US and EU Taxi Out Delay and Potential US Policy Options

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Significant Difference in Taxi Out Delays EU vs. US

Estimated excess time on flights to/from the main 34 airports (2007)		TIME per flight (minutes)		Predictability
		EUR	US	
Gate/ departure holdings	*en-route-related*	1.4	0.1	Low
	airport-related	1.4	1.1	Low
*Taxi-out phase**		3.7	6.8	Medium
Horizontal en-route flight efficiency		2.2-3.8	1.5-2.7	High
Terminal areas (ASMA/TMA)		3.2	2.5	Medium
Total estimated excess time per flight		11.9-13.5	12.0-13.2	

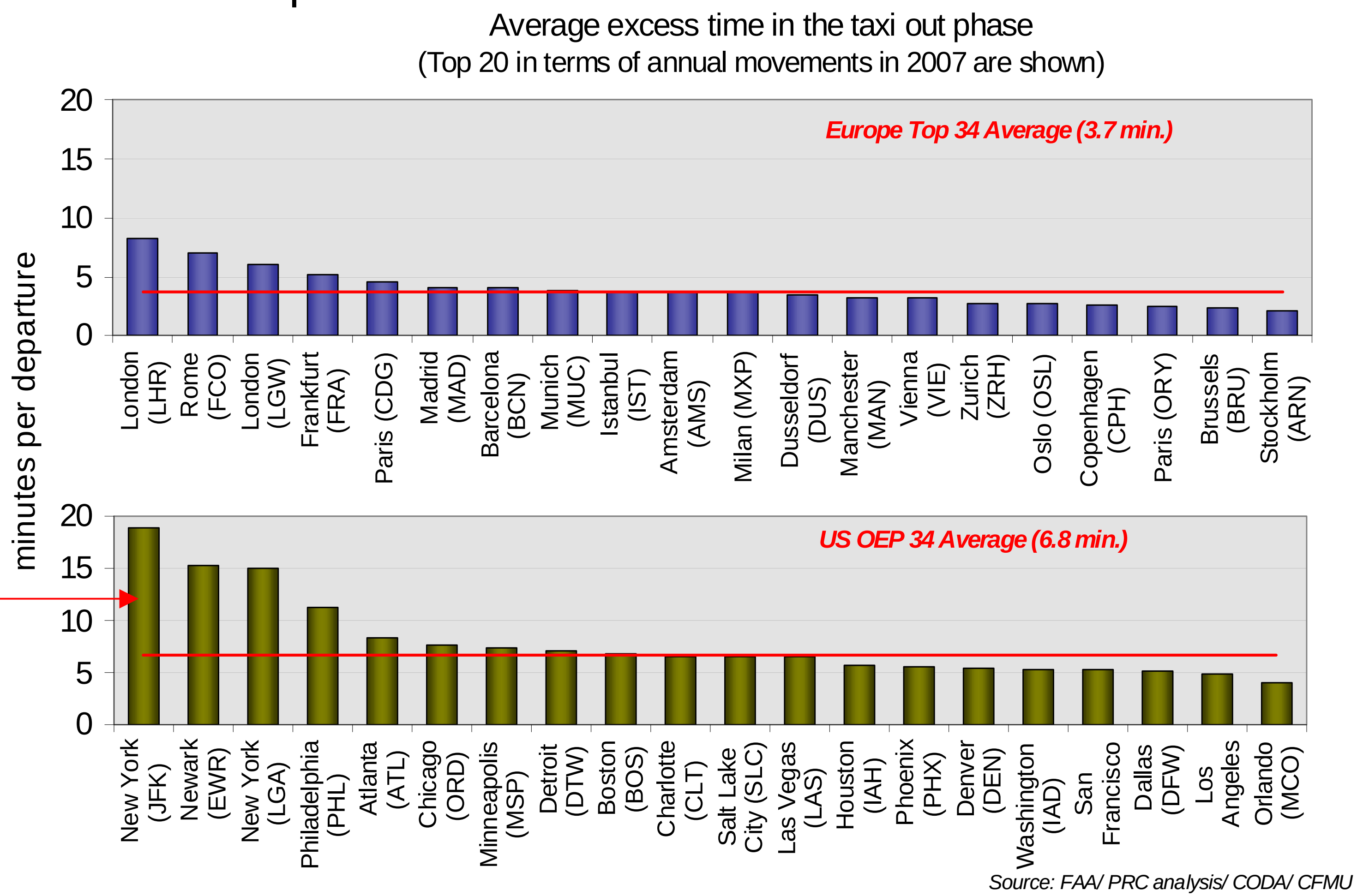
* Identified as a possible opportunity for US improvement

Source: Knorr and Fron

Definition: Taxi Out Delay

- Definition: Taxi out delay is defined as time spent between pushback and wheels up in excess of unimpeded time (ASPM)
  - Higher in US than in Europe

Note concentration of problem



Source: Knorr and Fron

Executive Summary

- Institutional differences (slots;control of airport surface) between US and EU contribute to differences in departure queuing
- Two departure control and two allocation approaches being worked on in US for instances when ADR< Demand:

Allocation Method	Departure Control	
	ATCT	**Airport**
Collaborative Virtual Queue	Aircraft calls for pushback; placed in Virtual Queue on FCFS basis; ATCT issues pushback clearance	Aircraft calls for pushback; placed in Virtual Queue on FCFS basis; Ramp Tower issues pushback clearance
Ration by Schedule	ATCT issues slots (=ADR) per schedule; carriers select flight for each slot; ATCT issues pushback clearance	Airport Coordinator issues slots (=ADR) per schedule; carriers select flight for each slot; Ramp Tower issues pushback clearance

Change in Ground Controller Function

Nextgen Acquisition

Local Airline Agreement

Airport Acquisition

- Important Question: How to Meld these approaches

Some Reasons for US vs. EU Differences

Summary of Institutional Differences US vs. EU

When the Runway is the Scarce Asset		
	US	**EU**
Demand	Not limited	Limited by slots
Demand/Capacity	Demand often → VMC capacity	Demand ← IMC capacity
Gates and Other Facilities	Preferential or exclusive	Common use; included in slot
Ramp/Apron/Taxiway/Runway	Ramp/apron independently management	All managed by ATCT
Consequences	Taxi out queue inevitable Reductions in ADR cause severe delay Schedule padding includes expected queuing	Taxi queues limited to feed runway Reductions in ADR less problematic Schedules less padded
Airport CDM	Without traditional slots*, improve management of queue. Use CVQ with first come first served, or RBS and department slots** based on ADR	Improve management of deviations from schedule by exchanging departure flow information and optimizing sequence

*HDR style slots
**Slots created on day of flight based on ADR in a time period

Possible New Motivation for Airlines

- **New DOT Consumer Rule Limits Airline Tarmac Delays, Provides Other Passenger Protections (**DOT-OST-2007-0022)
  - Prohibits U.S. airlines operating domestic flights from permitting an aircraft to remain on the tarmac for more than three hours without deplaning passengers
  - Carriers are required to provide adequate food and potable drinking water for passengers within two hours of the aircraft being delayed on the tarmac and to maintain operable lavatories and, if necessary, provide medical attention.
  - Prohibits airlines from scheduling chronically delayed flights, subjecting those who do to DOT enforcement action for unfair and deceptive practices;

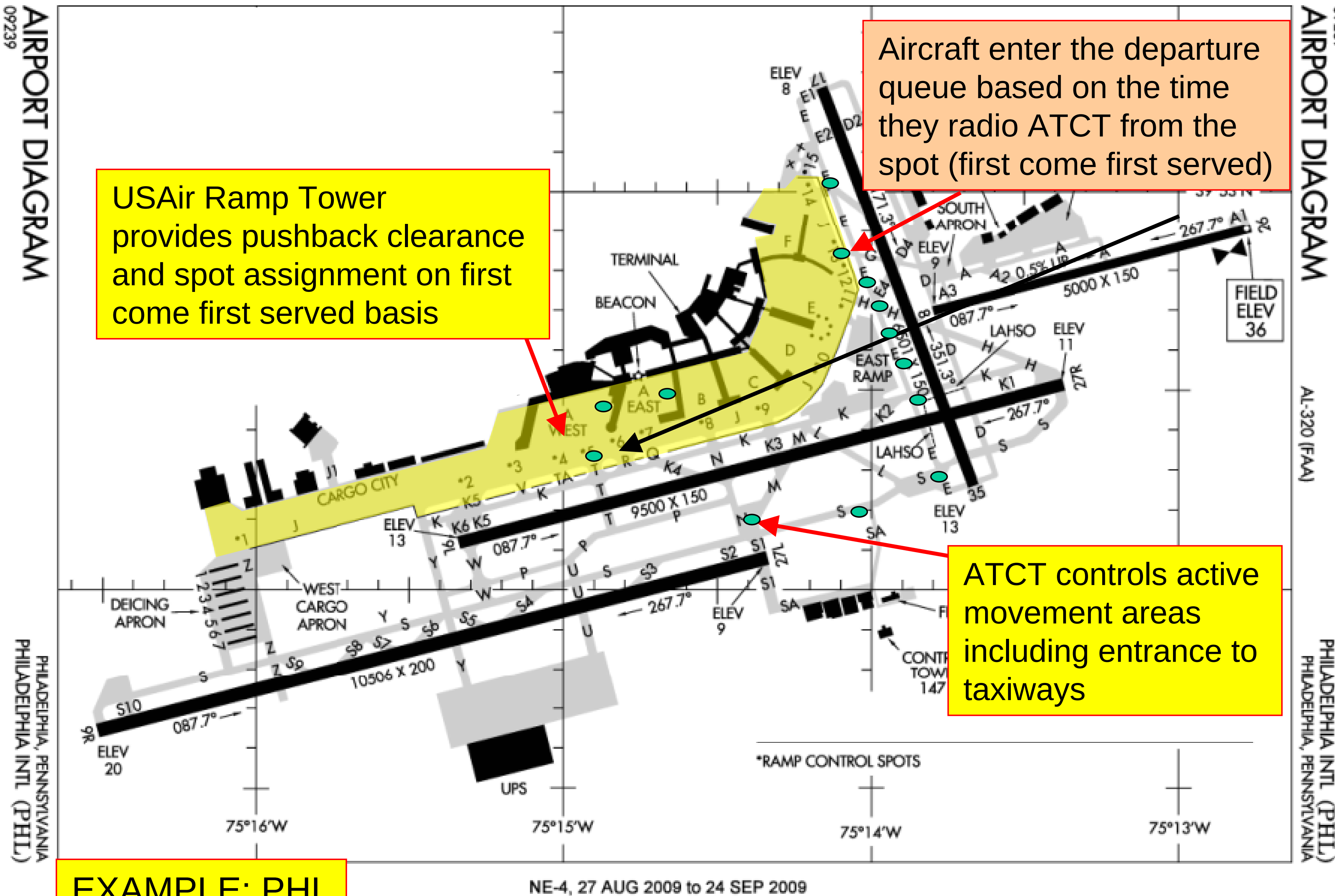
EU Airport CDM: Framework to Manage Deviations from Schedule; Insure Proper Use of Slots

