
Assessment of Impacts of JFK Departure Metering Program

Tom G. Reynolds (tgr@mit.edu)
Alex Nakahara (alexhn@mit.edu)



Massachusetts
Institute of
Technology



PASSUR Aerospace User Conference
Nashville, TN
June 24, 2011



- **Why is MIT involved?**
- **What is “Departure Metering” and why is it needed?**
- **What is the JFK Departure Metering Program?**
- **What are the impacts of the JFK Departure Metering Program?**

Why is MIT Involved?



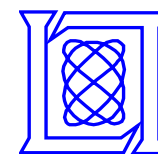
**MIT International Center
for Air Transportation**

Exploring methods to
improve efficiency of air
transport system



**Partnership for Air Transportation
Noise and Emissions Reduction**

Understanding and
mitigating environmental
impacts of aviation



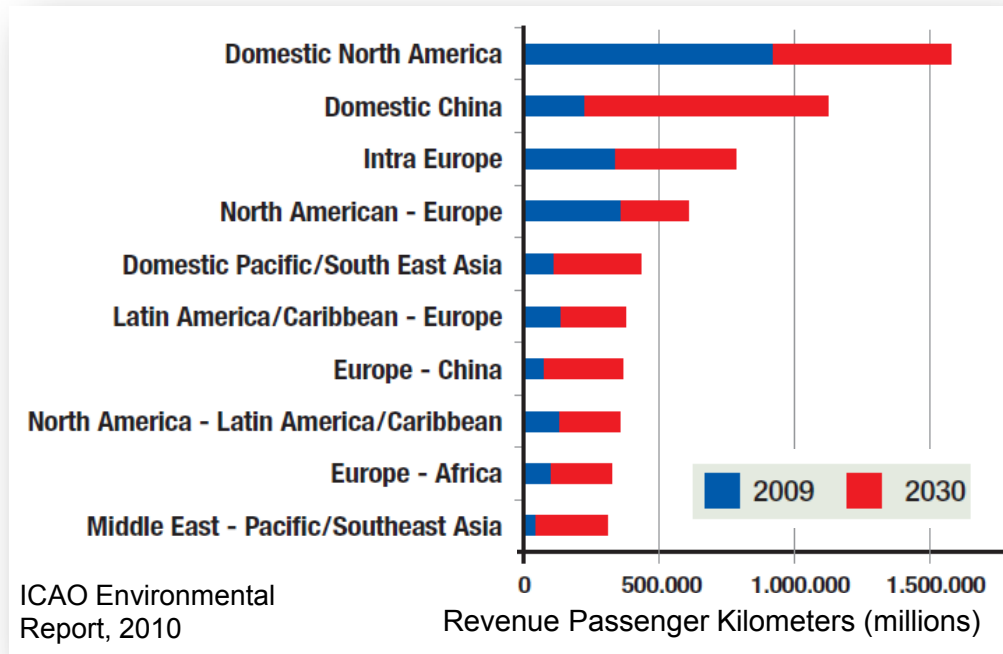
MIT Lincoln Laboratory

Prototyping and benefits
assessment of advanced
air traffic control systems

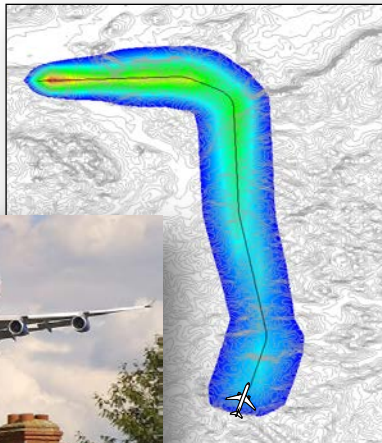


A Key Challenge for Commercial Aviation in the 21st Century

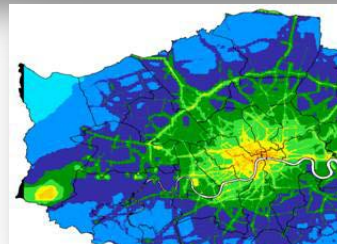
- Meeting demand for air transportation...
- while reducing environmental impacts



