

Objective and Automatic Estimation of Excess Taxi-Times

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Why Estimate Excess Fuel Cost

- Prior motivator: growth of demand, leading to congestion
- Current motivator: rising fuel costs
 - Airlines going out of business (Aloha, ATA, MLT, Eos)
 - Airlines consolidating (NWA/Delta)
 - Airlines in merger/alliance talks (COA/AA/BAA)
- Change focus
 - Improve operational efficiency
 - Reduce waste of fuel consumption
 - Maintain safety (just enough fuel)
 - Anticipate of future emissions constraints

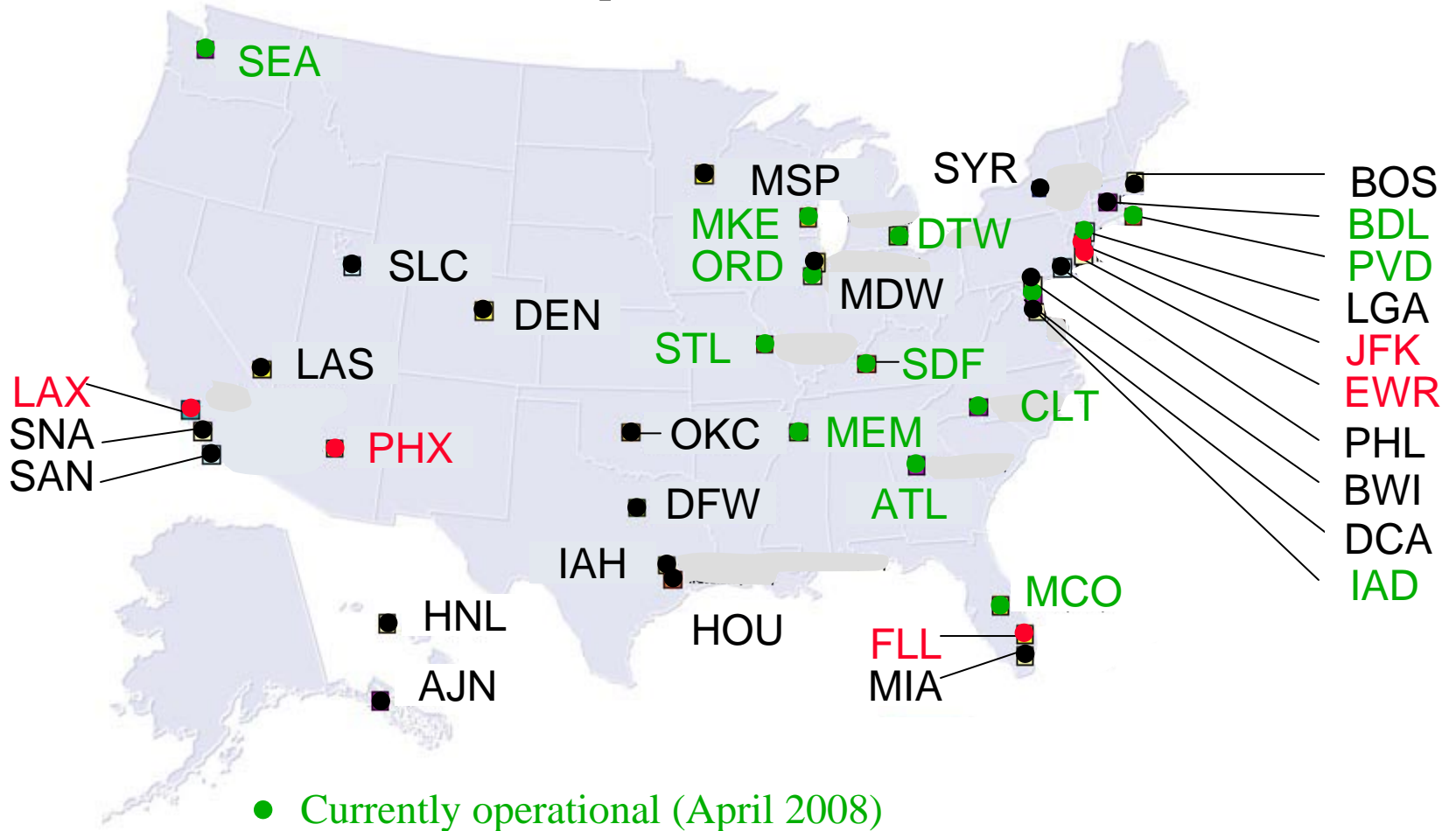
Main Points

- ASDE-X surveillance data is used to measure:
 - Movement area excess taxi-times
 - Excess fuel burn and cost
 - Excess emissions
- Data are summarized by:
 - Flight
 - Carrier
 - Airport
- Sensis Corporation has:
 - An automatic process to record, process, and measure
 - Developed algorithms and reporting summaries
 - Assumptions: movement area, one engine taxiing