EU AIRPORT CDM -- FEATURING CONSTANT UPDATE OF INFORMATION AMONG ALL PARTIES

Hours before Expected Off Block Time	AIRLINE/ HANDLER	AIRPORT CDM	ATCT	CENTRAL FLOW MGT
-3	Final Flight Plan	Combine Flight Plan with Slots		Marks flight from CDM airport and for Calc. Takeoff Time
-3	Updating Flight Plan Starts	Gate and handling Planning		
-2	Target Takeoff Time transmitted to Airport			
-1.25	Confirm Target Off Block Time	Automated Target Off Block Time		
-0.066	Confirm TSUT	Calculation of Target Start Up Time	ATCT Confirms Sequence	Flight Sequenced
-0.083	Request Startup		Startup Clearance	
0	Request Pushback		Pushback Issued	

Time Before Pushback

In US: ATCT Usually Manages Movement Area But Not Ramp/Apron and Demand Often > ADR



USAir Ramp Tower provides pushback clearance and spot assignment on first come first served basis

Aircraft enter the departure queue based on the time they radio ATCT from the spot (first come first served)

ATCT controls active movement areas including entrance to taxiways

NE-4, 27 AUG 2009 to 24 SEP 2009

EXAMPLE: PHL

US Airport CDM Concepts

RTCA Recommendations for Surface Management

- Surveillance systems in the movement and non movement areas (2010-2014)
- Situational awareness systems (2010-2014)
- Communications
  - Interoperability standards (2014-2018)
  - Datacomm (2009-2014)
- Enhanced situational awareness (2014-2018)
- But method of **allocating** scarce departure capacity not featured

Source: NEXTGEN Mid-Term Implementation Task Force Report (9 September 2009)

Two Views of Departure Capacity Allocation

- (1) **Collaborative Virtual Queue (CVQ):** Preserve First Come First Served but limit queuing
  - Aircraft call for pushback and are placed in a virtual queue
  - Aircraft remain at the gate or move to alternate parking spot
  - Once additional aircraft are needed for the queue, the “oldest” plane in the virtual queue is given a pushback clearance
    - Airline may swap a higher valued aircraft that is ready

- (2) **Ration By Schedule (RBS):** Allocate available capacity (ADR) per Schedule and issue departure slots; limit queuing
  - Airline decides which aircraft it wants to use the slots; manages departure time, gates, other issues
  - Consistent with existing CDM principles

Key Distinction Between Two Concepts

- **Collaborative Virtual Queue**: access to the runway remains first come first served
  - Aircraft enter the virtual queue in the same way they enter the actual queue today
  - A carrier gains an advantage by calling for pushback as early as feasible
    - No change in incentives
- **RBS**: access to runway is via allocated slots (based on ADR)
  - There is no advantage to call for pushback as early as feasible since an airline will only have a finite number of slots in a time period
  - Potentially, some gate delay could be taken in the terminal instead of on-board the aircraft
  - But this is a significant change in airline “rights”

Neither is a substitute for traditional slots. Neither restricts “over-scheduling” relative to departure capacity

Two Ways to Control Departure Allocation Process

- **ATCT Centric**: ATCT would issue pushback clearances
  - Similar to EU process including NEXTGEN technology applications to exchange information and track flights in real time
  - Increased ATCT controller workload
  - Requires FAA investment

- **Airport Centric**: Meld ASDE-X and other Situational Awareness tools with airline agreement to role of Coordinator; create website to share information on flights and allocation of departure capacity, weather etc.
  - Precedent: JFK Winter Operations
  - No change in ATCT workload or investment
  - Airport/operators pay for departure manager software and personnel

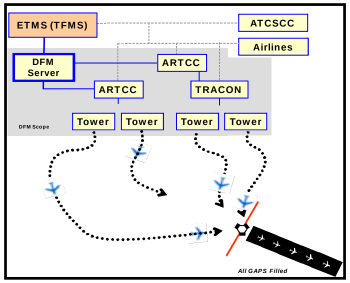
Advantages of ATCT and Airport Centric Approaches

- **ATCT Centric** Approach:
  - Improves flight departure management ⇨ better overall TFM
  - Single entity has control of airport surface
  - FAA is a neutral party
  - Consistent with Nextgen plan for "Arrival/Departure Management Tool" (2017)

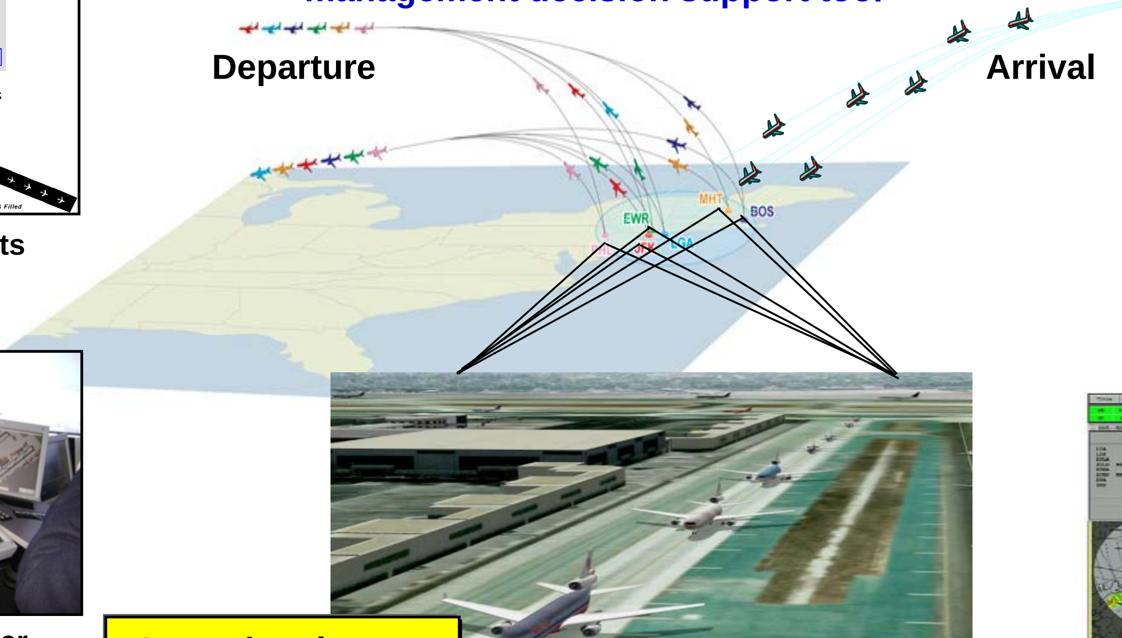
- **Airport Centric** Approach:
  - Can be done now (e.g. JFK Winter Irrops)
  - Does not increase ATCT work load or require major FAA investment
    - May create time for controllers to deal with closed fixes and/or desirable flight sequences
  - FAA can still capture improvement in departure management for overall TFM via web page

Both CVQ and RBS Would Work w/ Planned Nextgen Acquisitions/ ATCT Centric Plans

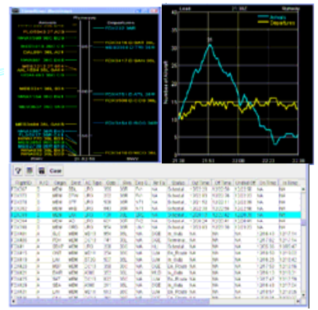
A/DMT: Integrated arrival, surface and departure management decision support tool



TFM Constraints

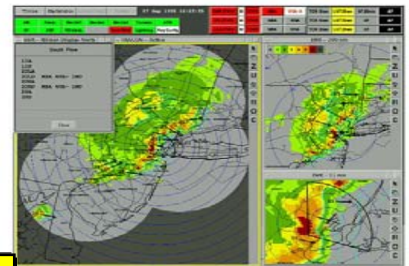


Surface



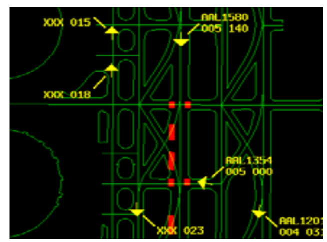
Arrival/Departure Demand

Integrated Tower Display Suite



Airport Weather

Flight Data Management



Terminal and Surface Surveillance

Operational Users

ATCT Controllers
- Flight
- Clearance
- Ground
- Local

Terminal TMC

Airline and Dispatch

Airport Authority

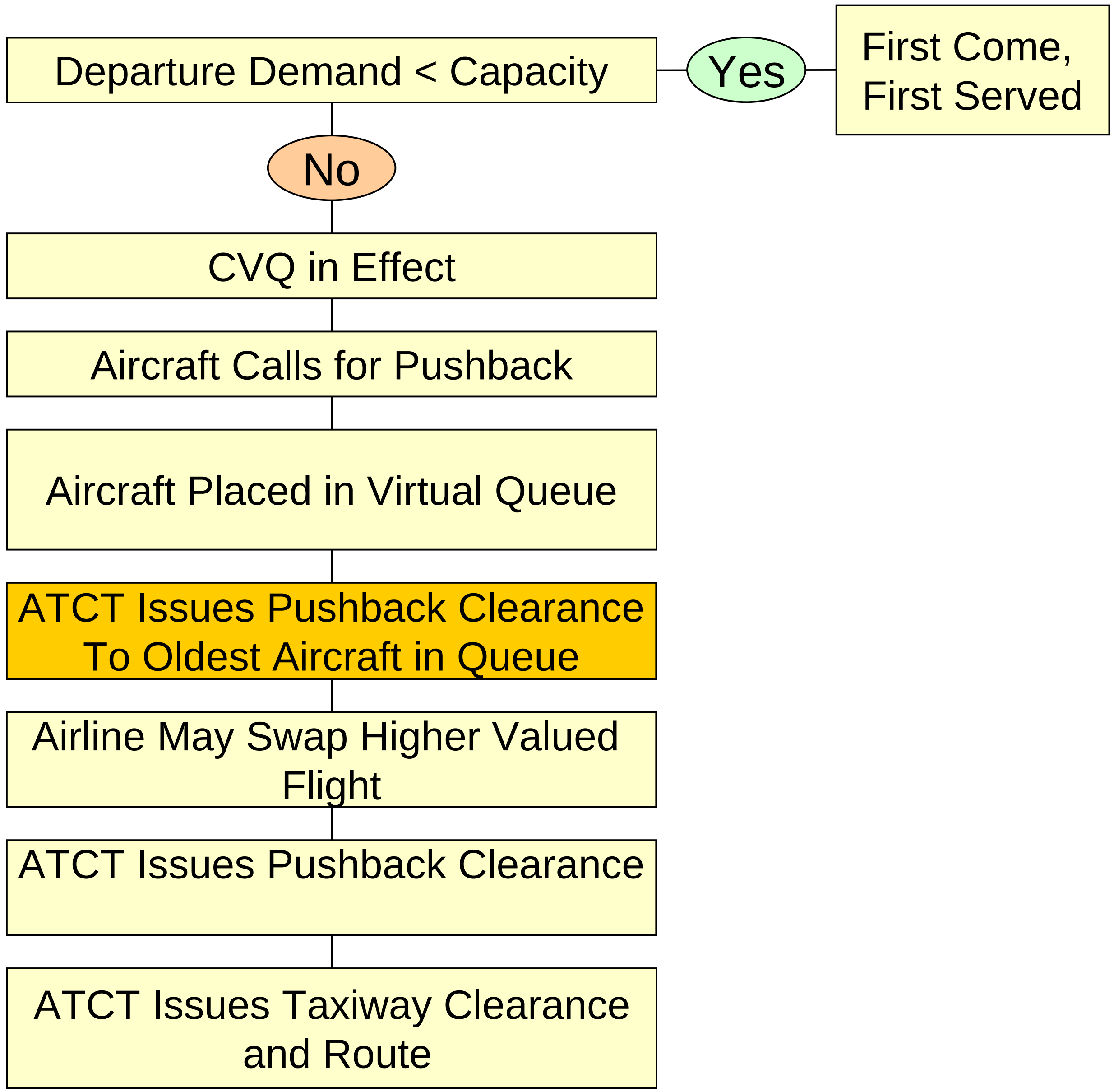
Airport Security

Activities

- Pushback control
- Taxi control
- Taxi conformance
- Departure sequencing
- Departure route assurance
- Runway configuration and load-balancing