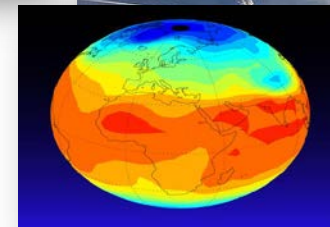
Noise



Air Quality

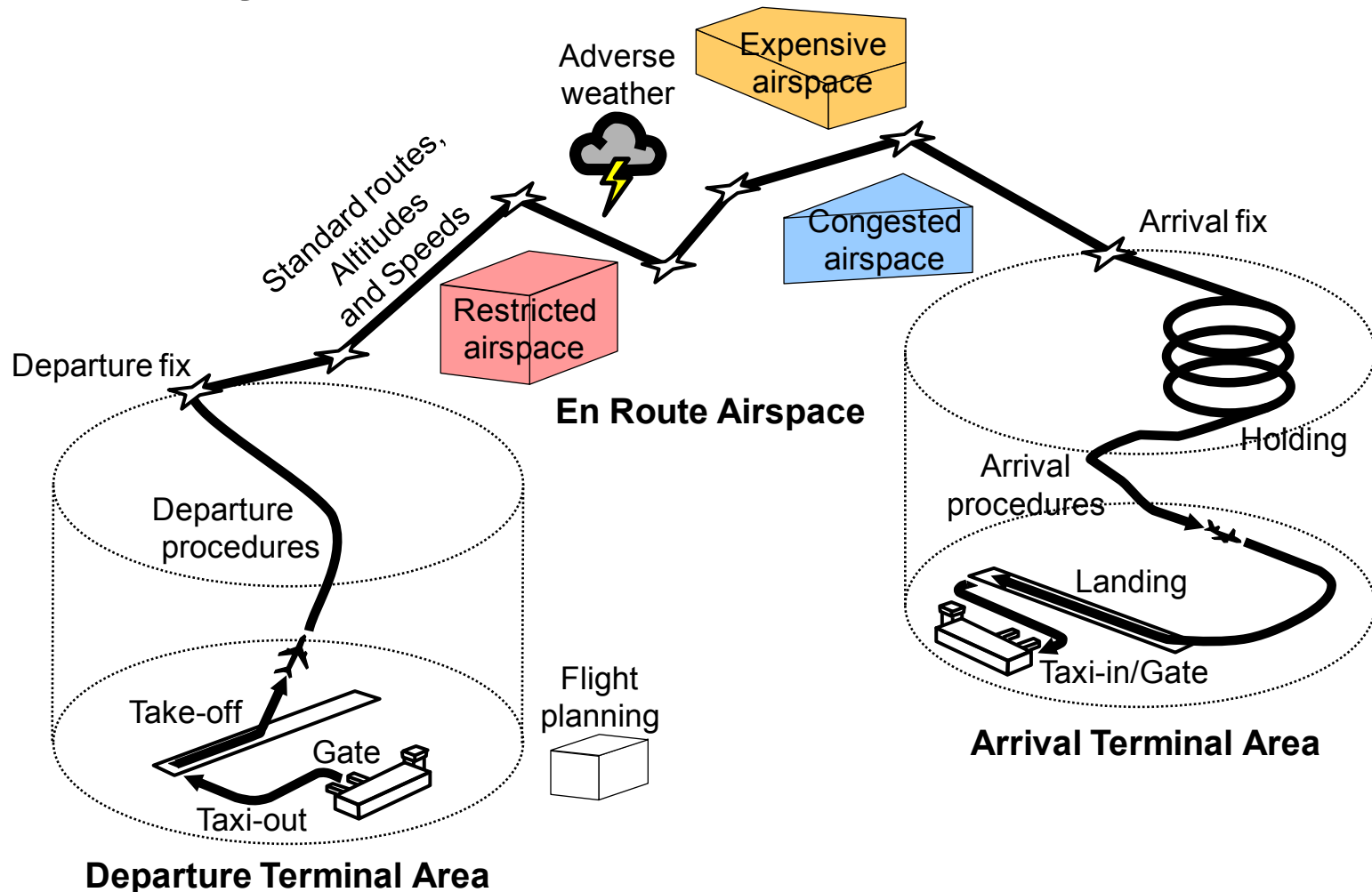


Climate



Air Transportation Inefficiencies

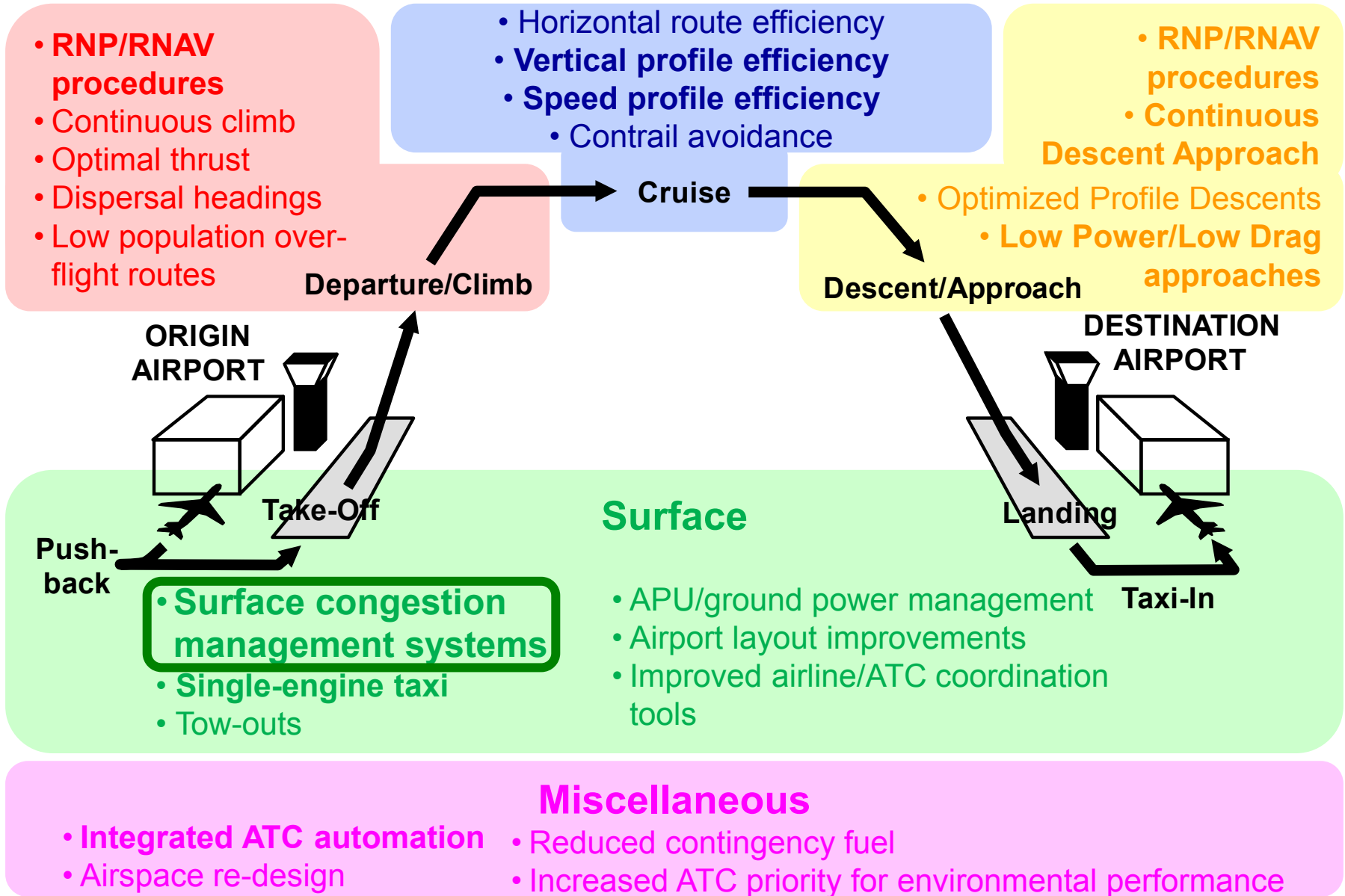
- Advanced operations have potential to address some air transport inefficiencies *relatively quickly* (compared to other mitigations) *with existing fleet*





“Gate-to-Gate” Operational Mitigations

MIT current focus areas in bold

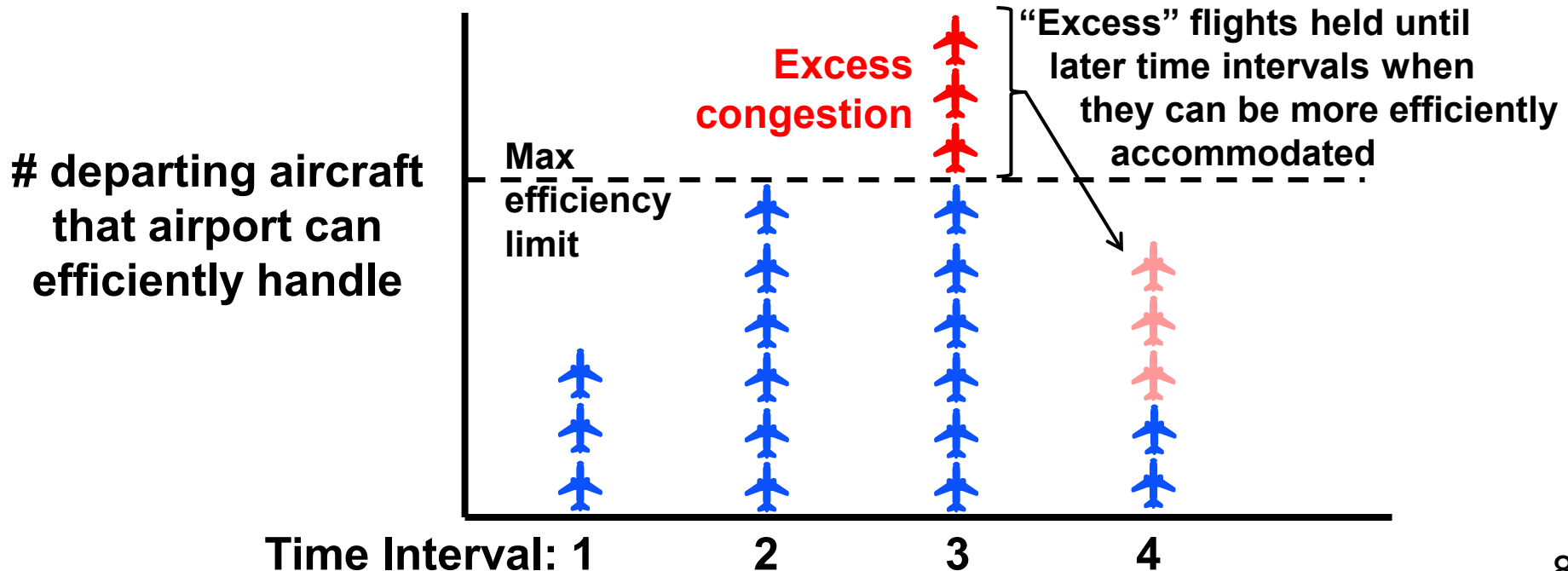


- Why is MIT involved?
- **What is “Departure Metering” and why is it needed?**
- What is the JFK Departure Metering Program?
- What are the impacts of the JFK Departure Metering Program?



Departure Metering = Element of Surface Congestion Management





- Surface congestion => increased taxi times, fuel burn & emissions
- Annually, at major airports in the United States (2009 ASPM)
 - Over 32 million mins taxi-out delay (over unimpeded times)
 - 130 million gallons excess taxi fuel => \$260-390 million @ \$2-3/gallon
- Departure metering can help:





Implementing Departure Metering

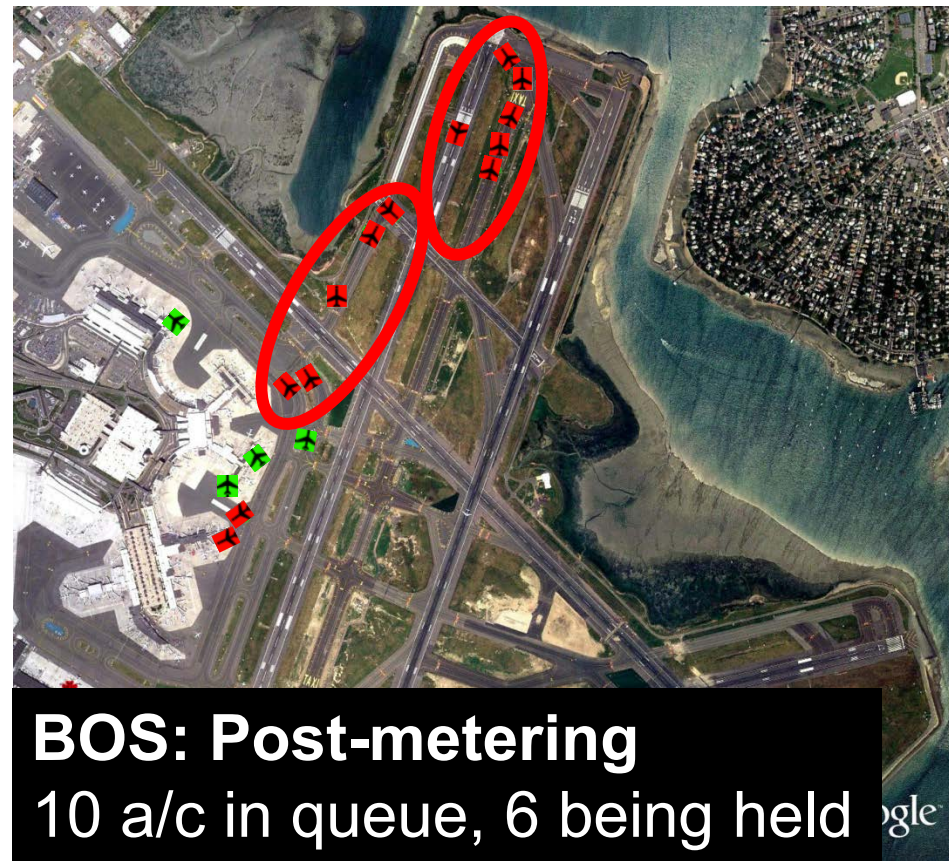
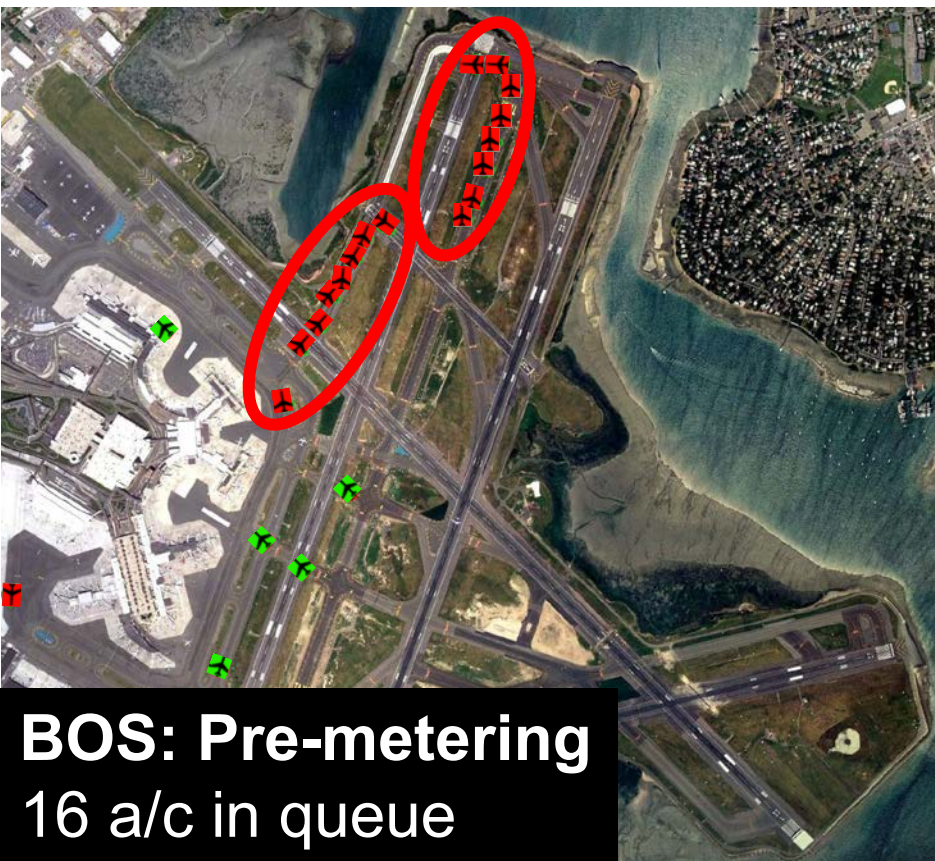
- Specifics of implementing metering concept depends on airport characteristics and level of sophistication desired

| Implementation | Currently being tested at/by: |
|---|---|
| Inform ATC of max efficiency limit, ATC determines who pushes when | Boston (BOS) “Pushback rate control”  |
| Allocate quotas to airlines, who then allocate flights within quota | Memphis (MEM) Orlando (MCO) “CDQM”  |
| Allocate push times to specific flights with airline collaboration | New York (JFK)   |



Departure Metering Concept

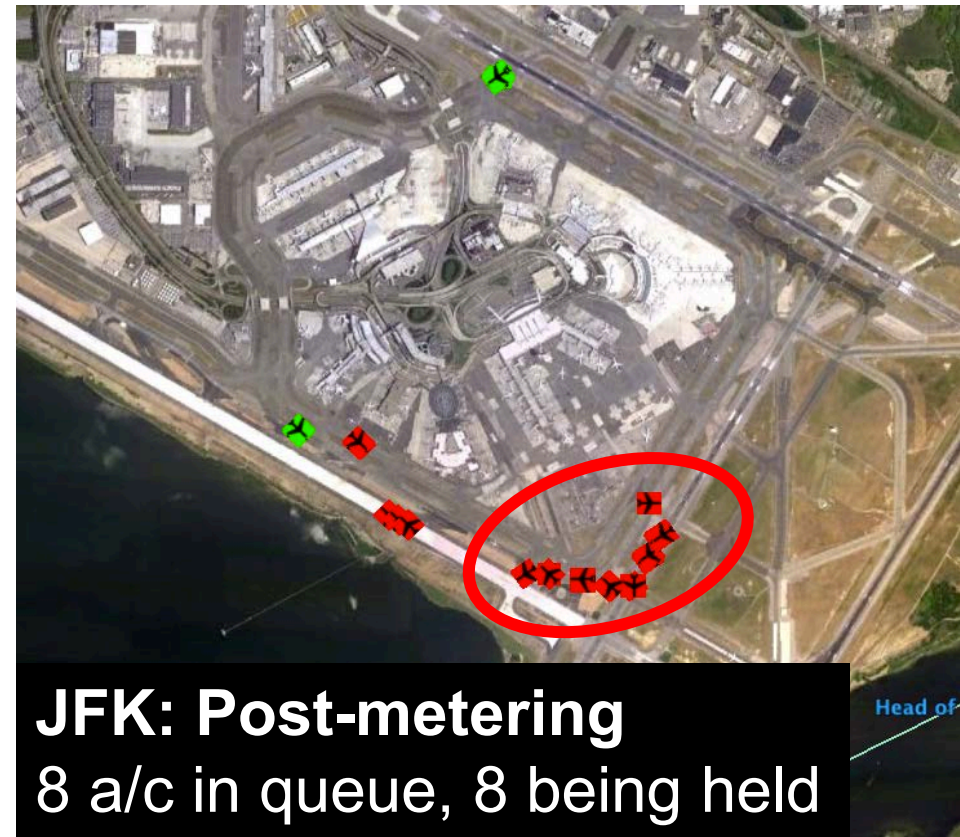
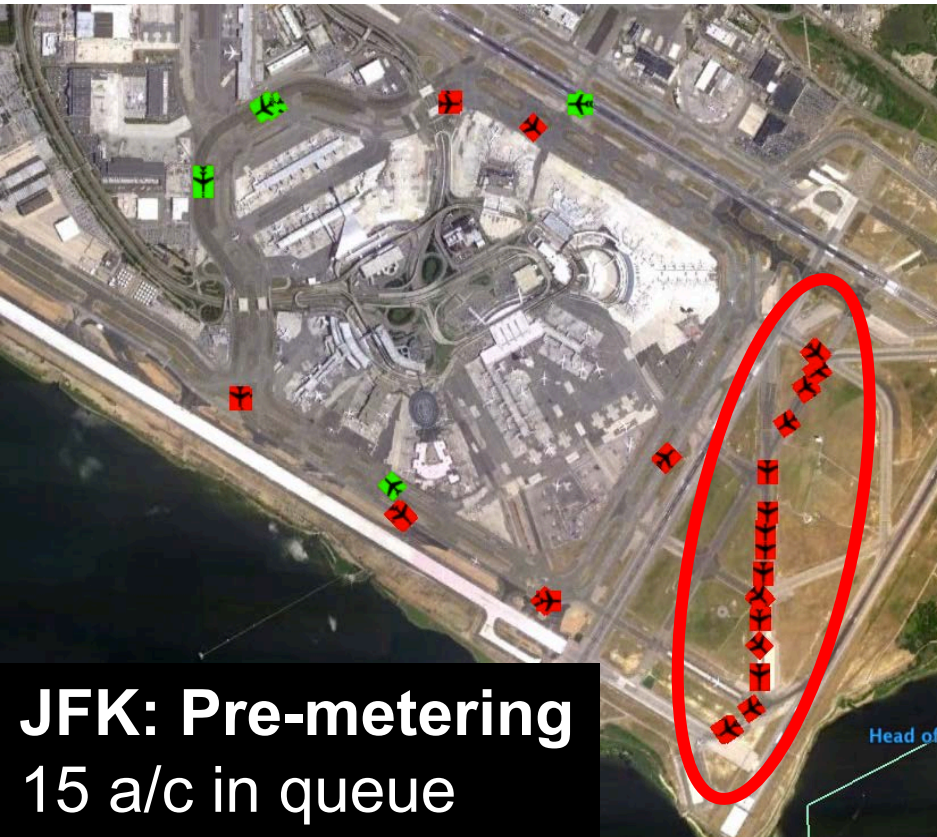
- At times of high congestion, hold “excess” aircraft at gate or other designated area (ideally with engines off) to reduce surface congestion & fuel burn while not adversely affecting wheels off or airport throughput