What We Do

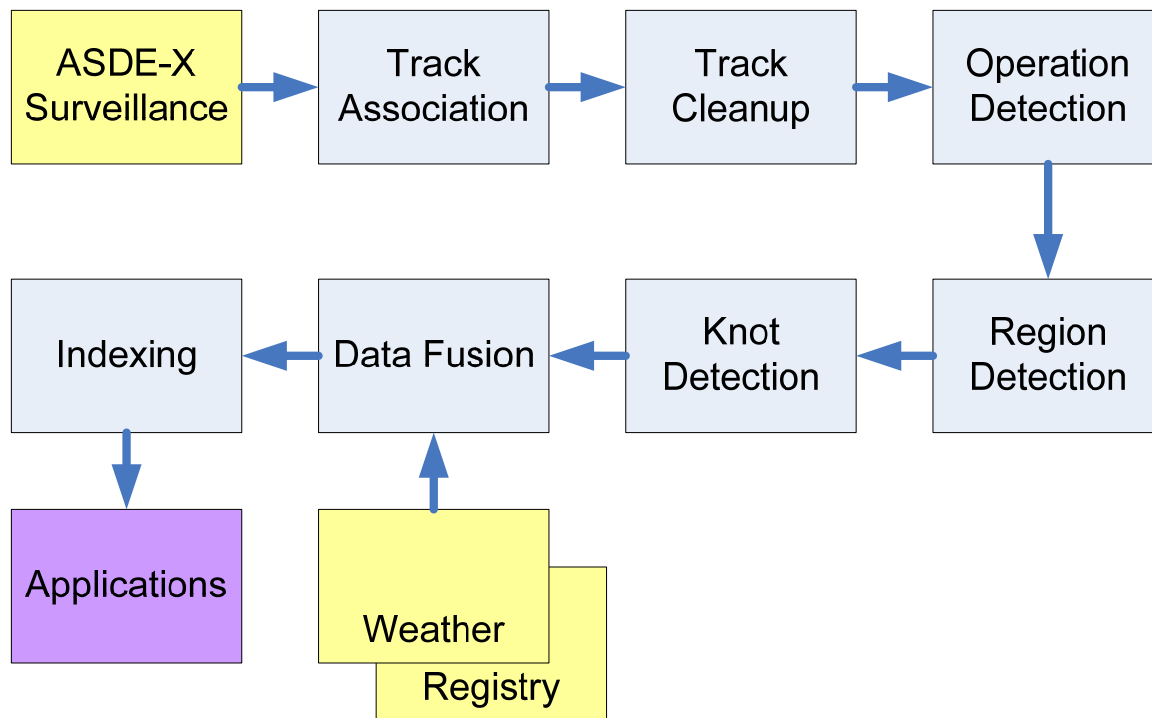
- Daily processing of ASDE-X surveillance data (FAA-fielded system)
- Current airport list
 - ATL, BDL, CLT, DTW, IAD, MCO, MEM, MKE, ORD, PVD, SDF, SEA, STL
 - Adding EWR, FLL, JFK, LAX, PHX in FY2008 (Federal Gov't)
- Construction of flight objects
- OOOI time measurement
- Taxi-time measurement
 - Movement area taxi times
 - Total taxi-time - Excess (holding) taxi-time = Minimum (unimpeded) taxi-time
 - Complete trajectory
 - Arrival: on-time to in-time
 - Departure: out-time to off-time
- Fuel burn and emissions measurement

ASDE-X Airports in the US

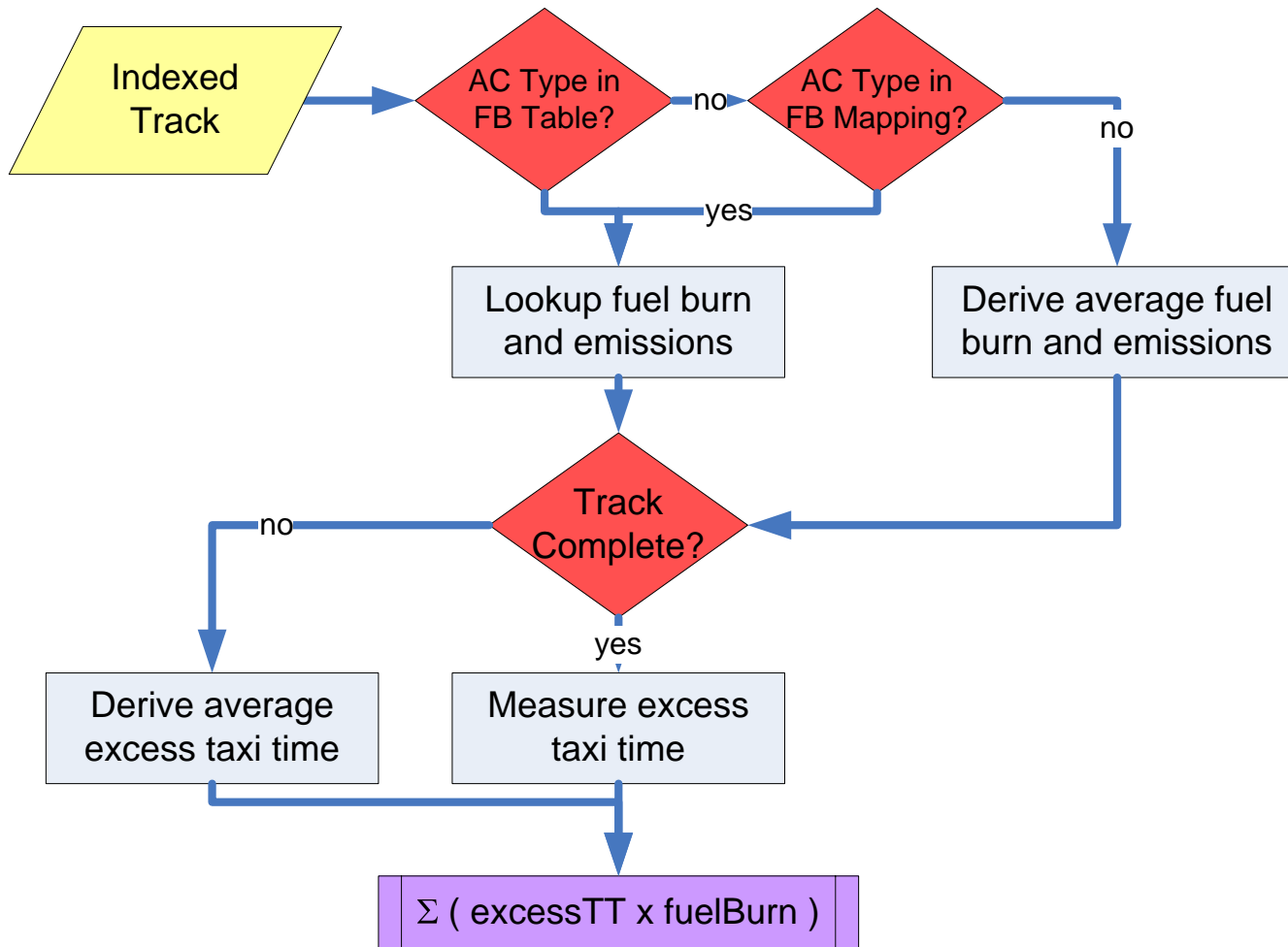


- Currently operational (April 2008)
- Scheduled operational (FY 2008, Fed. Gov.)
- Other ASDE-X sites