Source: AJT Systems Engineering

A U.S. CDM Concept with CVQ: ATCT Manages Demand



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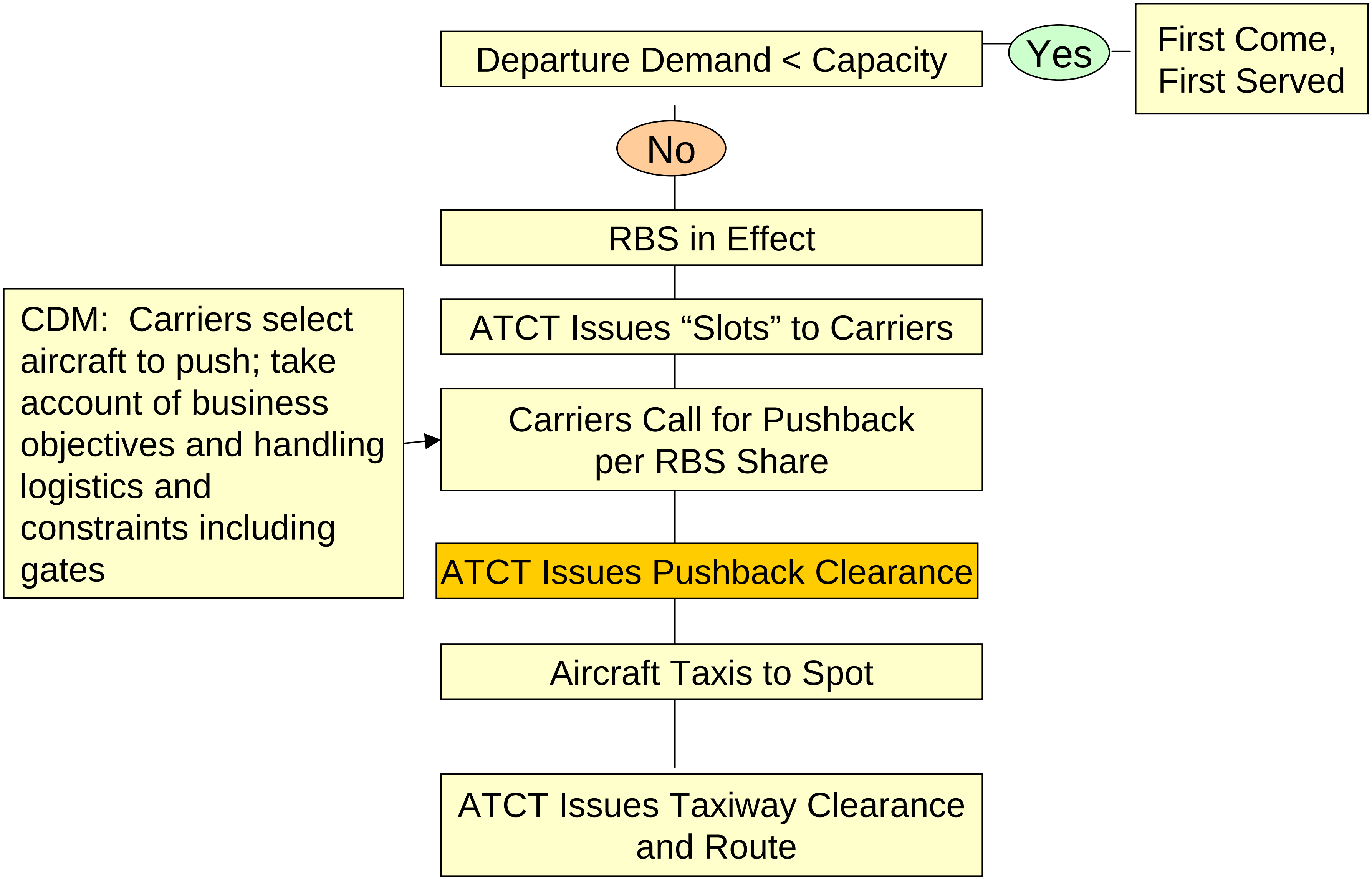
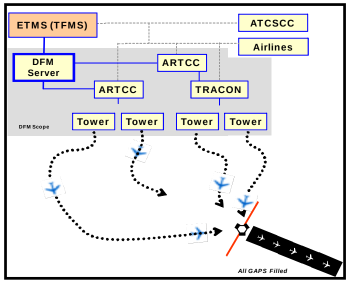


Both CVQ and RBS Would Work w/ Airport Centric Coordinator of Departure Process



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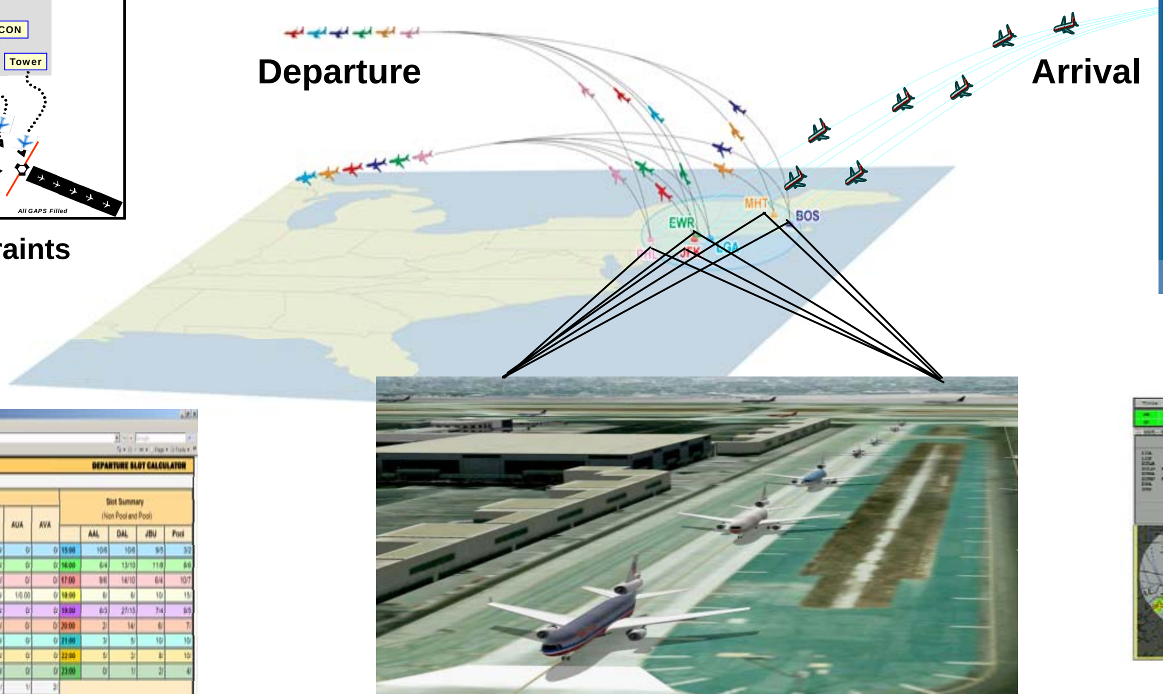
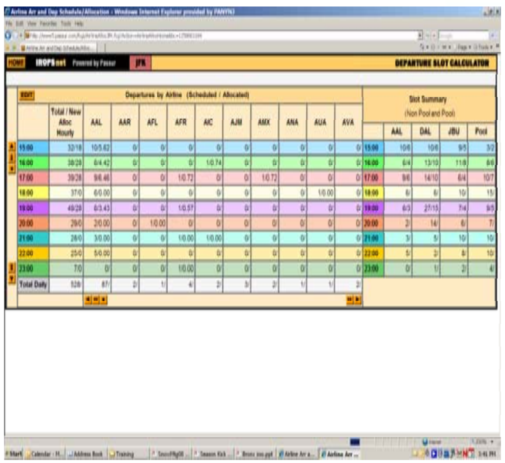
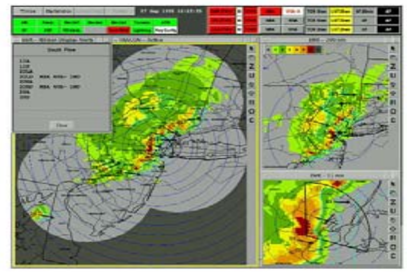


Surface

Demand/Capacity Profile



Departure Capacity Allocation



Airport Weather

Operational Users

ATCT Controllers

Terminal TMC

Airline and Dispatch

Airport Authority

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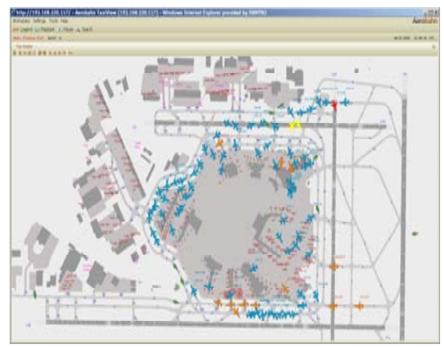

Situational Awareness

Alternative US Airport CDM: "Coordinator" Manages Departures via CVQ

ATCT, Tracon, Ramp Tower, Airport, Airlines All on Common Webpage

↓

Airport/Vendor Declares Departure CDM based on ADR vs. Demand

↓

Aircraft Calls for Pushback and is Placed in a Virtual Queue
(first come first served)

↓

Coordinator Seeks to Set the Queue Length to be Efficient

↓

When a Spot in the Queue Opens Up, Coordinator Notifies
Airline with "Oldest" Aircraft in the Virtual Queue

↓

Airline Selects the Flight It Wants to Use the Next Spot in the Queue

↓

Pilot Calls for Pushback Clearance which Ramp Controller Issues
Consistent with Slot Allocation