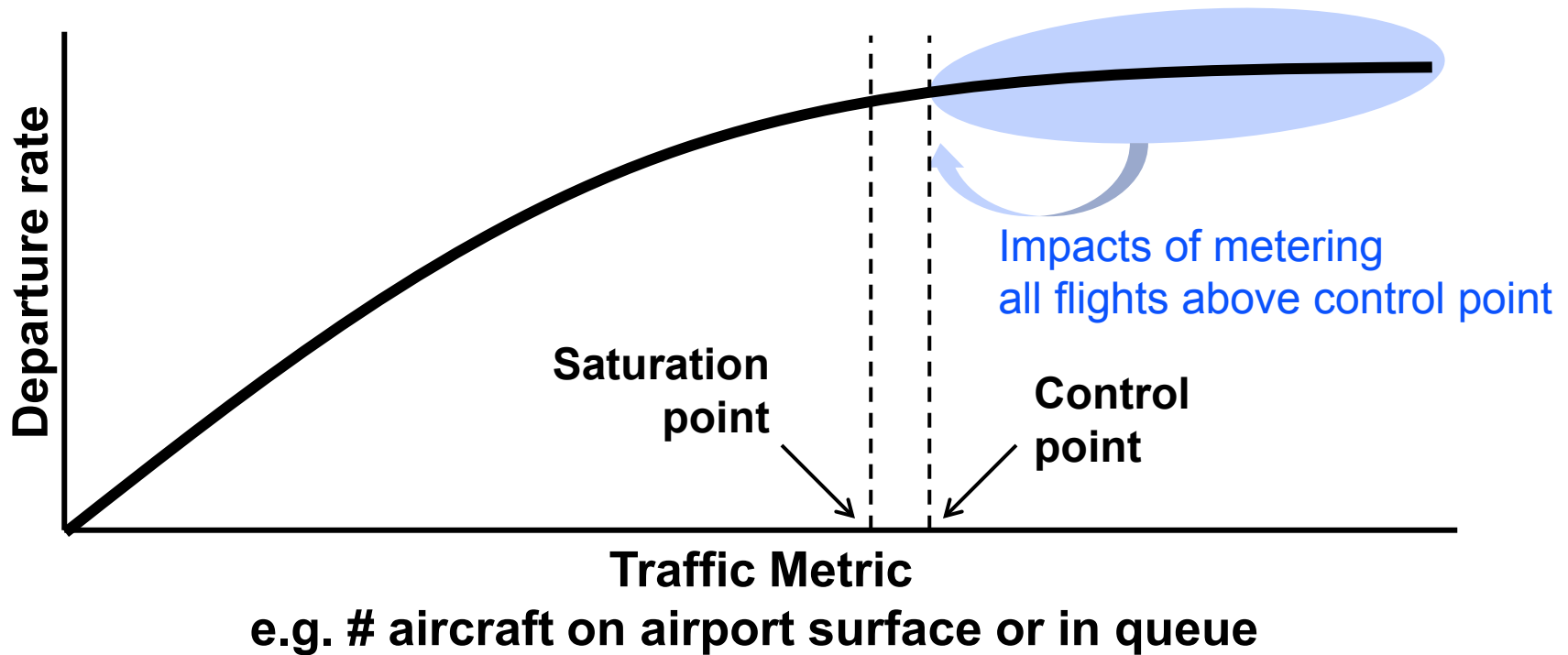
Departure Metering Concept

- At times of high congestion, hold “excess” aircraft at gate or other designated area (ideally with engines off) to reduce surface congestion & fuel burn while not adversely affecting wheels off or airport throughput



Departure Metering Concept

Airport X, Configuration Y, Condition Z



- Why is MIT involved?
- What is “Departure Metering” and why is it needed?
- **What is the JFK Departure Metering Program?**
- What are the impacts of the JFK Departure Metering Program?



What is the JFK Departure Metering Program?

- **Goals of the Program:**
 - **Reduce fuel burn**
 - Reduce air emissions
 - Reduce cost
 - Reduce fuel load
 - **Enhance the passenger experience through fewer and shorter onboard delays**
- **History:**
 - **2002: JFK/LGA begin early form of departure metering for deicing operations**
 - **2002-2010: fourteen other airports adopt the same program for deicing and/or field condition reporting**
 - **February 2010: JFK expands the departure metering program (software and processes) to full-time to address five month runway closure**
 - **July 2010: JFK runway reopens, airlines unanimously elect to continue departure metering at JFK**



JFK Departure Metering Process

- **Collaborative process involving all carriers**
- **Utilizes a “Virtual Queue” (VQueue™)**
 - **Departures allocated and sequenced based on schedule, actual demand, and actual capacity**
 - **Delays taken at gate/“metering area” rather than active queue**
 - **Aircraft “delivered” to tower with less congested path to runway**
- **Process**
 - **Departure plan submitted and/or modified by carriers**
 - **Automated slot management based on “ration by schedule”**
 - **PASSUR assesses:**
 - **Predicted and current system performance (airspace & surface)**
 - **Rates set by tower**
 - **Arrival operation status**
 - **Departure demand & capacity**



JFK Departure Metering Process

| HOME | | IROPS net | | Powered by Passur | | JFK | | 1515L 1915Z | | DEPARTURE SLOT ALLOCATION TEMPLATE (DSAT) SCREEN | | | | | | | | | |
|------------------------------|----------|-------------|-----------|---------------------------------------|-----------|---------|---------------|-----------------------|-----------------------|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------|--|
| Flight: <input type="text"/> | | Find Flight | | Sort Slot Columns: In Order Allocated | | Legend: | | Selected | | Unassigned | | Assigned | | New taxi time | | Revoked ATD | | Flight Cancelled | |
| REFRESH Departure Schedule | | | | | | | | Departure Slots | | | | | | | | | | | |
| FLT | A/C Type | SKD | PLND TAXI | SLOT | TRM/ GATE | DST | DEP FIX/ CXLD | 1400 L 1800 Z 0 | 1415 L 1815 Z 0 | 1430 L 1830 Z 0 | 1445 L 1845 Z 0 | 1500 L 1900 Z 3 | 1515 L 1915 Z 3 | 1530 L 1930 Z 9 | 1545 L 1945 Z 7 | 1600 L 2000 Z 7 | 1615 L 2015 Z 7 | | |
| B681 | 320 | 1510 | 1515 | 1515 | T5- | FLL | WAVEY | | | | | AA577:R | B681:V | UA29:R | DL721:R | DL80:M | DL6019:R | | |
| B6137 | 320 | 1517 | 1522 | 1515 | T5- | RSW | RBV | | | | | AA4146:R | B6137:R | DL6567:C | AA4172:R | B66:N | AA4403:V | | |
| UA29 | 757 | 1530 | 1525 | 1530 | T7-7-10 | LAX | RBV | | | | | N535FX: | DL6031:D | DL6557:V | AA611:V | DL6482:V | B643: | | |
| AA85 | 763 | 1520 | 1525 | 1530 | T8-8-5 | SFO | RBV | | | | | | | DL6703:R | AA3944:R | AA133:R | US17:R | | |
| DL6031 | ERJ | 1520 | 1525 | 1515 | T2-23J | PHL | DIXIE | | | | | | | B6835:S | AA1687:V | DL6364:N | MX5:R | | |
| DL6567 | CRJ | 1525 | 1530 | 1530 | T2-23A | PIT | COATE | | | | | | | B6709:S | B69:V | DL209:V | LH401:M | | |
| DL6557 | CR9 | 1525 | 1530 | 1530 | T2-25Q | DCA | WAVEY | | | | | | | AA1917:V | DL2738:R | DL1687:V | DL5881: | | |
| DL6703 | CRJ | 1525 | 1530 | 1530 | T2-25M | CLE | RBV | | | | | | | AA4618:M | | | | | |
| B6835 | 320 | 1529 | 1534 | 1530 | T5- | STI | SHIPP | | | | | | | AA85:R | | | | | |
| B6709 | 320 | 1529 | 1534 | 1530 | T5- | SJU | SHIPP | | | | | | | | | | | | |
| AA4618 | ER3 | 1530 | 1535 | 1530 | T8- | BOS | MERIT | | | | | | | | | | | | |
| DL721 | 752 | 1530 | 1535 | 1545 | T2-2-21 | SFO | RBV | | | | | | | | | | | | |
| AA4172 | ER4 | 1530 | 1535 | 1545 | T8- | CLE | RBV | | | | | | | | | | | | |