Data Processing Steps



Determination of Fuel Burn Rate



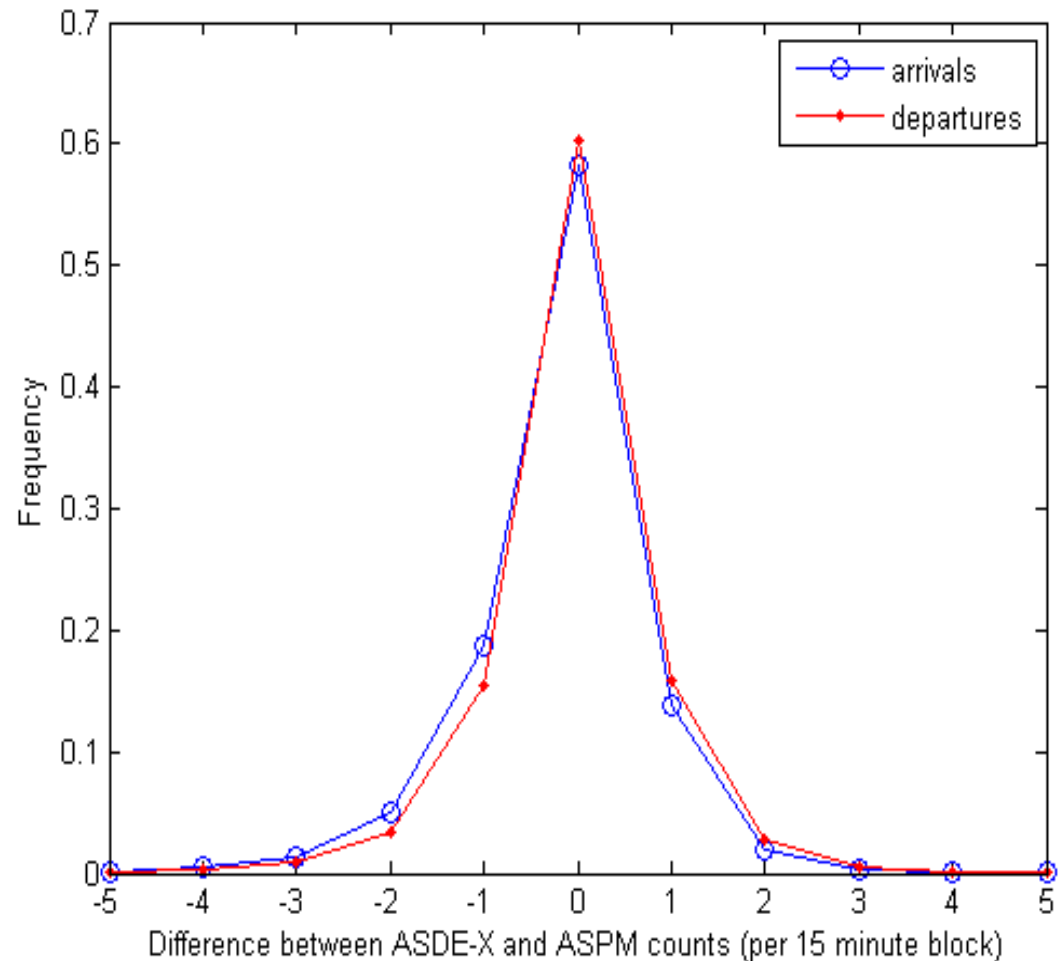
Validation: Operation Counts from ASPM and ASDE-X

- Data from 13 airports during January 2008
 - ASPM quarter-hour data

- Arrivals
 - 24,801 operations
 - $S_e = 0.92$ operations

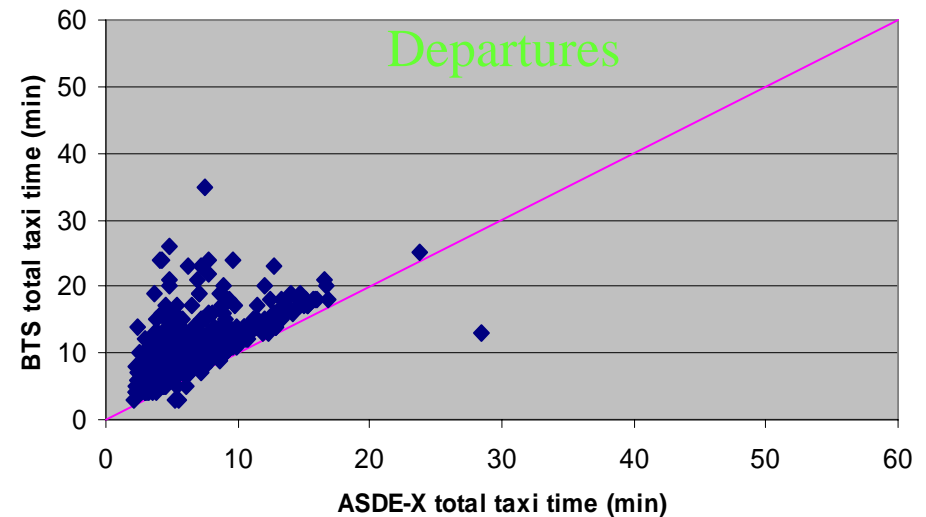
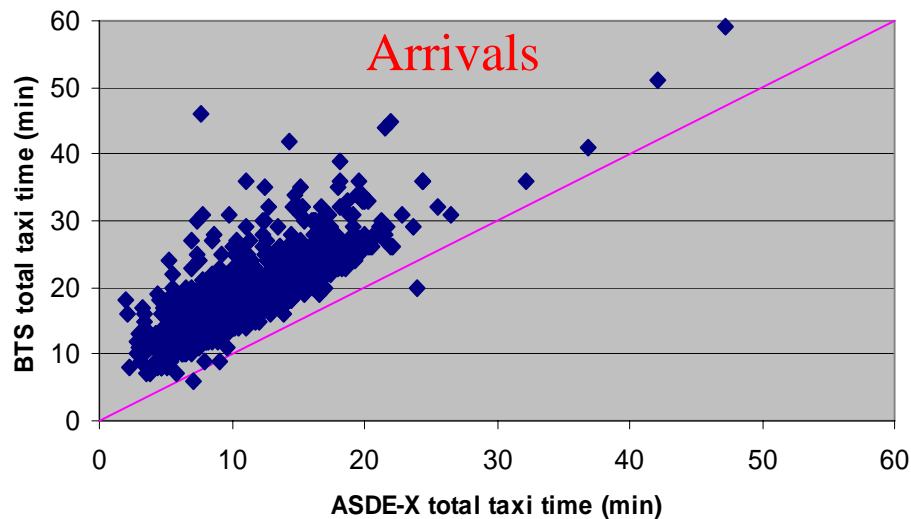
- Departures
 - 26,500 operations
 - $S_e = 0.91$ operations