↓

FAA ATCT Ground Controller Provides Clearance to Enter Movement Area

Alternative US Airport CDM: "Coordinator" Manages Departures via RBS

ATCT, Tracon, Ramp Tower, Airport, Airlines All on Common Webpage

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Airport/Vendor Declares Departure CDM based on ADR vs. Demand

↓

Airport/Vendor Allocates ADR Slots Based on OAG and EDCT's

↓

Airlines Report Flight Numbers of Departures Using Slots and Identify Desired Runway

↓

Airport/Vendor Uses Software to Develop Desirable Sequence (Diverging Departures, Heavies, MIT's, Fixes Open, Minimum Taxi Time)

↓

Airport/Vendor Assigns Time for Flight to be at Spot to Radio for Clearance to Taxi

↓

Pilot Calls for Pushback Clearance which Ramp Controller Issues Consistent with Slot Allocation

↓

FAA ATCT Ground Controller Provides Clearance to Enter Movement Area

Work is Required to Determine If/How to Meld the ATCT and Airport Centric Approaches

- As NextGen is evolving with **ATCT** Centric Approach
- How does **Airport** Centric Approach merge with the new technologies and operational concepts?
- Can Advantages of Airport Centric Approach be captured NOW
  - JFK demonstration this spring: procedures/software/systems are near maturity
    - One metric: JFK Winter IRROPS has eliminated secondary deicing at JFK
  - Reduced future work load and FAA investment

Some Issues with Airport CDM

Possible Legal Issues with the Alternatives

If ATCT Controls Both Pushback and Taxi Clearances Using CVQ or RBS:

- FAA has traditionally avoided safety oversight and operational control of ramp and apron areas

- If FAA assumes control over ramp and apron:
  - It might assume some liabilities for accidents and injuries in those areas
  - It would be overriding private carrier contracts

If Coordinator Appointed by Airport Allocates Slots Using CVQ or RBS:

- Requires carrier agreement but carriers would not do the allocation
  - Avoids carriers allocating scarce departure capacity, which might be subject to anti-trust enforcement
  - Carrier scheduling committees can only be convened under FAA auspices

Requires review with Chief Counsel's office

Some Other Potential Issues

- At most airports, dominant carrier(s) will be the chief beneficiary
  - A carrier with only a few flights will have a very small share of departure slots and may choose to opt out of an agreement to sanction the Airport Centric Approach
  - **Possible Solution**: FAA to develop a master agreement to cover congested airports nationwide; then carriers need only agree on trigger for implementing departure management at each airport

- Holding aircraft at gates directly affects pilot pay and on-time performance
  - Brake release triggers Flight Pay (most mainline airlines)
    - Pilot cost per block hour falls if aircraft held at gate
  - Brake release is measure of DOT departure time
    - Disincentive for carriers to take some delay at gate
    - Suggestion: Examine trade-offs of changing on-time measurement to some Standardized Elapsed Time Concept (TBD)

- Gate constraints may make gate holds difficult to manage
  - Tightly scheduled inter-gate time could trigger inbound queues
  - **Possible Solution**: w/ ATCT cooperation, carriers unable to manage gates are given more circuitous taxi routings
  - **Possible Solution**: Set maximum gate hold time to help airlines manage

Chief Beneficiaries of Airport CDM are Largest Operators at PHL

- If airport CDM manages departures so that the **maximum** queue length was 10 aircraft (at runway and taxiing)

Time in excess of unimpeded taxi time

Airline	Departures	OAG			Maximum Queue Length = 10		
		Tot.Excess Time	Avg Queue	Avg. Queue Time	Tot.Excess Time	Avg Queue	Avg. Queue Time
9E	5	0:39:33	6.8	0:07:55	0:22:49	3.8	0:04:34
AA	22	2:36:36	6.0	0:07:07	1:36:27	3.5	0:04:23
AC	5	0:21:49	4.6	0:04:22	0:13:27	2.4	0:02:41
AF	1	0:14:11	13.0	0:14:11	0:09:23	8.0	0:09:23
BA	2	0:29:43	13.5	0:14:51	0:07:26	2.5	0:03:43
CO	11	1:26:24	6.9	0:07:51	0:45:45	3.5	0:04:10
DL	14	1:19:25	4.9	0:05:40	0:28:51	1.9	0:02:04
F9	2	0:06:57	3.5	0:03:29	0:06:57	3.5	0:03:29
FL	18	3:48:25	10.5	0:12:41	2:26:21	6.1	0:08:08
JM	1	0:06:43	5.0	0:06:43	0:06:14	5.0	0:06:14
LH	1	0:00:00	0.0	0:00:00	0:00:00	0.0	0:00:00
NW	13	0:36:37	2.6	0:02:49	0:23:31	1.7	0:01:49
OH	7	0:27:37	3.7	0:03:57	0:05:51	0.9	0:00:50
OO	2	0:00:00	0.0	0:00:00	0:00:00	0.0	0:00:00
U5	3	0:04:12	1.3	0:01:24	0:06:58	1.7	0:02:19
UA	19	1:43:44	4.9	0:05:28	0:44:38	2.3	0:02:21
US	457	85:02:46	9.8	0:11:10	35:26:45	3.9	0:04:39
WN	66	14:58:27	11.5	0:13:37	7:16:06	5.0	0:06:36
XE	4	0:32:51	7.5	0:08:13	0:00:00	0.0	0:00:00
YV	1	0:10:14	9.0	0:10:14	0:07:32	7.0	0:07:32
YX	2	0:16:08	7.0	0:08:04	0:06:32	3.0	0:03:16
TOTALS	**656**	**115:02:22**	**9.2**	**0:10:31**	**50:41:33**	**3.8**	**0:04:38**

Source: GRA queuing model for 17 August 07 (as scheduled)

Avg. Excess Queue Time Cut in Half

Under CDM, Carriers Deal w/ Gate Constraints

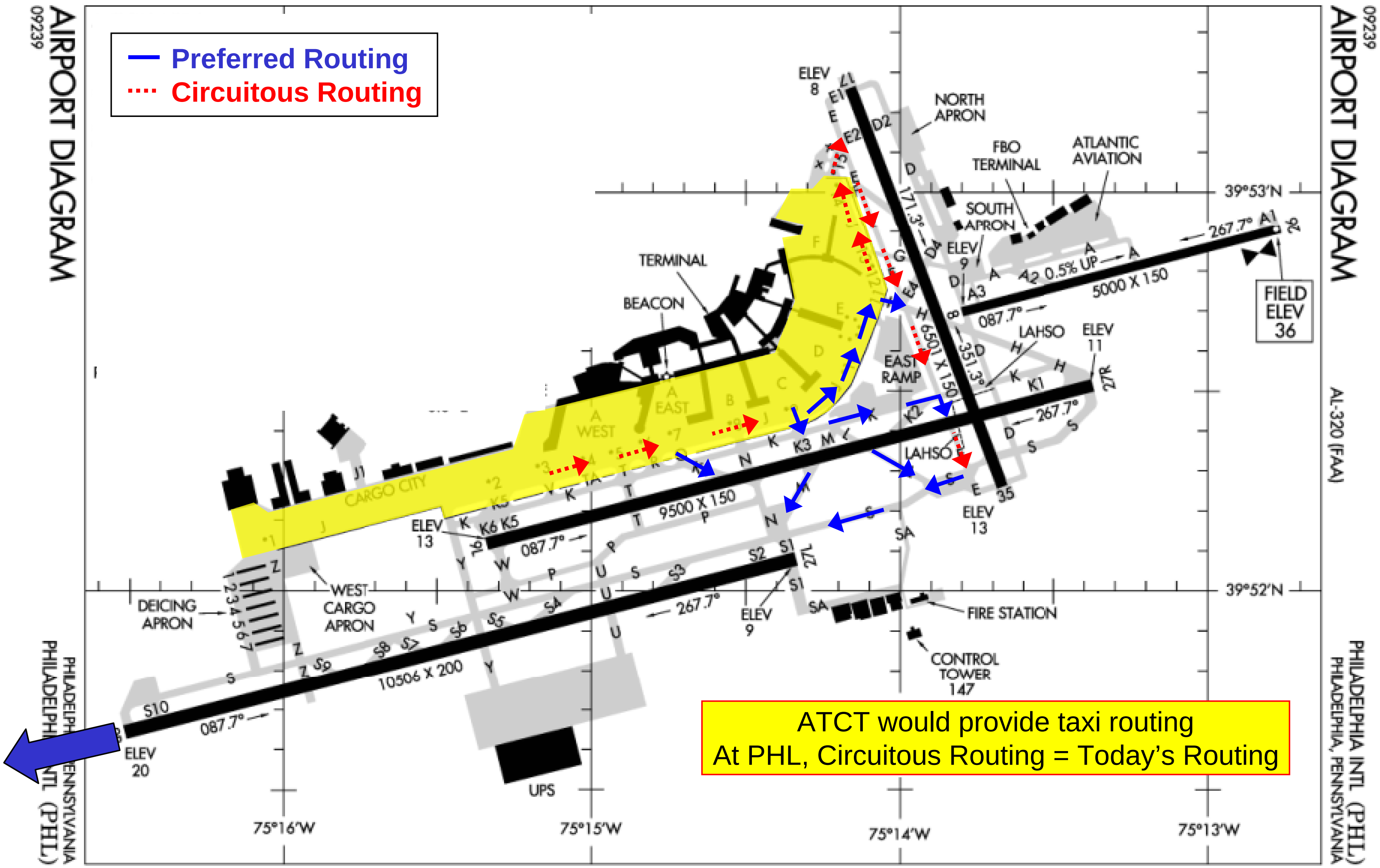
Airline	Avg. Intergate Time	Minimum Intergate Time	Turns
1	244	30	16
2	211	64	19
3	221	147	4
4	77	77	1
5	92	15	198
6	45	45	1
7	68	68	1
8	153	15	52
9	216	37	15
10	272	40	16
11	280	61	9
12	229	54	16