- Why is MIT involved?
- What is “Departure Metering” and why is it needed?
- What is the JFK Departure Metering Program?
- **What are the impacts of the JFK Departure Metering Program?**

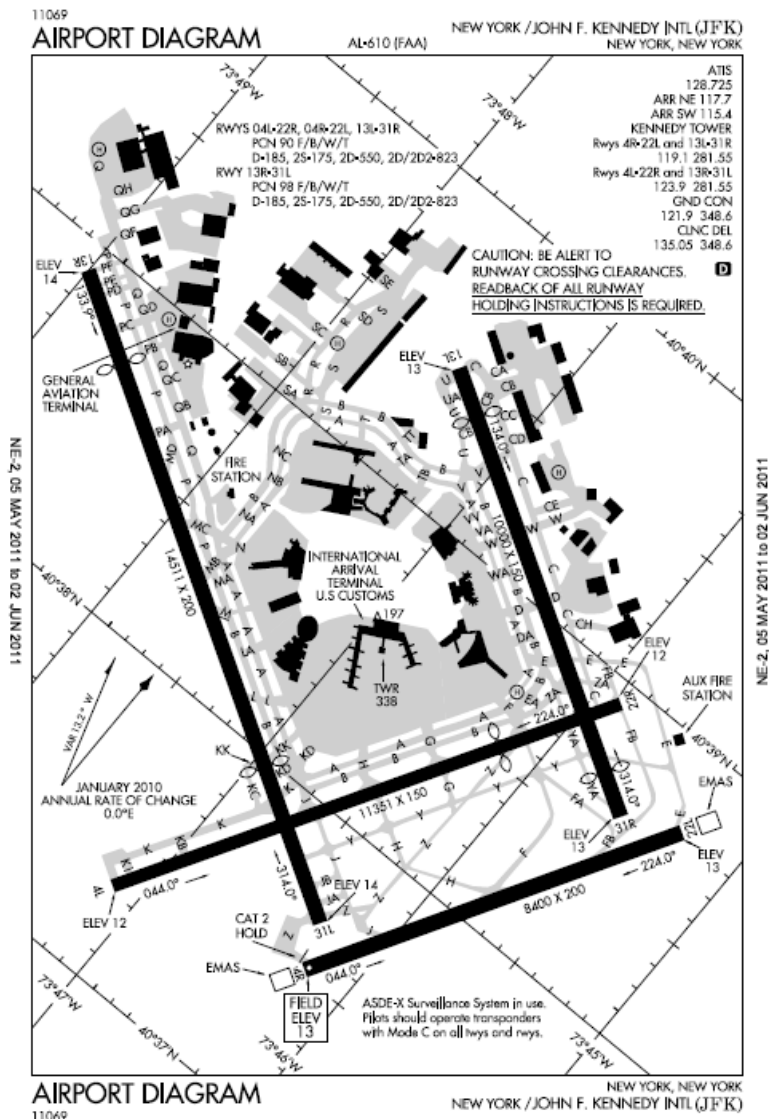


Objectives of MIT Study

- **First order assessment of JFK departure metering program in terms of taxi time, fuel burn & CO₂ emissions**
- **Many other potential impacts of metering operation:**
 - **Throughput**
 - **Gate usage**
 - **Holding area usage**
 - **Ground crew operations**
 - **Passenger connectivity**
 - **Bag connectivity**
 - **Airport terminal occupancy**
 - **Airport terminal revenues**
 - **etc.**

- **Compare taxi times, fuel burn & emissions pre/post metering implementation, *everything else being as equal as possible***
 - Demand
 - Capacity
 - Airport configuration
 - Weather/ATC constraints (EDCTs, MITs,)
 - Equipment status
 - etc

- **Runway 13R/31L under construction 1 Mar-31 Jul 2010**
 - Pre-metering assessment period: 1 Jan 2009-28 Feb 2010
 - Post-metering assessment period: 1 Jul-31 Dec 2010