- Difference between arrivals and departure counts
 - One in seven ASPM reports missing



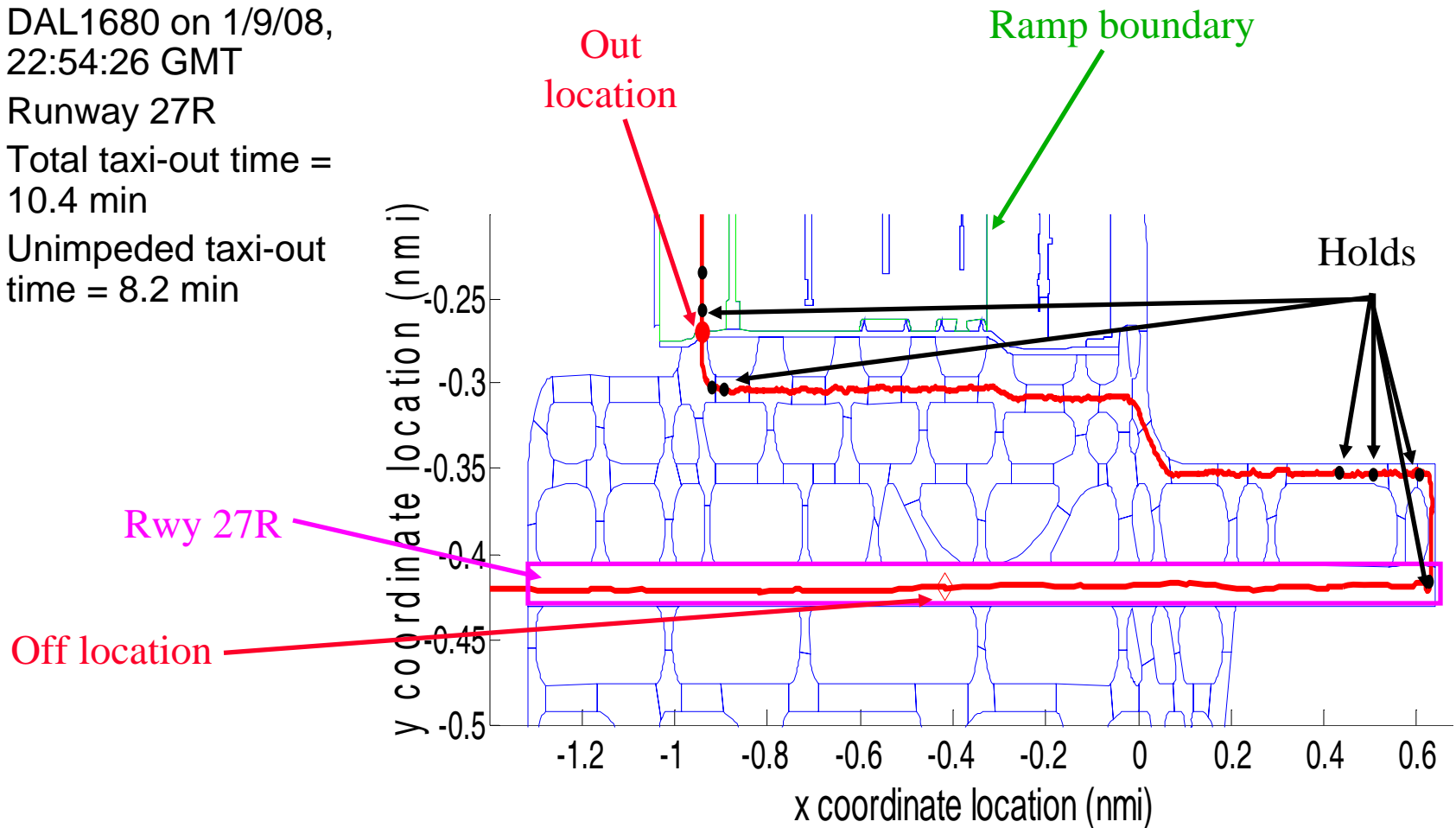
Total Taxi-Times for BTS and ASDE-X

- Arrivals and Departures at ATL, 1/9/08
 - Match on tail number and operation time (off, on)
- Coverage differences:
 - ASDE-X: movement area only; minimum taxi-time
 - BTS: movement and non-movement area; total taxi-time
- More delays in movement area for departures; smaller difference between BTS and ASDE-X measured taxi-times; **ASDE-X measurements are lower minima**