Intergate times measured in minutes

May need some other location to hold if airline cannot manage own gates

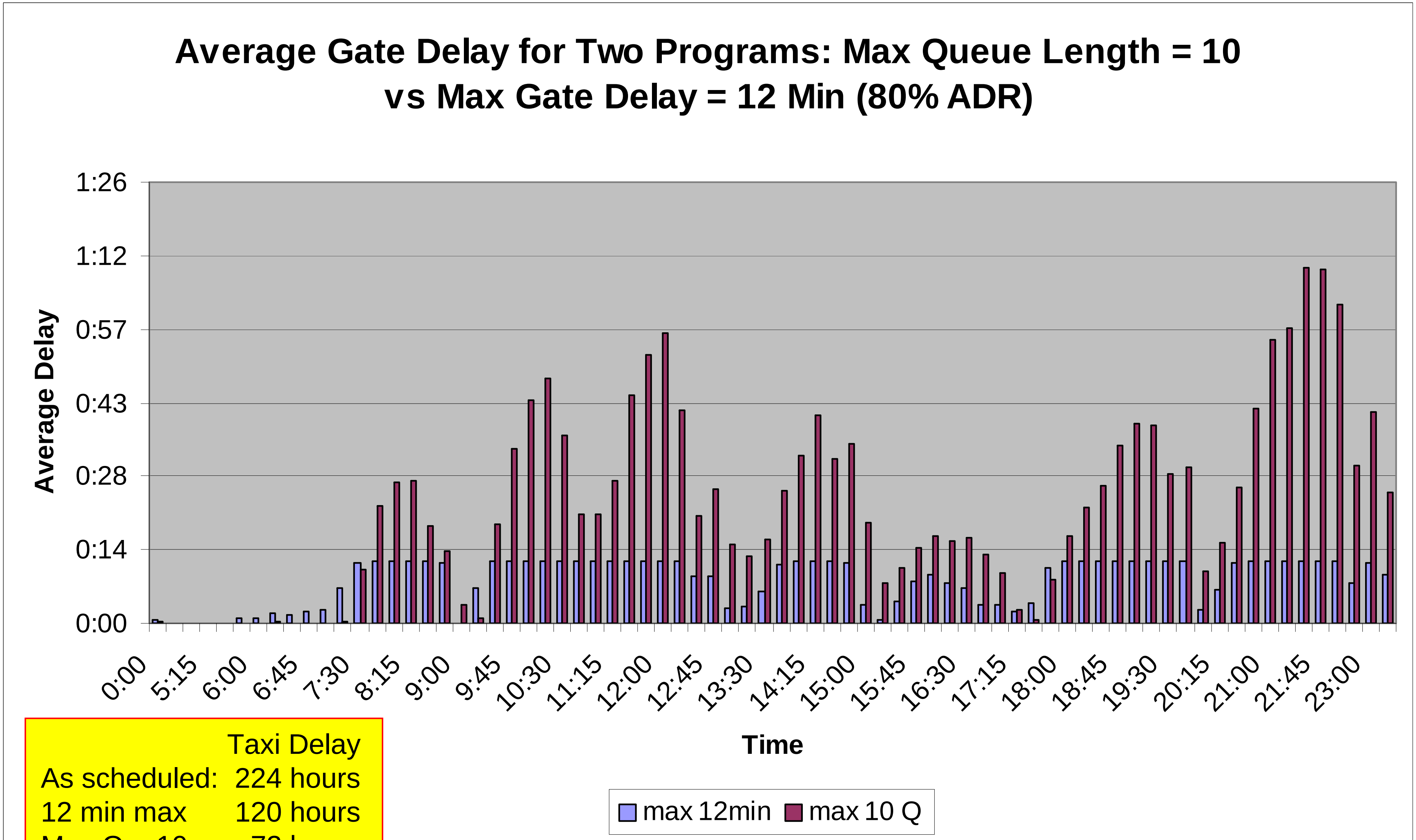
PHL 17Aug07

Preferred Taxi Routing for Carriers Managing Gate Constraints



NE-4, 27 AUG 2009 to 24 SEP 2009

The Impact of Capping Gate Delays: PHL 80% ADR



	Taxi Delay
As scheduled:	224 hours
12 min max	120 hours
Max Q = 10	72 hours

Benefits and Costs of Airport CDM
Initial Analysis of PHL

Rough BCA for PHL

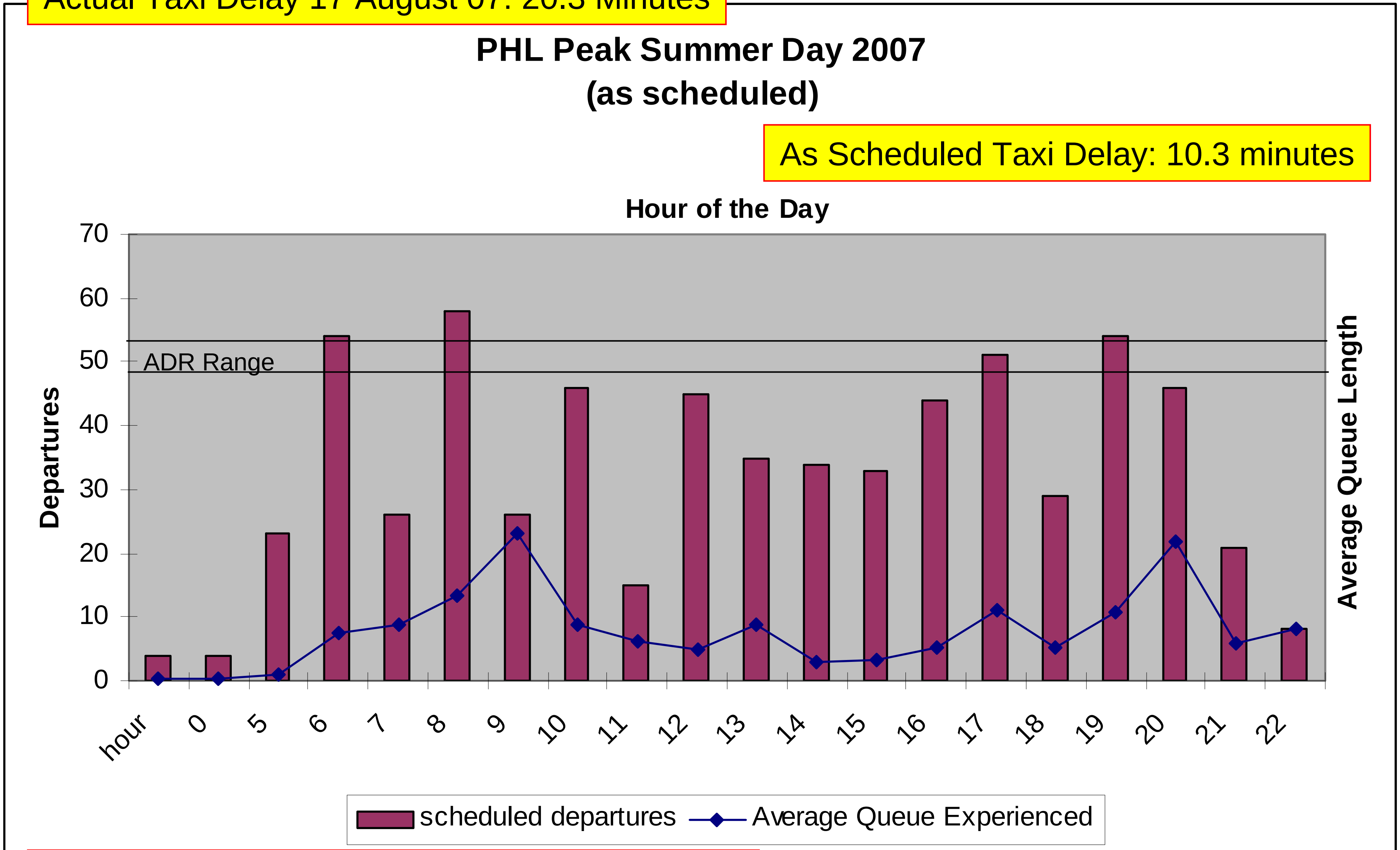
- Apply EU Airport CDM Benefit Cost model to estimate costs
  - Adjusted for size of airport (PHL is 2X average airport in model)

- Benefits estimated from GRA queuing model (17AUG07) and Sensis simulation (19NOV09)
  - Fuel
  - Emissions
  - Excludes potential benefits of improved reliability

- PHL selected because it is a pure case:
  - High departure demand relative to capacity
  - Very limited taxi routings
  - Gate constraints

PHL Taxi Delays Inevitable Even Without Disruptions

Actual Taxi Delay 17 August 07: 20.3 Minutes



As scheduled average queue length: 9.2 aircraft

Initial Estimate of PHL Annualized Fuel Savings

Airline	17 Aug 07 Departures	Fuel Cost Avoided ($2 gal)
9E	5	$18,273
AA	22	$65,684
AC	5	$9,136
AF	1	$5,242
BA	2	$24,333
CO	11	$44,390
DL	14	$55,219
F9	2	$0
FL	18	$89,617
JM	1	$528
LH	1	$0
NW	13	$14,305
OH	7	$23,769
OO	2	$0
U5	3	-$3,021
UA	19	$64,537
US	457	$3,249,810
WN	66	$504,886
XE	4	$35,872
YV	1	$2,948
YX	2	$10,483
TOTALS	656	$4,216,012

Based on annualizing 17 August 07 (as scheduled); Fuel consumption rate per Levy et al: "Quantification and Forecasting from Taxiing Aircraft"

Initial Estimates of Annualized Avoided Emissions at PHL

Airline	17AUG 07 Departures	CO Emitted(lb)	NOx Emitted (lb)
9E	5	3,513	187
AA	22	12,628	673
AC	5	1,757	94
AF	1	1,008	54
BA	2	4,678	249
CO	11	8,534	455
DL	14	10,616	565
F9	2	-	-
FL	18	17,229	918
JM	1	101	5
LH	1	-	-
NW	13	2,750	146
OH	7	4,570	243
OO	2	-	-
U5	3	(581)	(31)
UA	19	12,408	661
US	457	624,797	33,280
WN	66	97,068	5,170
XE	4	6,897	367
YV	1	567	30
YX	2	2,015	107
TOTALS	656	810,556	43,174

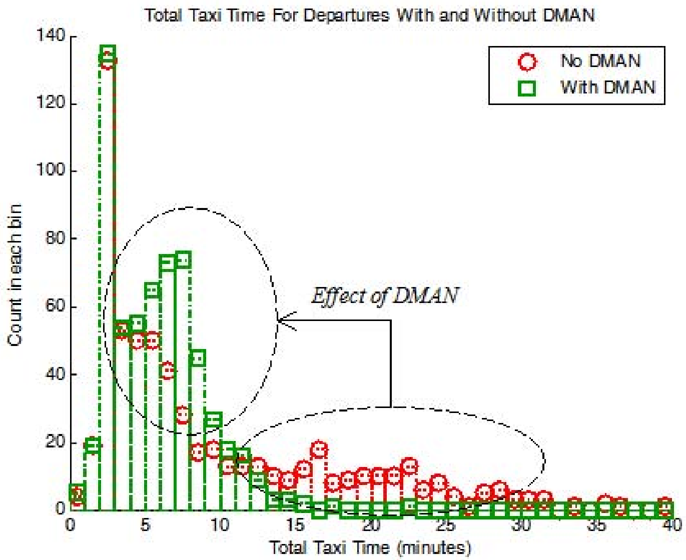
Based on annualizing 17 August 07 (as scheduled); emission rates per Levy et al.