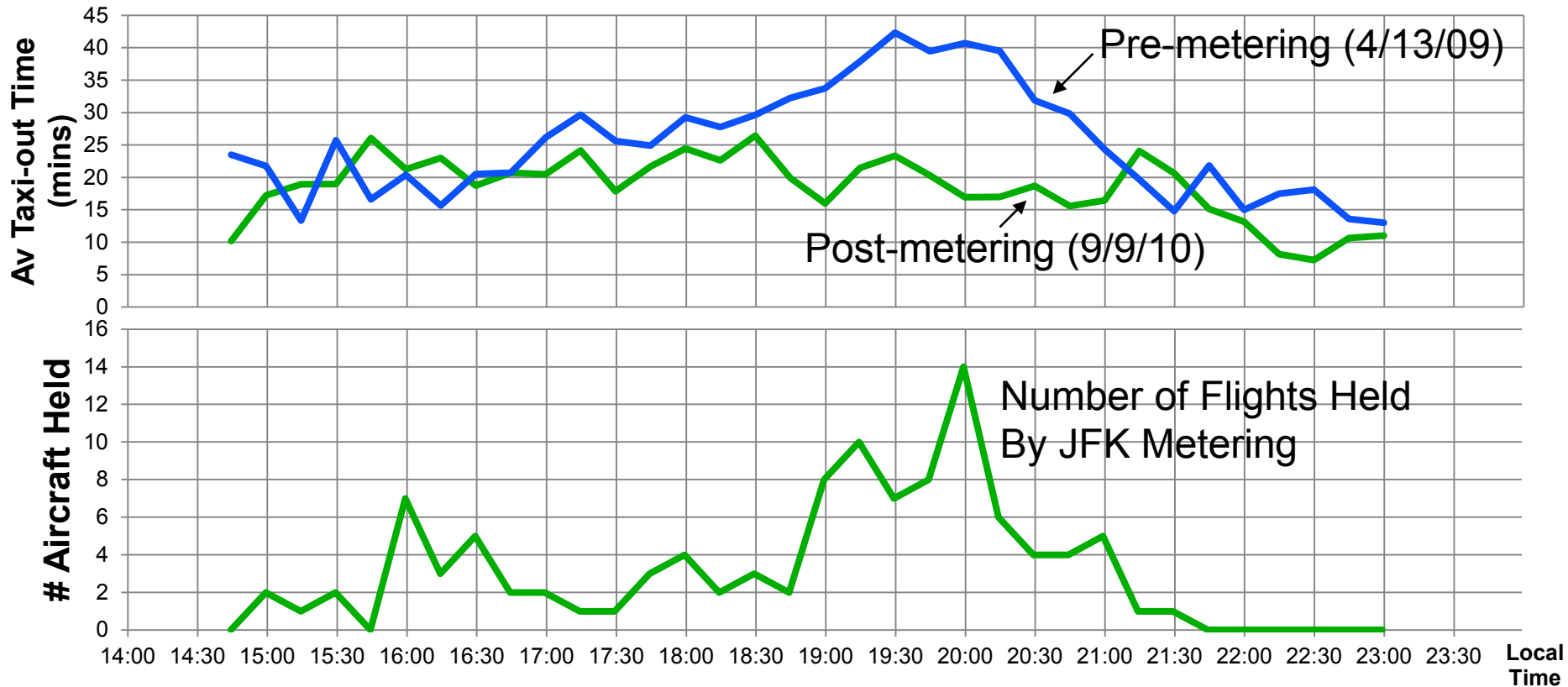


NE-2, 05 MAY 2011 to 02 JUN 2011



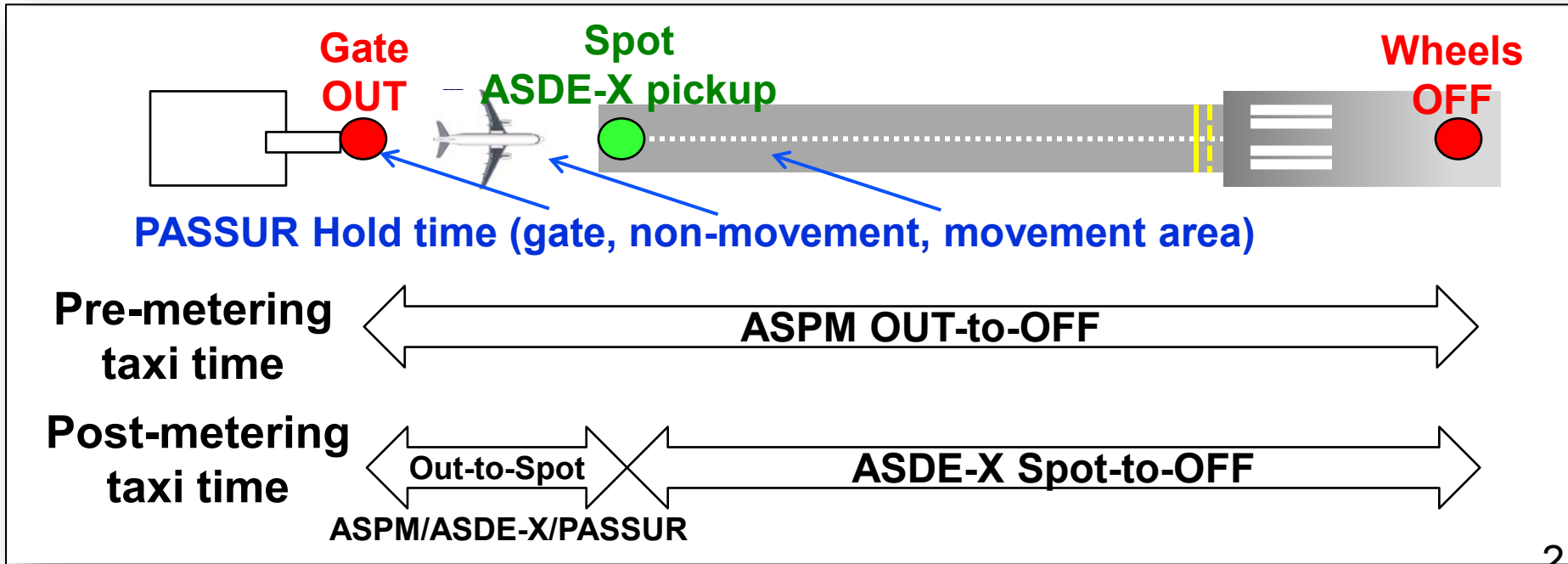
Basic Analysis Approach

- In practice, very difficult to normalize for all operational factors
- Some “similar” days found based on throughput, config, wx

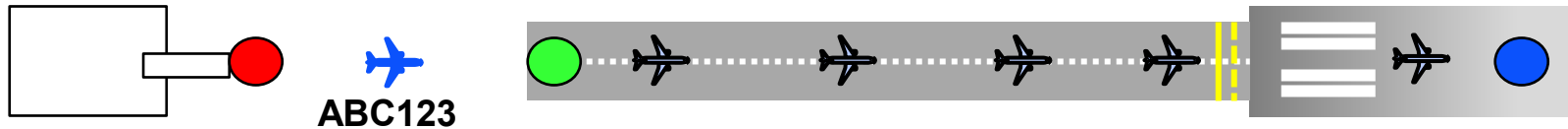


- For broad applicability, derived statistical relationships between metering and taxi time impact from set of sample days and applied found relationships to all data

- **FAA Aviation System Performance Metrics (ASPM) data**
 - Flight-specific OOOI (OUT, OFF, ON, IN) times
 - Airport throughput in 15 mins intervals
- **Airport Surface Detection Equipment-X (ASDE-X)**
 - Position in active movement area (not ramp) at 1 sec update
- **PASSUR metering hold data**
 - Flight-specific desired vs. metered slot times



- Define appropriate congestion metric & variation pre/post metering
 - “Takeoff queue” = # of other aircraft that take off between pushback and wheels off for a flight
 - Different from number on surface due to possible “overtakes”