Definition of OOOI Events and Holds

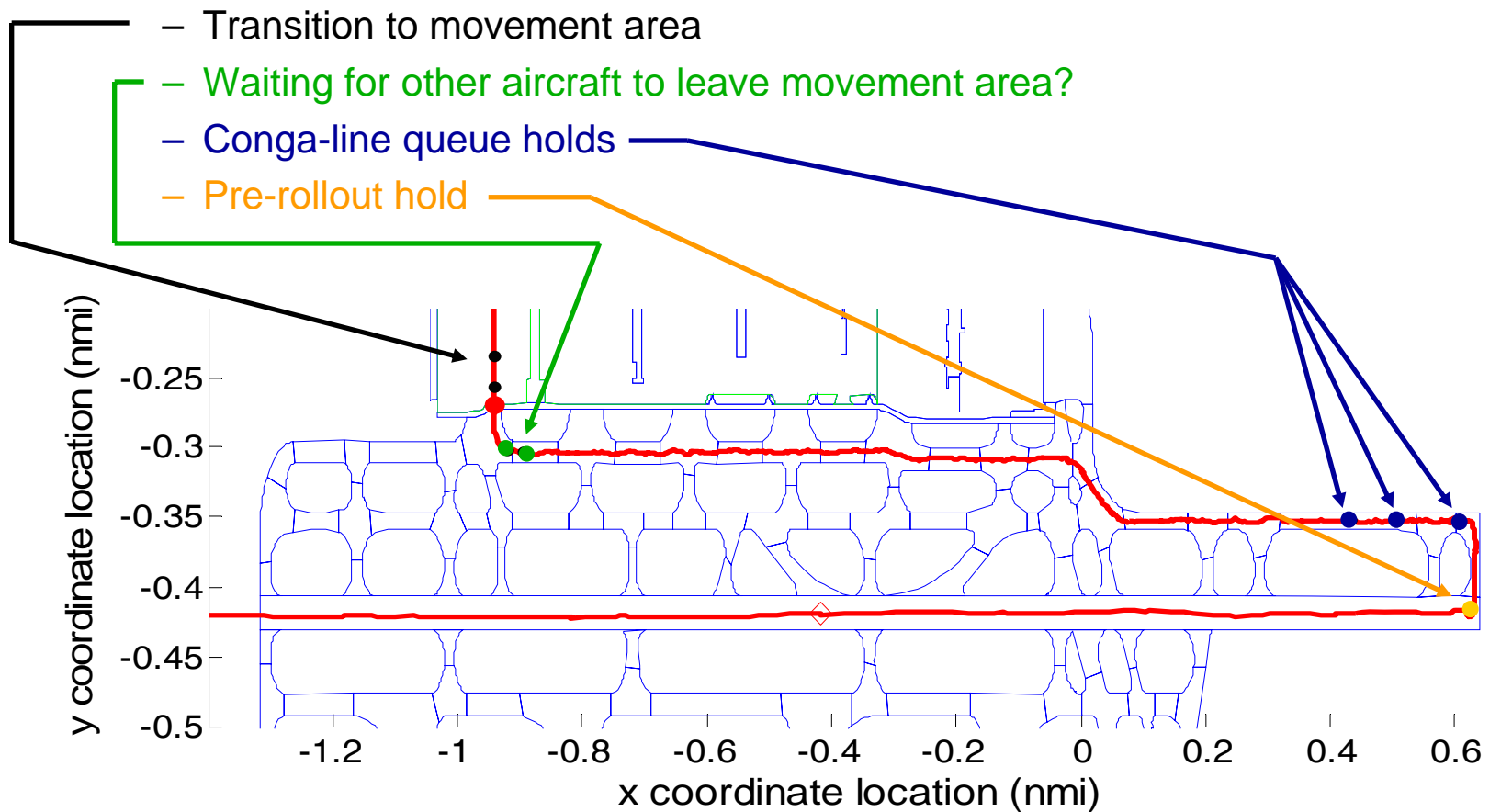
- Departure from ATL
 - DAL1680 on 1/9/08, 22:54:26 GMT
 - Runway 27R
 - Total taxi-out time = 10.4 min
 - Unimpeded taxi-out time = 8.2 min



Delay Attribution

“How Delays Occur”

■ Departure holds for DAL1680, categorized by:



Departure Operations Summary, ATL, January 5-31, 2008

- Average operation count: 1253 (\pm 134) departures per day

- Average excess taxi-out time: 6.86 min (\pm 2.32 min)

- Total excess fuel burned: 2,740,000 lbs

- Total excess fuel cost: \$1,980,000
 - AeroBahn, SMS, and ASDE-X system cost justification
 - Environmental impact reduction

- Average departure operational efficiency: 0.65 (\pm 0.08)
 - Excess taxi-out/total taxi-out time

Excess Fuel Cost Summary by Airport (Five largest on 1/8/08 GMT)

Arrivals

Rank	Airport	Operation	Excess Fuel		Annualized Excess Fuel (based on Jan 5-31, 2008)	
	Name	Count	Burned (lbs)	Cost (\$)	Burned (lbs)	Cost (\$)
1	ORD	1,154	48,200	34,900	16,530,000	11,950,000
2	ATL	1,340	47,300	34,200	13,770,000	9,960,000
3	MEM	511	6,000	4,400	2,190,000	1,580,000
4	SEA	437	5,800	4,200	1,420,000	1,030,000
5	CLT	666	5,600	4,000	1,820,000	1,320,000