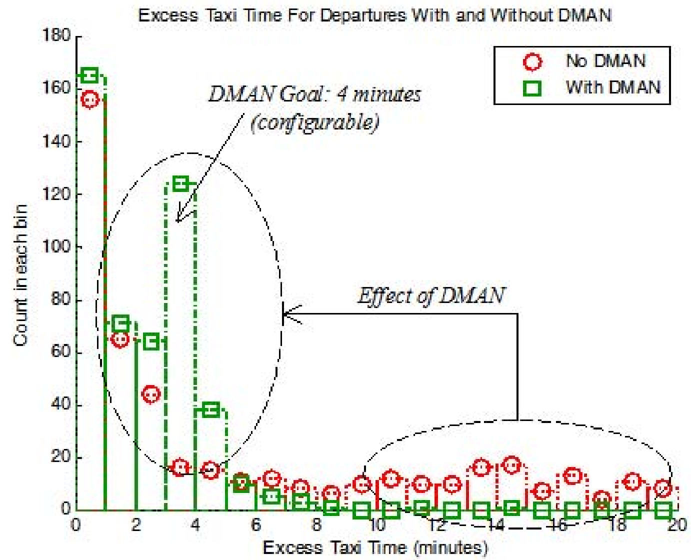
Results of Sensis Simulation for PHL 19Nov09

Sensis

Simulation of 1 day: Nov. 19, 2009

Effect of DMAN on Taxi Times





Total Taxi Time in MA for Departures

	No DMAN	With DMAN	Difference
Total	91.2 hrs	57.7 hrs	33.4 hrs
Mean	9.0 min/op	5.7 min/op	3.3 min/op
Std. dev.	7.9 min/op	3.1 min/op	4.8 min/op

Excess Taxi Time in MA for Departures

	No DMAN	With DMAN	Difference
Total	51.6 hrs	18.2 hrs	33.4 hrs
Mean	5.1 min/op	1.8 min/op	3.3 min/op
Std. dev.	7.2 min/op	2.0 min/op	5.3 min/op

Example of Evaluating Benefits and Costs of Airport CDM

BENEFIT COST FRAME WORK

	Base Case	Modified Airport CDM	Alternatives Considered
Definition	Current first come first served system with ramp/apron controlled by airlines and taxiways and departure control controlled by ATCT	Airport CDM via RBS where Airport/Vendor assigns time for an airline to have aircraft at a spot ready to taxi and Ramp control issues pushbacks consistent with slot allocation	(1) ATCT issues both pushback and taxiway clearances per CVG (2) ATCT issues both pusback and taxiway clearances per RBS
Institutional changes	None	Carriers agree to CDM via RBS Intercarrier agreement to have Ramp tower issue pushbacks to meet Airport/Vendor spot instructions and/or change in airport use agreement	FAA assumes control of ramp and apron; manages queue
Incremental Investment	None	See Surface Management Incremental Information Requirements	See Surface Management Incremental Information Requirements
Incremental Operating Costs	None	Controller work load (ATCT; Ramp Tower); Airline dispatch work load; System Command Center workload	Controller work load (ATCT; Ramp Tower); Airline dispatch work load; System Command Center workload
Benefits Metrics	Fuel consumed; emissions; improved TFM due to better departure information		

Sample Calculation of BCA for Airport CDM at PHL

Sample PHL Airport CDM Benefit Cost Analysis
Based only on Average Fuel Savings 17 August 07 and 19Nov 09

Discount Rate	7%

							Discounted			
Year	Fuel Benefits	Investment (based on EU Model)	Ann. IT Cost	Annual Personnel Cost	Total Cost	Net Benefits	Fuel Benefits	Total Costs	Net Benefits	Cumulative Net Benefits
0		$ 3,900,000			$ 3,900,000	$(3,900,000)		$ (3,644,860)	$ (3,644,860)	$ (3,644,860)
1	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 2,765,441	$ (1,410,604)	$ 1,354,838	$ (2,290,022)
2	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 2,584,525	$ (1,318,321)	$ 1,266,204	$ (1,023,818)
3	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 2,415,444	$ (1,232,076)	$ 1,183,368	$ 159,549
4	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 2,257,424	$ (1,151,473)	$ 1,105,951	$ 1,265,501
5	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 2,109,742	$ (1,076,143)	$ 1,033,599	$ 2,299,100
6	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,971,721	$ (1,005,741)	$ 965,981	$ 3,265,081
7	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,842,730	$ (939,945)	$ 902,786	$ 4,167,866
8	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,722,178	$ (878,453)	$ 843,725	$ 5,011,591
9	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,609,512	$ (820,984)	$ 788,528	$ 5,800,119
10	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,504,217	$ (767,275)	$ 736,942	$ 6,537,061
11	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,405,810	$ (717,079)	$ 688,731	$ 7,225,792
12	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,313,841	$ (670,168)	$ 643,674	$ 7,869,466
13	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,227,889	$ (626,325)	$ 601,564	$ 8,471,030
14	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,147,560	$ (585,350)	$ 562,210	$ 9,033,240
15	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,072,486	$ (547,056)	$ 525,429	$ 9,558,669
16	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 1,002,323	$ (511,268)	$ 491,056	$ 10,049,725
17	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 936,751	$ (477,820)	$ 458,930	$ 10,508,655
18	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 875,468	$ (446,561)	$ 428,907	$ 10,937,562
19	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 818,194	$ (417,347)	$ 400,848	$ 11,338,410
20	$ 3,166,154		$ 375,000	$ 1,240,000	$ 1,615,000	$ 1,551,154	$ 764,668	$ (390,044)	$ 374,624	$ 11,713,034
Sample Days	Excess Taxi Hours Saved									
17-Aug-07	65					TOTAL	$31,347,924	$(19,634,891)	$ 11,713,034	
19-Nov-09	33									
Average	49							B/C Ratio	1.60	

Sources: 17 August 07 per GRA queueing model; 19 November 09 per Sensis Corporation Simulation; EU BCA model for Airport CDM

Conclusions

- Airport CDM shows promise
  - Rough BCA
  - Willingness of carriers to invest at JFK
- Two control approaches: ATCT vs. Airport
  - Difference in who pays
  - ATCT-Centric is focus of Nextgen plan and suggests change ATCT role to include pushback clearance
  - Airport-Centric requires carrier assent and investment
- Two allocation approaches: CVQ vs. RBS
  - CVQ preserves first come first served; passengers on-board before aircraft enters the queue
  - RBS diverts from first come first served; passengers could stay at gate (if feasible)
- Next Step: Refinement of definitions of alternatives and analysis of costs and benefits