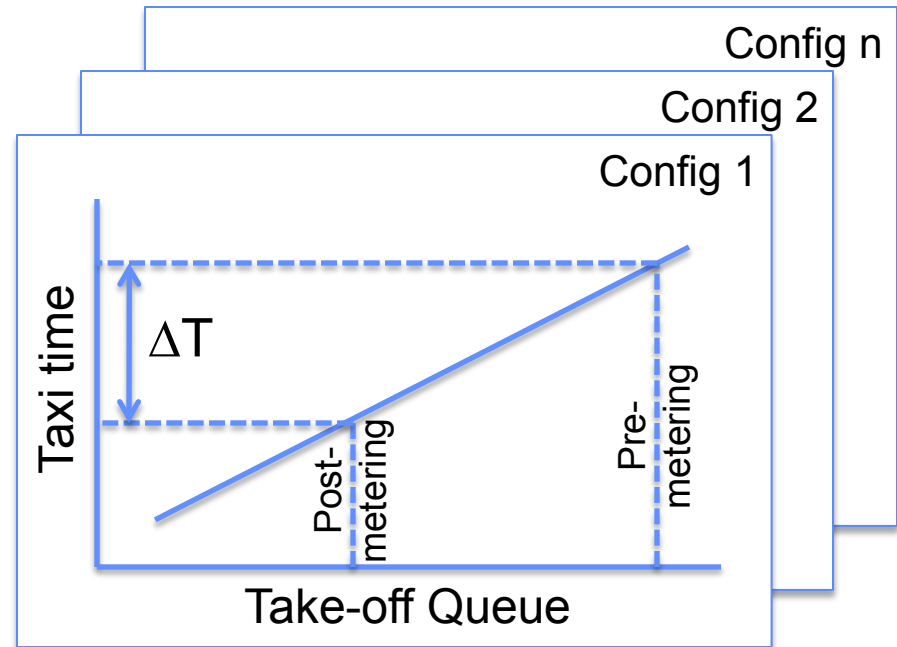


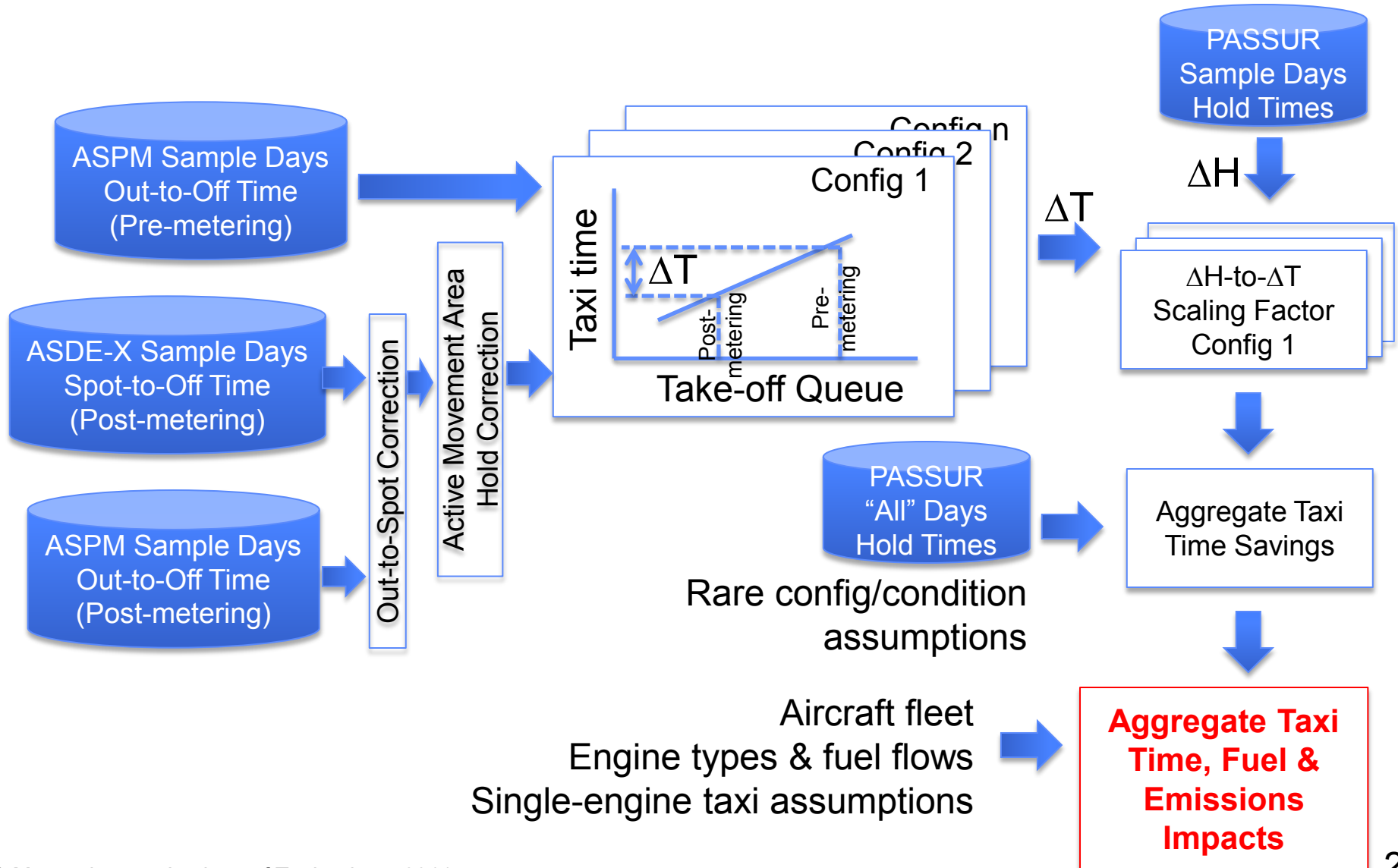
- Example:
 - Flight ABC123, **push-back 12:00**, **wheels-off 12:30**
 - During ABC123 taxi-out, other a/c depart at 12:05, 12:10, 12:15, 12:20, 12:25
 - “Take-off queue” for ABC123 = 5
- Tried other metrics but this was most robust



Key Concepts in Analysis Methodology

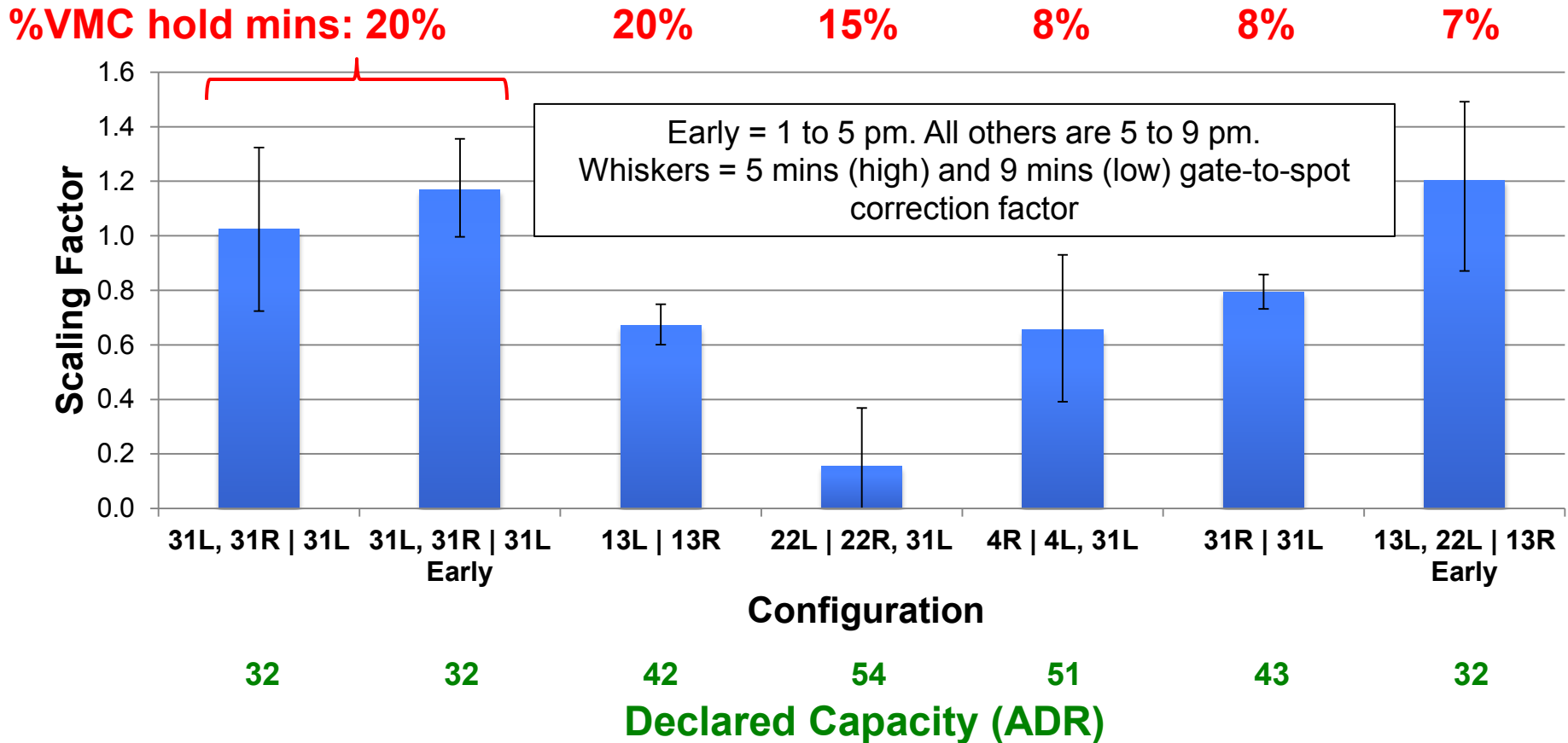
- Establish how congestion metric relates to taxi time on representative sample days
- Find relationship ΔT to hold time for each config (“scaling factors”)
- Apply scaling factors to all PASSUR hold data
- Determine total taxi time impacts of metering
- Determine fuel burn impacts of metering
 - Assumed holds > 10 mins with engines off, APU on
 - Match individual aircraft to engine types (fleet database)
 - ICAO-certification ground idle fuel flow numbers for engine types
 - Fleet average fuel flows established (JFK av fleet = 6.1 gallons/min)
 - Explored sensitivity to single-engine taxi %