Departures

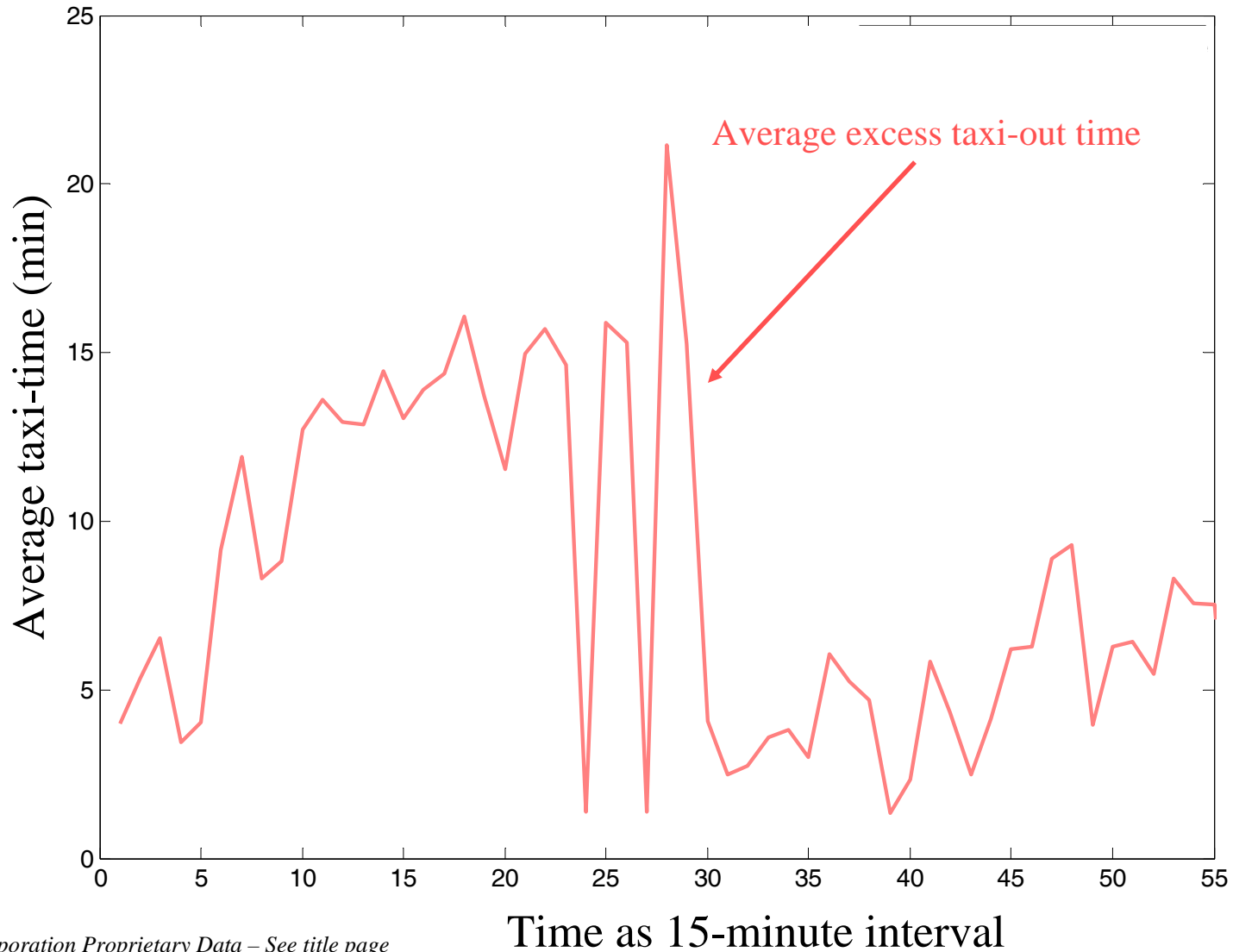
Rank	Airport	Operation	Excess Fuel		Annualized Excess Fuel (based on Jan 5-31, 2008)	
	Name	Count	Burned (lbs)	Cost (\$)	Burned (lbs)	Cost (\$)
1	ORD	1,128	197,000	124,500	28,370,000	20,520,000
2	ATL	1,328	131,800	95,300	37,020,000	26,770,000
3	MEM	525	70,000	50,500	16,380,000	11,850,000
4	CLT	648	61,000	43,800	21,610,000	15,630,000
5	IAD	529	31,000	22,400	10,320,000	7,470,000