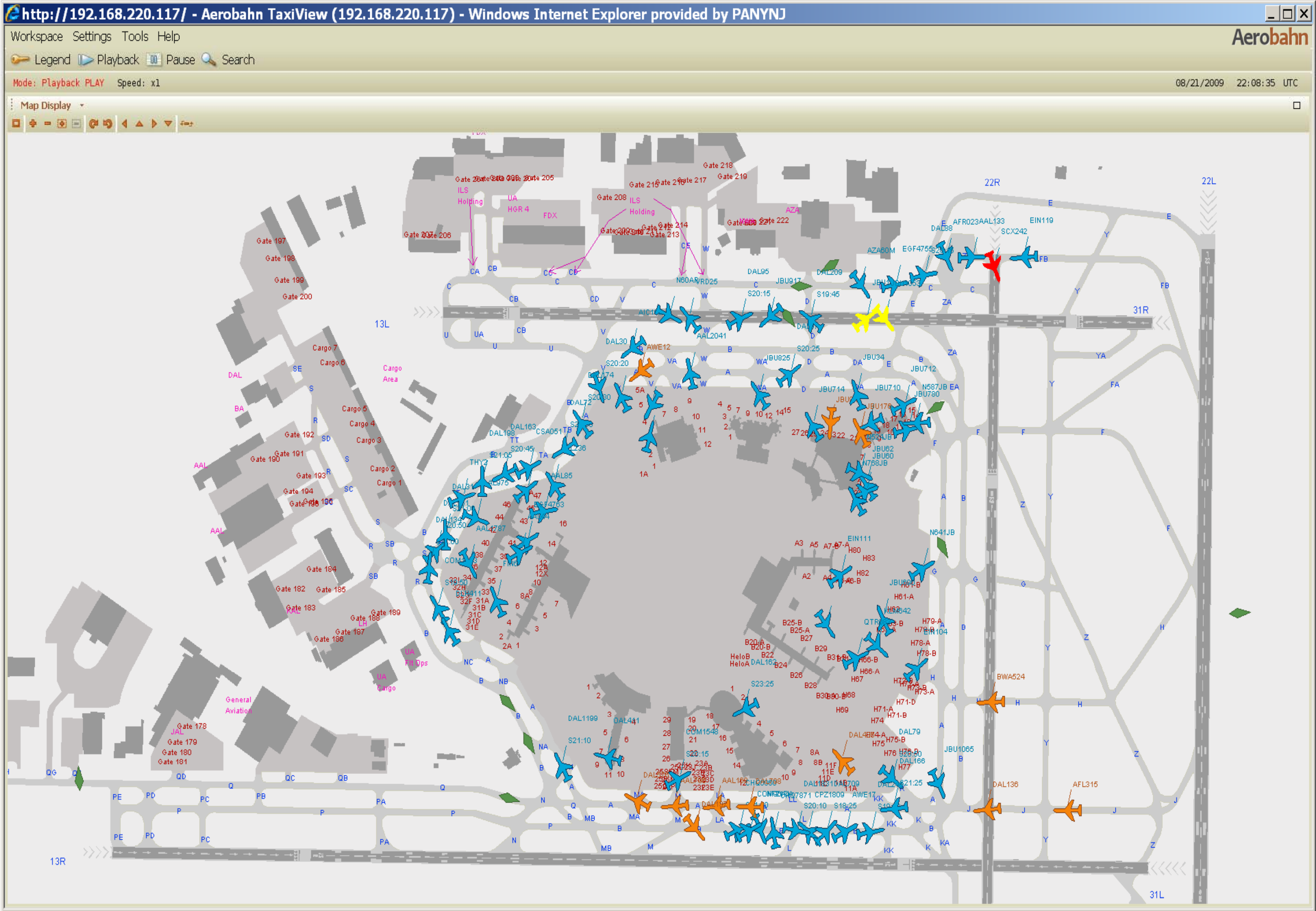
Extra Slides

Key Features of a Coordinator CDM System: Common Website

Key Feature: Demand and Capacity Profile

JFK Irrops System

Key Feature:
Situational Awareness Including Gates



Key Feature: Slot Calculation Based on ADR and OAG

HOME IROPSnet Powered by Passur JFK DEPARTURE SLOT CALCULATOR

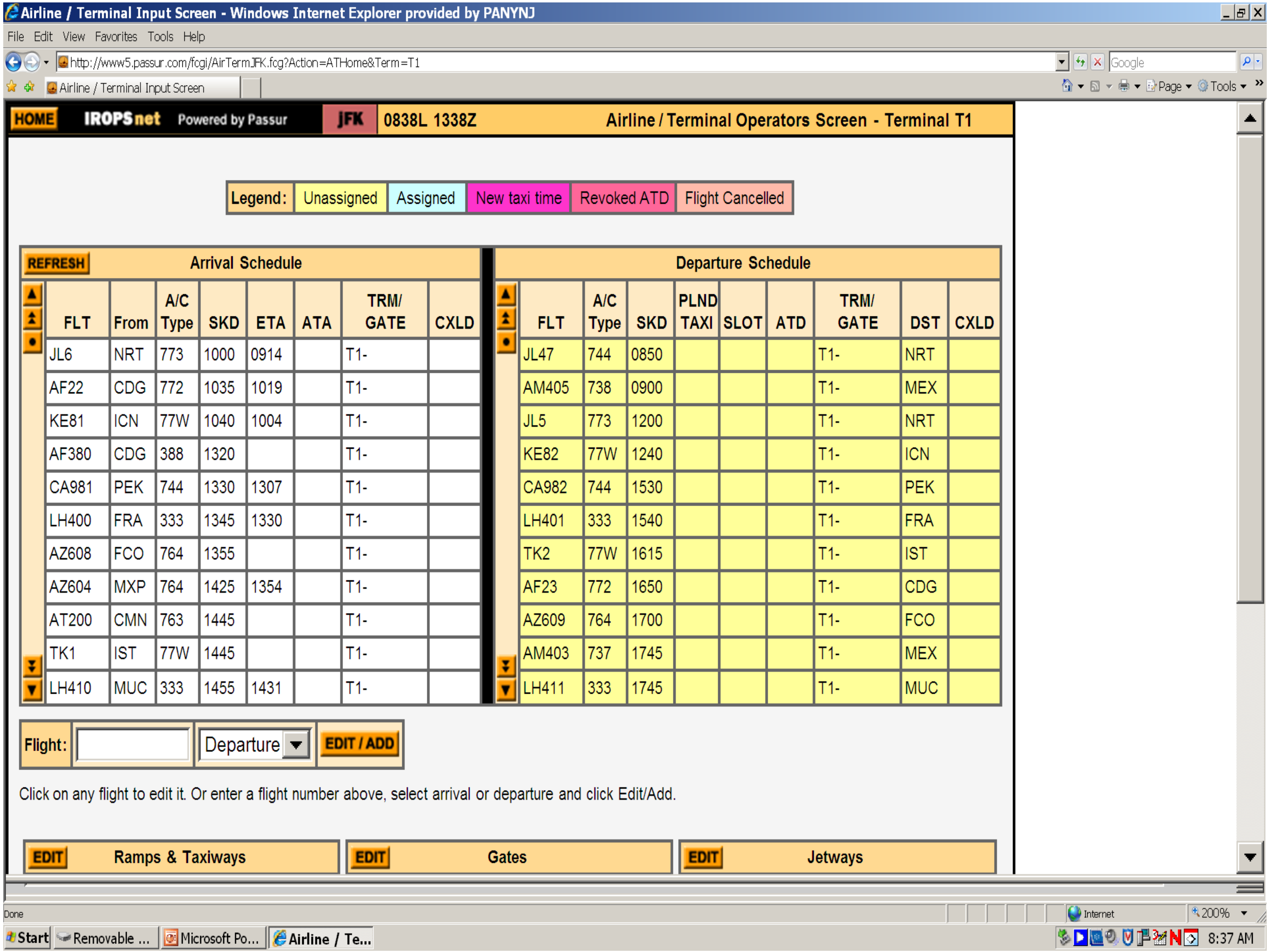
EDIT Departures by Airline (Scheduled / Allocated)

	Total / New Alloc Hourly	AAL	AAR	AFL	AFR	AIC	AJM	AMX	ANA	AUA	AVA
15:00	32/18	10/5.62	0/	0/	0/	0/	0/	0/	0/	0/	0/
16:00	38/28	6/4.42	0/	0/	0/	1/0.74	0/	0/	0/	0/	0/
17:00	39/28	9/6.46	0/	0/	1/0.72	0/	0/	1/0.72	0/	0/	0/
18:00	37/0	6/0.00	0/	0/	0/	0/	0/	0/	0/	1/0.00	0/
19:00	49/28	6/3.43	0/	0/	1/0.57	0/	0/	0/	0/	0/	0/
20:00	29/0	2/0.00	0/	1/0.00	0/	0/	0/	0/	0/	0/	0/
21:00	28/0	3/0.00	0/	0/	1/0.00	1/0.00	0/	0/	0/	0/	0/
22:00	25/0	5/0.00	0/	0/	0/	0/	0/	0/	0/	0/	0/
23:00	7/0	0/	0/	0/	1/0.00	0/	0/	0/	0/	0/	0/
Total Daily	528/	87/	2/	1/	4/	2/	3/	2/	1/	1/	2/

Slot Summary (Non Pool and Pool)

	AAL	DAL	JBU	Pool
15:00	10/6	10/6	9/5	3/2
16:00	6/4	13/10	11/8	8/6
17:00	9/6	14/10	6/4	10/7
18:00	6/	6/	10/	15/
19:00	6/3	27/15	7/4	9/5
20:00	2/	14/	6/	7/
21:00	3/	5/	10/	10/
22:00	5/	2/	8/	10/
23:00	0/	1/	2/	4/

Key Feature: Common Website for Airline Schedule Update



Airline / Terminal Input Screen - Windows Internet Explorer provided by PANYNJ

File Edit View Favorites Tools Help

http://www5.passur.com/fcgi/AirTermJFK.fcg?Action=ATHome&Term=T1

HOME IROPSnet Powered by Passur JFK 0838L 1338Z Airline / Terminal Operators Screen - Terminal T1

Legend: Unassigned | Assigned | New taxi time | Revoked ATD | Flight Cancelled

REFRESH Arrival Schedule

FLT	From	A/C Type	SKD	ETA	ATA	TRM/ GATE	CXLD
JL6	NRT	773	1000	0914		T1-	
AF22	CDG	772	1035	1019		T1-	
KE81	ICN	77W	1040	1004		T1-	
AF380	CDG	388	1320			T1-	
CA981	PEK	744	1330	1307		T1-	
LH400	FRA	333	1345	1330		T1-	
AZ608	FCO	764	1355			T1-	
AZ604	MXP	764	1425	1354		T1-	
AT200	CMN	763	1445			T1-	
TK1	IST	77W	1445			T1-	
LH410	MUC	333	1455	1431		T1-	

Departure Schedule

FLT	A/C Type	SKD	PLND TAXI	SLOT	ATD	TRM/ GATE	DST	CXLD
JL47	744	0850				T1-	NRT	
AM405	738	0900				T1-	MEX	
JL5	773	1200				T1-	NRT	
KE82	77W	1240				T1-	ICN	
CA982	744	1530				T1-	PEK	
LH401	333	1540				T1-	FRA	
TK2	77W	1615				T1-	IST	
AF23	772	1650				T1-	CDG	
AZ609	764	1700				T1-	FCO	
AM403	737	1745				T1-	MEX	
LH411	333	1745				T1-	MUC	

Flight: [ ] Departure EDIT / ADD

Click on any flight to edit it. Or enter a flight number above, select arrival or departure and click Edit/Add.

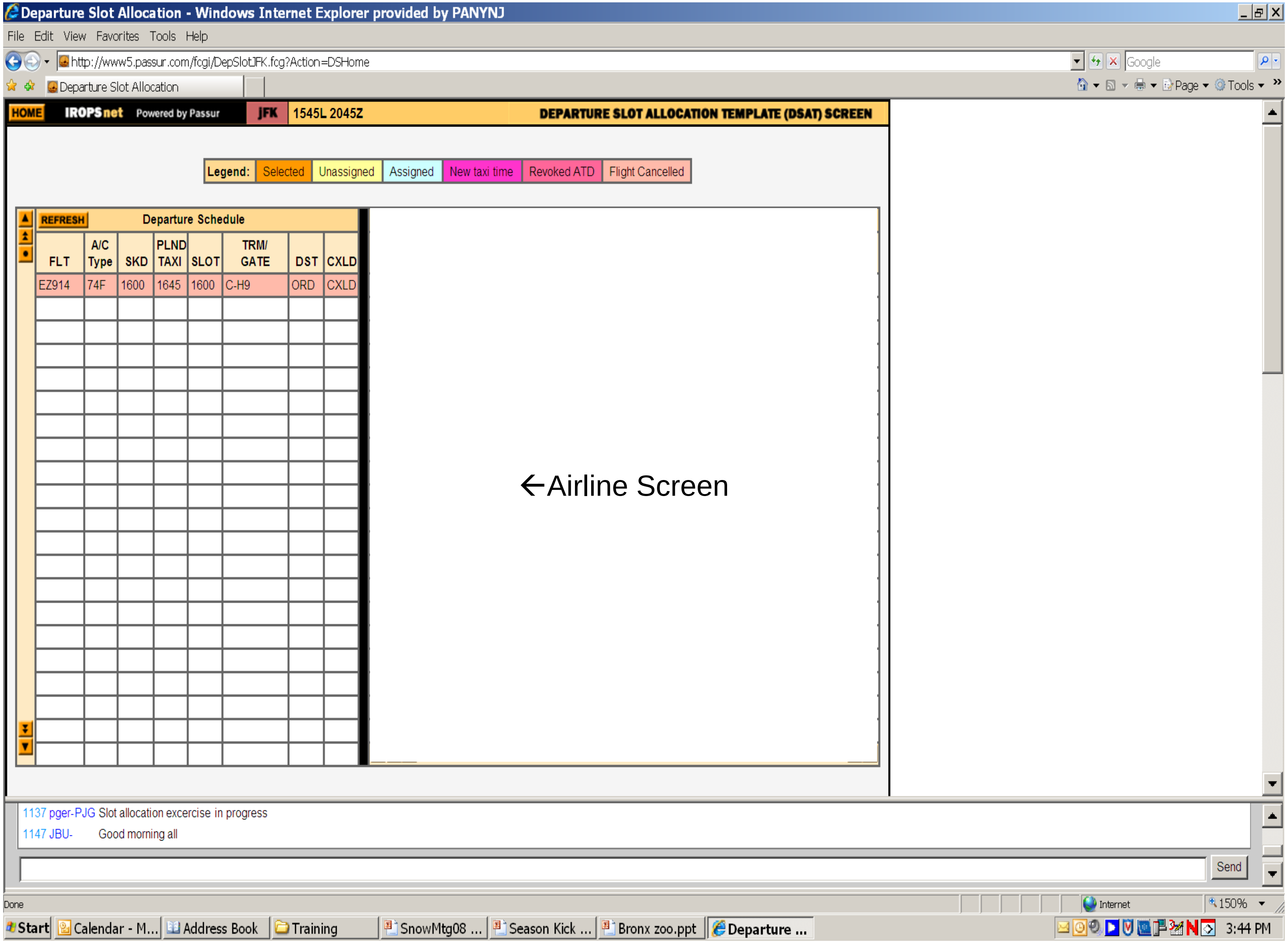
EDIT Ramps & Taxiways | EDIT Gates | EDIT Jetways