Scaling Factors Summary

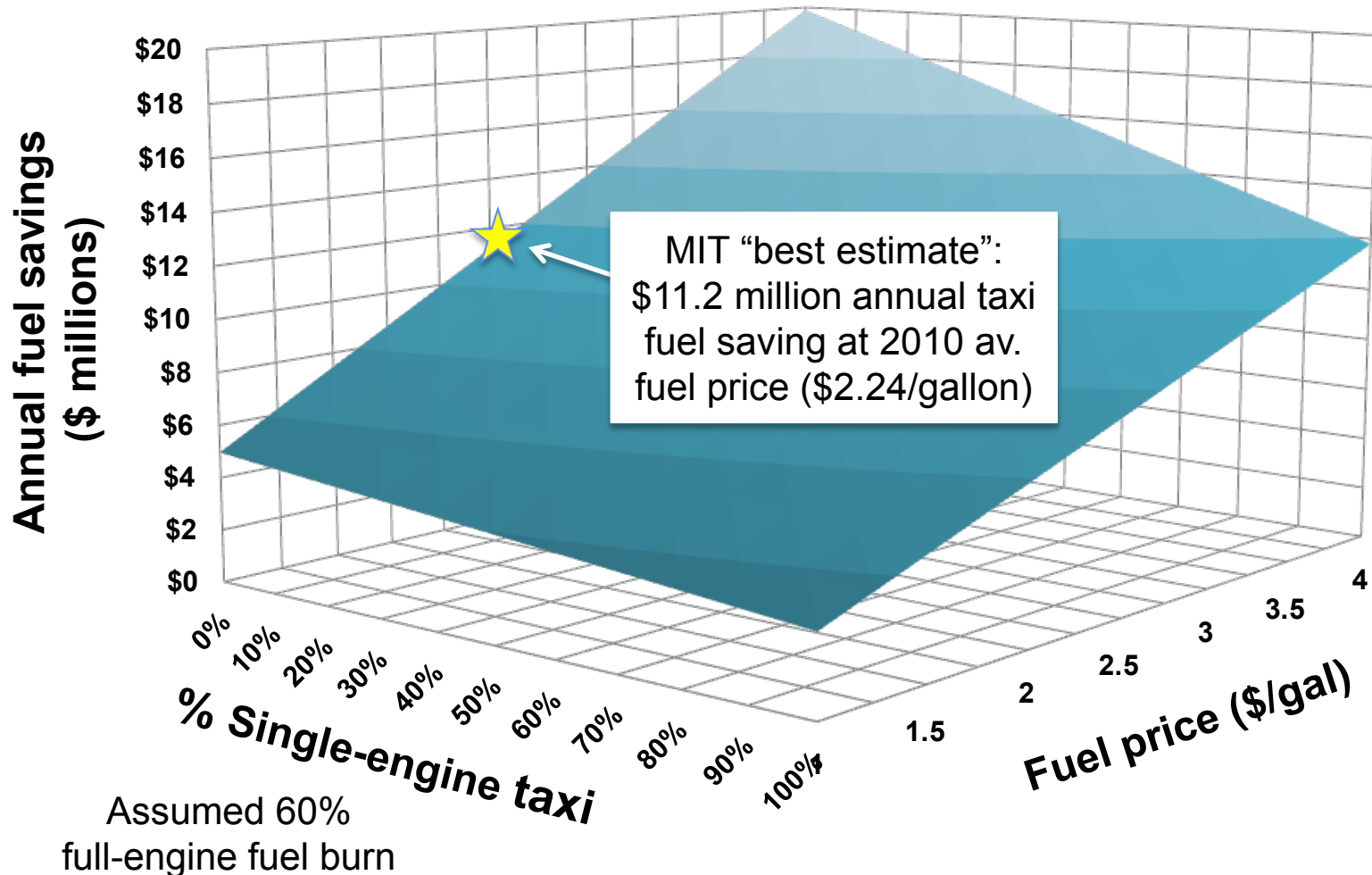


- Differences in scaling factors show benefits of metering differ by configuration
 - Benefits greatest for configurations with lowest declared capacity



Annual Monetized Benefits of JFK Metering

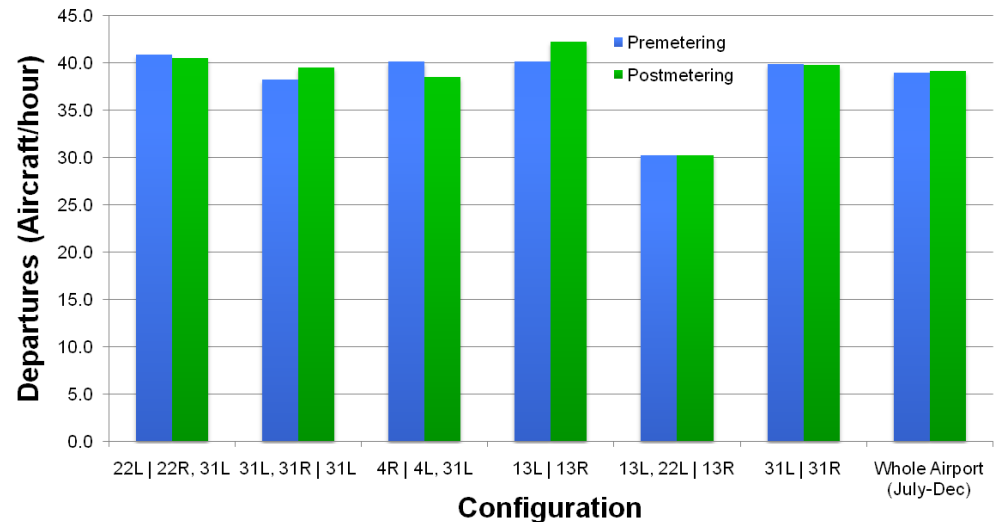
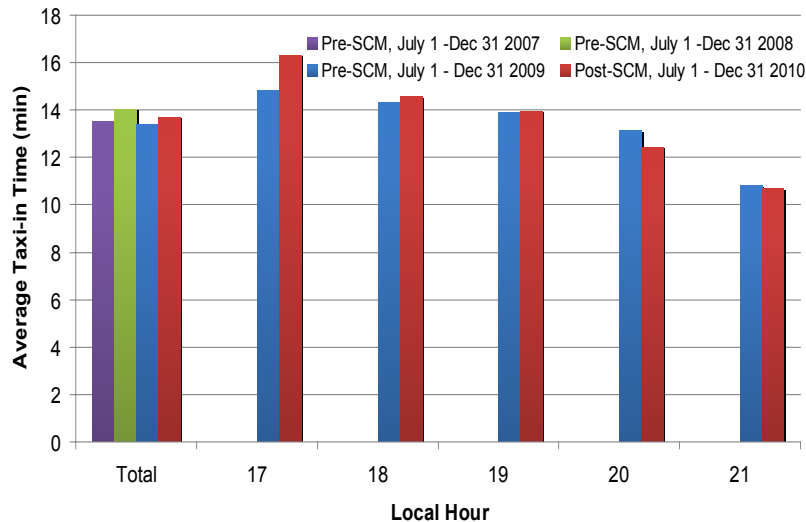
- 14,800 hours taxi time reduction
- 5.0 million gallons fuel saving: \$10.0-15.0 million at \$2-3/gallon
- 48,000 metric tons CO₂ saving





Other Operational Impacts

- **Need to carefully monitor impacts of metering to ensure no adverse operational consequences**
 - Gate conflicts
 - Increased ramp congestion
 - Lost throughput
- **To first order, no evidence of adverse consequences at JFK**
 - Further study recommended into scaling factor differences and taxi-in/throughput differences with some configurations

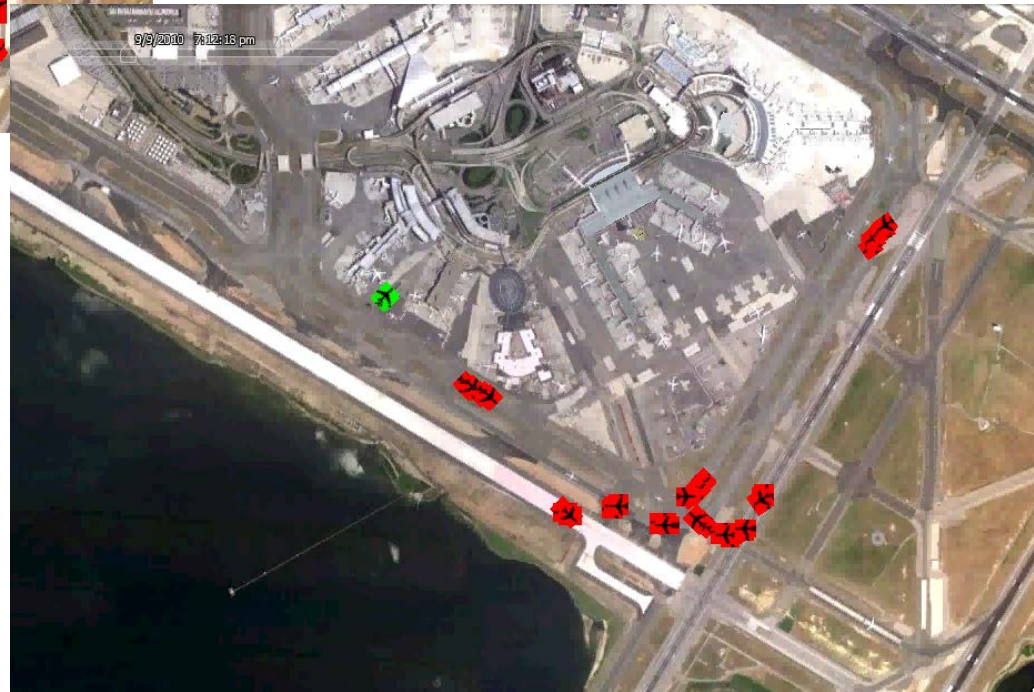


- **Major challenge to meet demand for air transportation while reducing environmental impacts**
- **Departure metering an important operational mitigation**
- **Departure metering being studied at various airports**
 - **Implementation approaches vary by airport**
- **Estimated annualized reductions of 14,800 hrs taxi time, \$11.2 million fuel & 48,000 metric ton CO₂ from departure metering operation at JFK**
- **Need to explore other operational impacts**
 - **Currently exploring throughput: no impact to first order seen pre/post metering**

Questions?



Pre-metering
2/11/2010, 19:12-19:20



Post-metering
9/9/2010, 19:12-19:20