Performance of the Three-Largest Carriers at ATL, 1/9/08 GMT

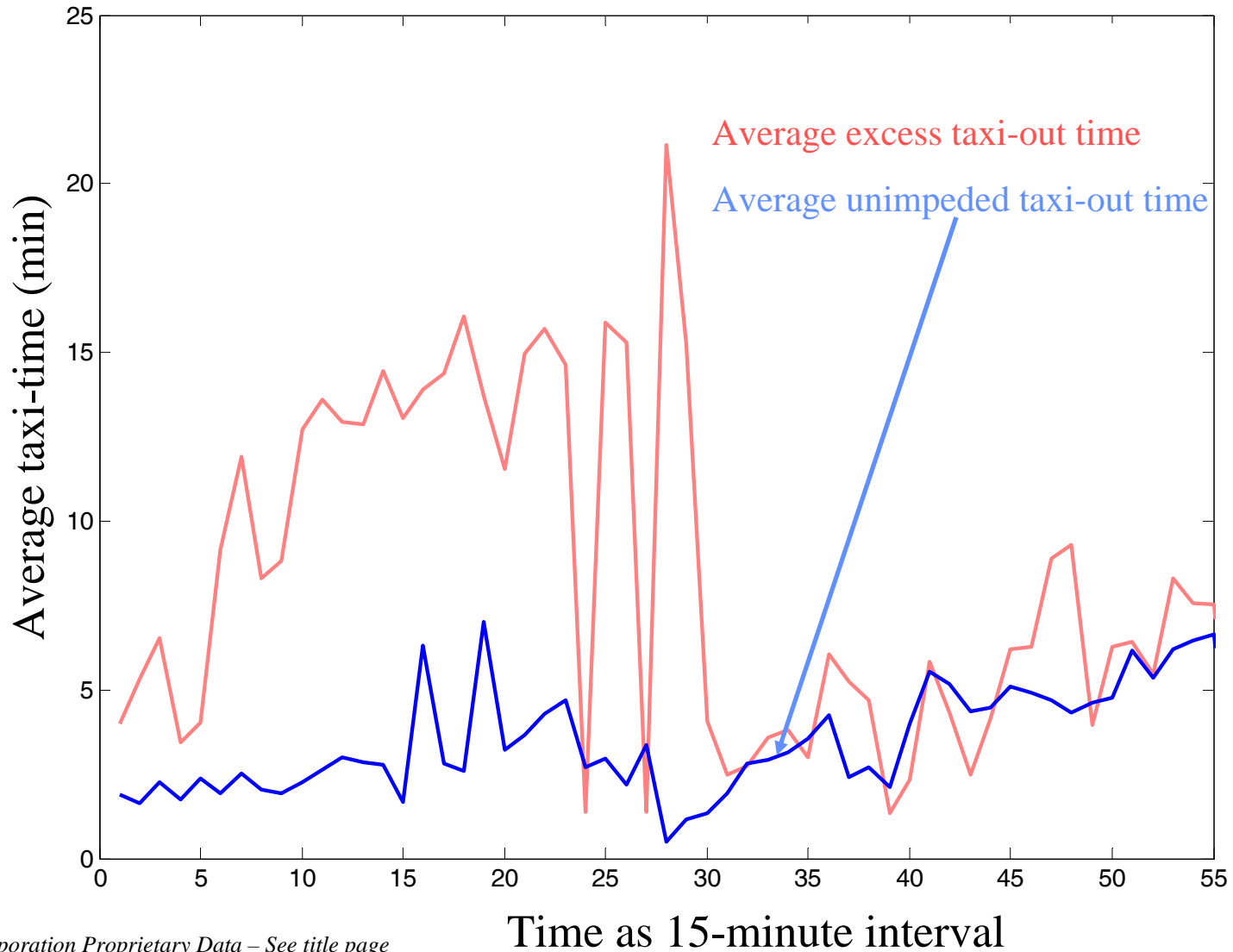
- Break-down summary by:
 - Carrier
 - Individual flight

Arrivals	Total Taxi-Time		Excess Taxi-Time		Excess /
Carrier_id	Mean	Std	Mean	Std	Total Ratio
21	7.2	4.0	2.5	3.2	0.35
6	6.5	2.8	3.4	2.4	0.52
45	7.3	3.7	3.2	3.7	0.44
Departures	Total Taxi-Time		Excess Taxi-Time		Excess /
Carrier_id	Mean	Std	Mean	Std	Total Ratio
21	11.1	5.4	6.9	4.8	0.62
6	11.2	5.2	8.4	5.0	0.75
45	10.3	4.8	6.5	4.3	0.63

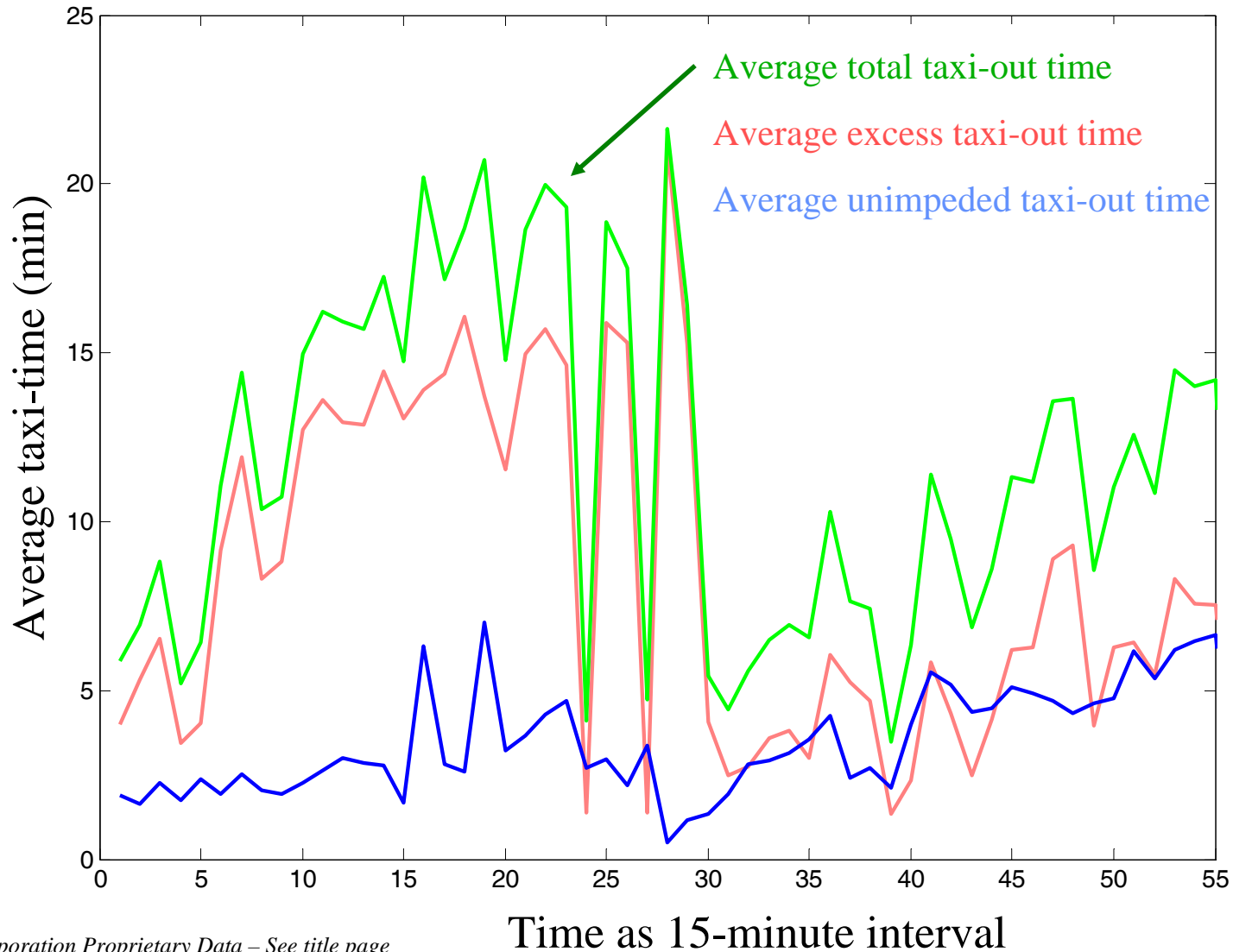
Average **Excess** Taxi-Out Time at ATL Changes with Time of Day, 1/9/08