Done | Internet | 200%

Start | Removable ... | Microsoft Po... | Airline / Te... | 8:37 AM

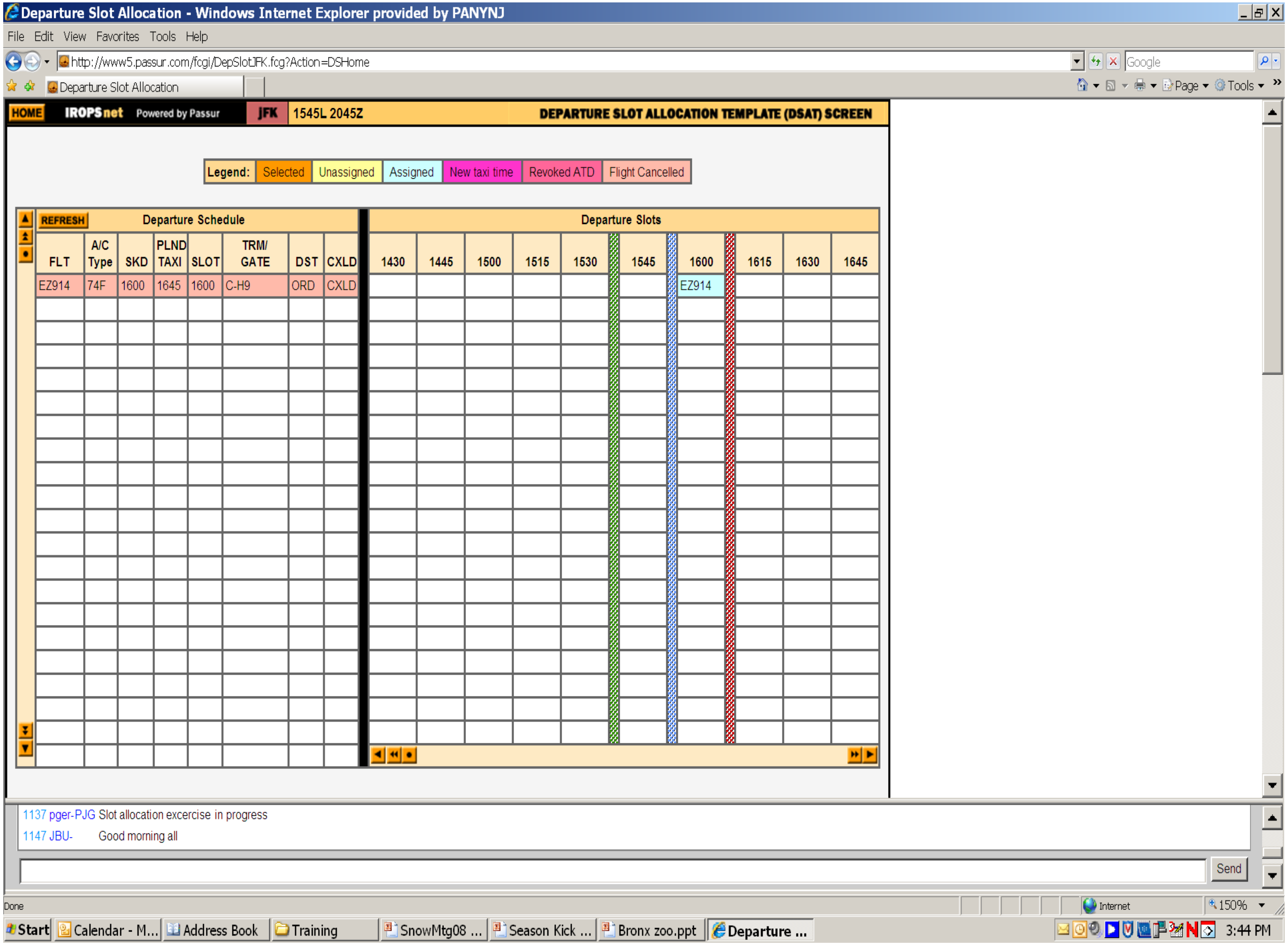
JFK Irrops System

Key Feature: Airline Assignment of Flights to Slots



JFK Irrops System

Key Feature: Coordinator Screen Where Slots Assigned



JFK Irrops System

Simulation of DMAN at PHL

Jan. 12, 2010

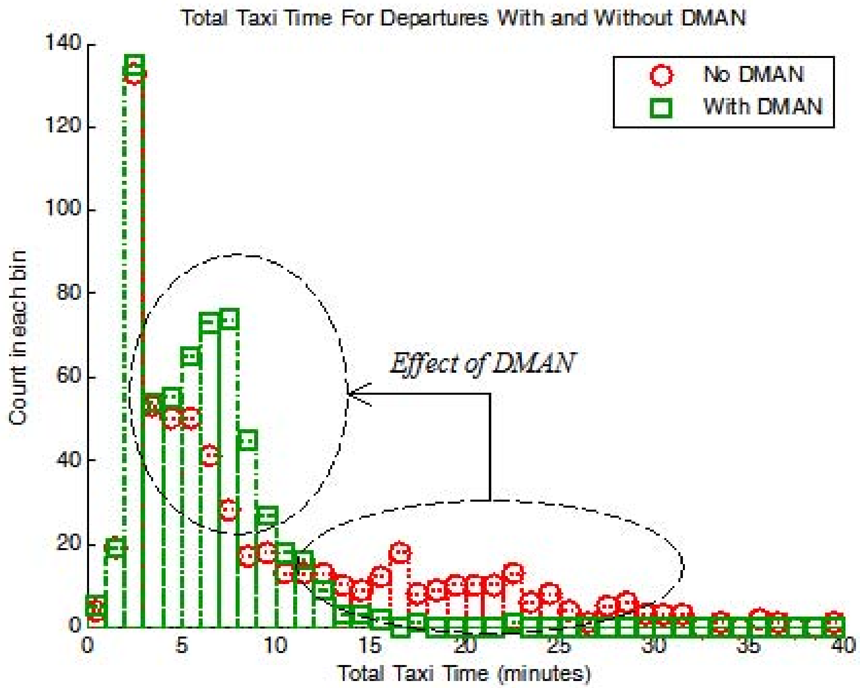
DMAN Simulation Description

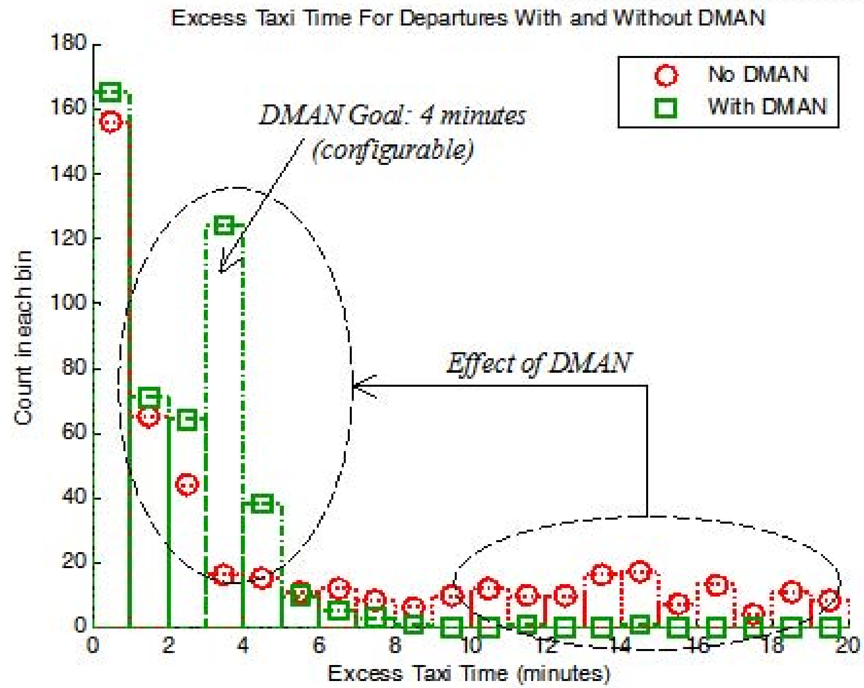
- Simulation of two scenarios:
  - No DMAN action. (Aircraft enter the movement area as soon as possible.)
  - With DMAN action. (Movement area entry is delayed.)
    - (Enter MA at last possible time minus 4 minutes.)
- Compare taxi times in the movement area between the scenarios.
  - Assume that when DMAN delays MA entry, the aircraft accepts the delay at the gate (engines off).
  - That is, assume ramp area taxi times are unchanged.
- Simulate one full day at PHL: Nov. 19, 2009

Sensis

Simulation of 1 day: Nov. 19, 2009

Effect of DMAN on Taxi Times





Total Taxi Time in MA for Departures

	No DMAN	With DMAN	Difference
Total	91.2 hrs	57.7 hrs	33.4 hrs
Mean	9.0 min/op	5.7 min/op	3.3 min/op
Std. dev.	7.9 min/op	3.1 min/op	4.8 min/op

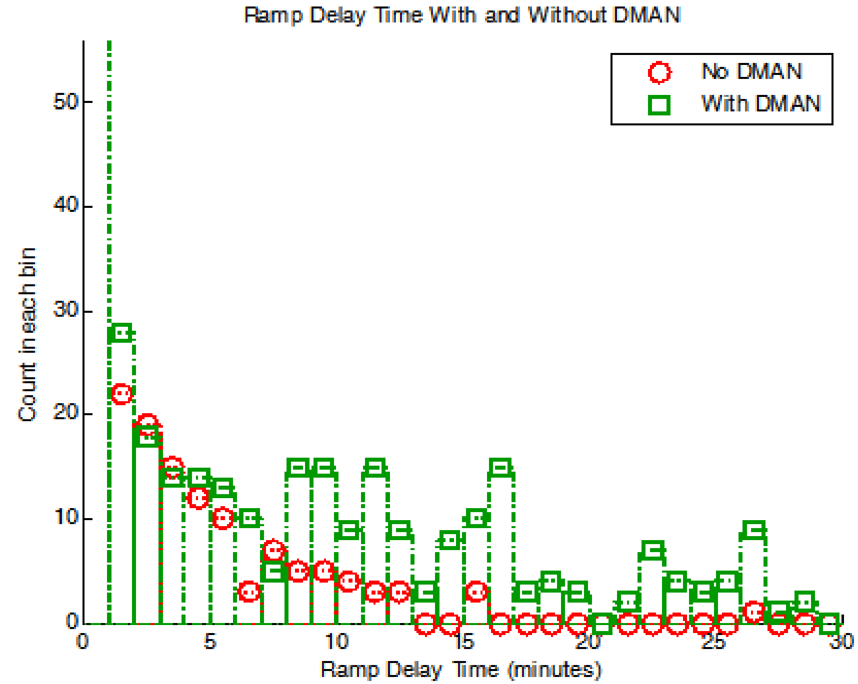
Excess Taxi Time in MA for Departures

	No DMAN	With DMAN	Difference
Total	51.6 hrs	18.2 hrs	33.4 hrs
Mean	5.1 min/op	1.8 min/op	3.3 min/op
Std. dev.	7.2 min/op	2.0 min/op	5.3 min/op

Simulation of 1 day: Nov. 19, 2009

Delay Time in the Ramp Area (At Gate)

- Reductions in movement area taxi times achieved by additional holding at the gate.
- Depends upon gate availability.
  - May send departure to a "holding area" if another flight needs the gate. (not simulated)



Ramp Delay Time for Departures

	No DMAN	With DMAN	Difference
Total	11.9 hrs	45.1 hrs	33.2 hrs
Mean	1.2 min/op	4.5 min/op	3.3 min/op
Std. dev.	3.9 min/op	7.6 min/op	3.6 min/op