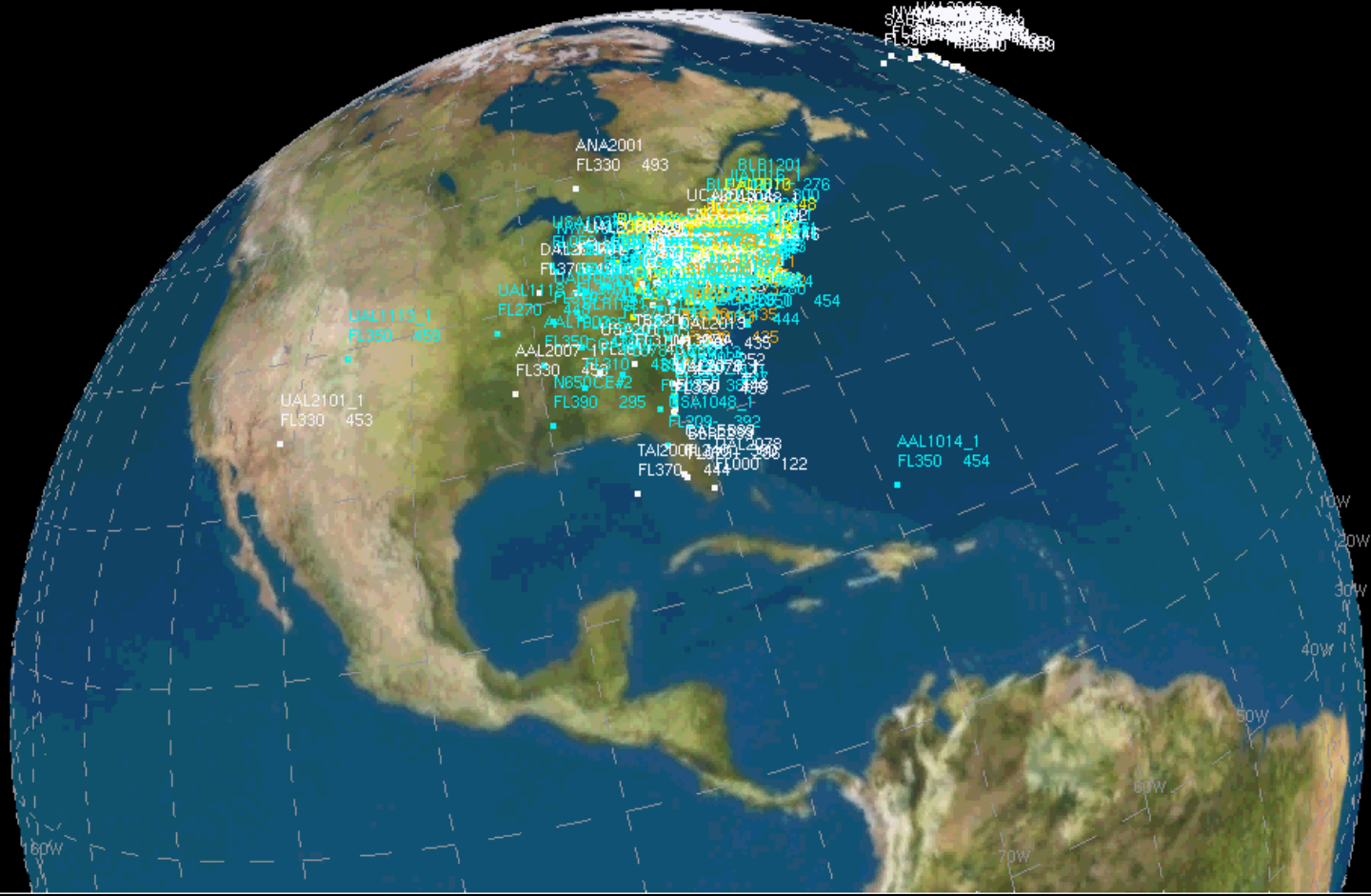
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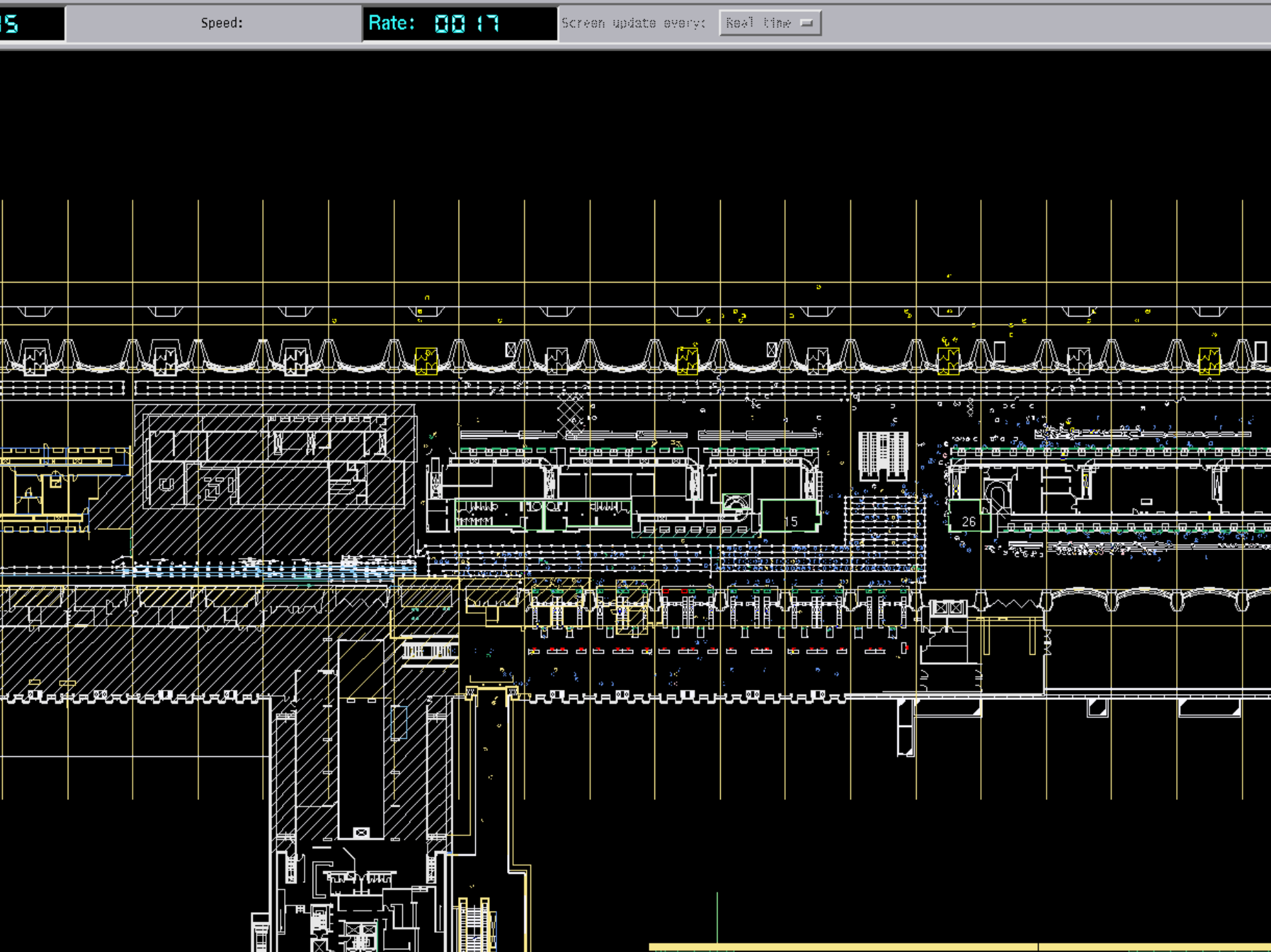
50W
60W
70W
80W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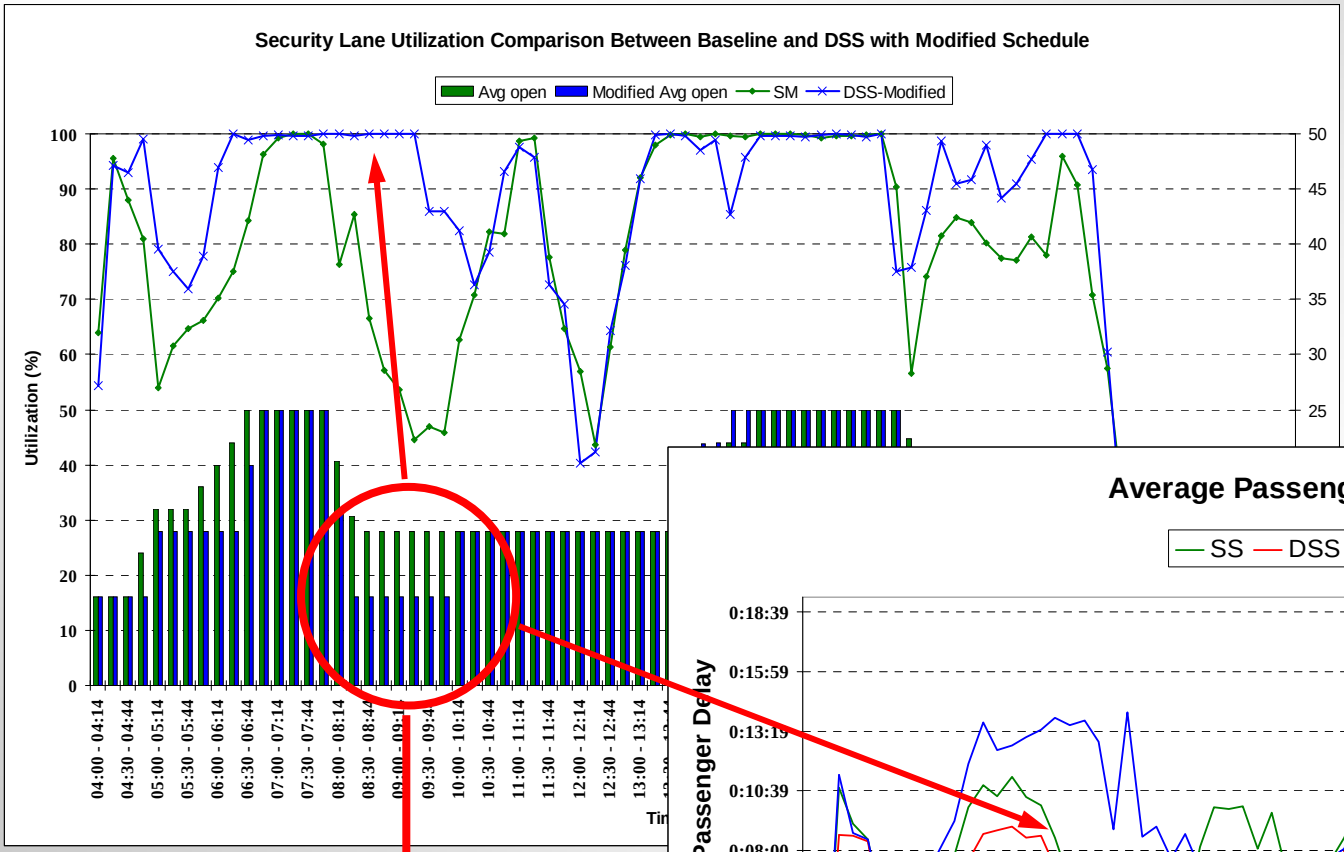
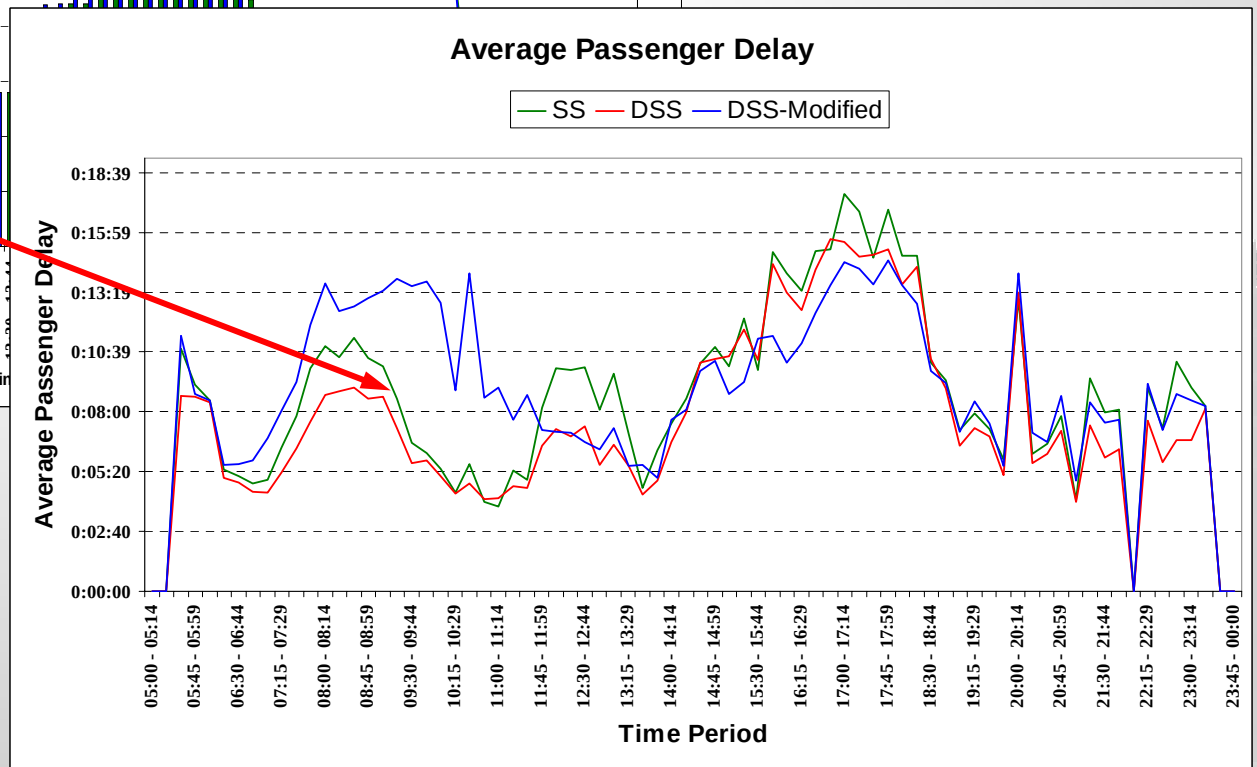
Screen update every:
Real time
15
26

IAD: Delay/Utilization Tradeoff





Opening additional 6-8 lanes reduces wait time during off-peak periods

From Individual Models to Toolsets

CATSR

From NAS-wide effects to individual airport models

First-class simulation tools

Stochastic modeling: scientific approach to using fast-time simulation models

Plug-ins and data analysis tools built at GMU

“Air traffic analysis” (capacity/demand/procedures/expansion), safety analysis, and economic analysis go hand-in-hand

Use of sophisticated tools and models to educate the next generation of model users and analysts

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