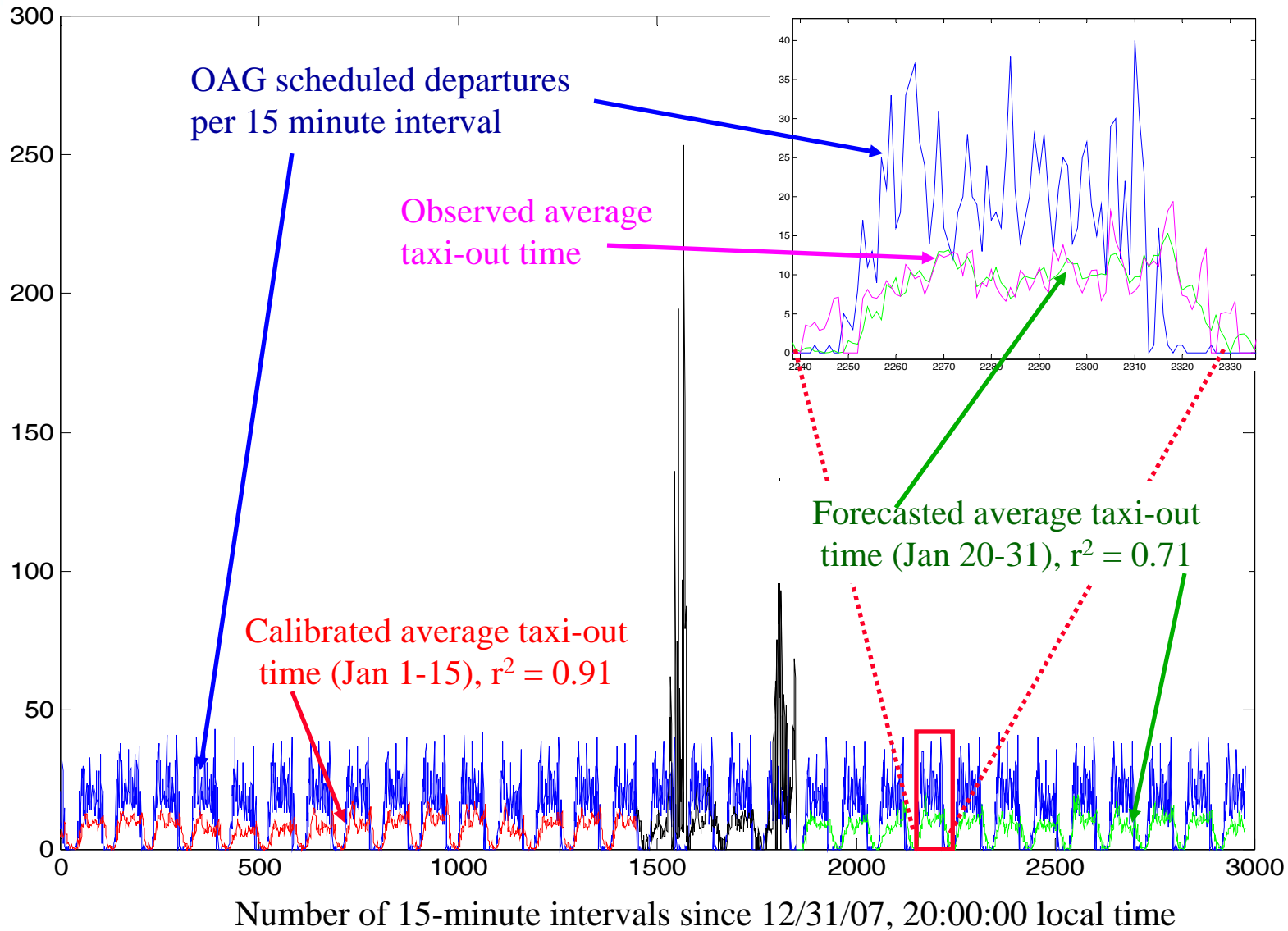
Average **Unimpeded** Taxi-Out Time at ATL Also Increases During the Day



Average **Total** Taxi-Out Time is Mostly Due to Excess Taxi-Out Time



Forecast Average Taxi-Out Time (January 2008, ATL)



Going Forward

- 3Ms
 - Measure the data
 - Monitor the conditions
 - Mentor the system
- Adding more airports
- Automatic metrics generation
 - Web-delivered content, etc.
- Additional metrics
 - Delay attribution
 - Runway occupancy time, runway threshold inter-arrival time
- Validation
 - Additional checks against BTS statistics
- Extend measurement to include non-movement area operations given to-gate surveillance coverage

What We Can Do for You

- Airlines (e.g., NWA)
 - Reduce fuel excess fuel consumption
 - Better schedule adherence
- Airports (e.g., DTW)
 - Environmental emissions monitoring
 - Construction business case justification
 - Improved economic
- ANSPs (e.g., FAA)
 - Delay reduction
- Annualized cost of excess fuel consumed in movement area
 - Six airports (ORD/ATL/MEM/SEA/CLT/IAD)
 - Arrivals: 35 x 10⁶ lbs excess fuel burned (\$26 x 10⁶)
 - Departures: 114 x 10⁶ lbs excess fuel burned (\$82 x 10⁶)