Incorporating A380 Impacts on Surface Movements into the ACES Simulation Environment

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Outline

- Overview of main project
- Profile of A380 current and planned A380 operations
- A380 impacts at current airports
- Measuring delay consequences of A380 operations
- Modeling surface delay impacts
- Future work

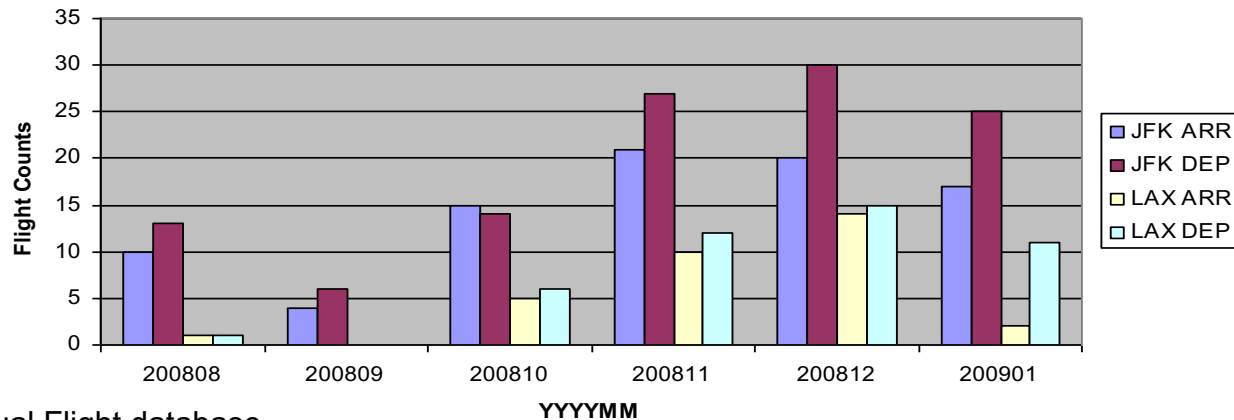# Advanced Concepts and Vehicles Project Overview

- **Project demand for operations of future vehicles, including:**
  - Super heavy transports (i.e., A380)
  - Supersonic business jets
  - Very light jets
  - Lightweight, un-crewed aircraft
- **Develop use cases scenarios for each of the vehicles**
- **Predict environmental impacts**
- **Predict congestion impacts**
  - Our part: surface traffic congestion modeling in the ACES simulation

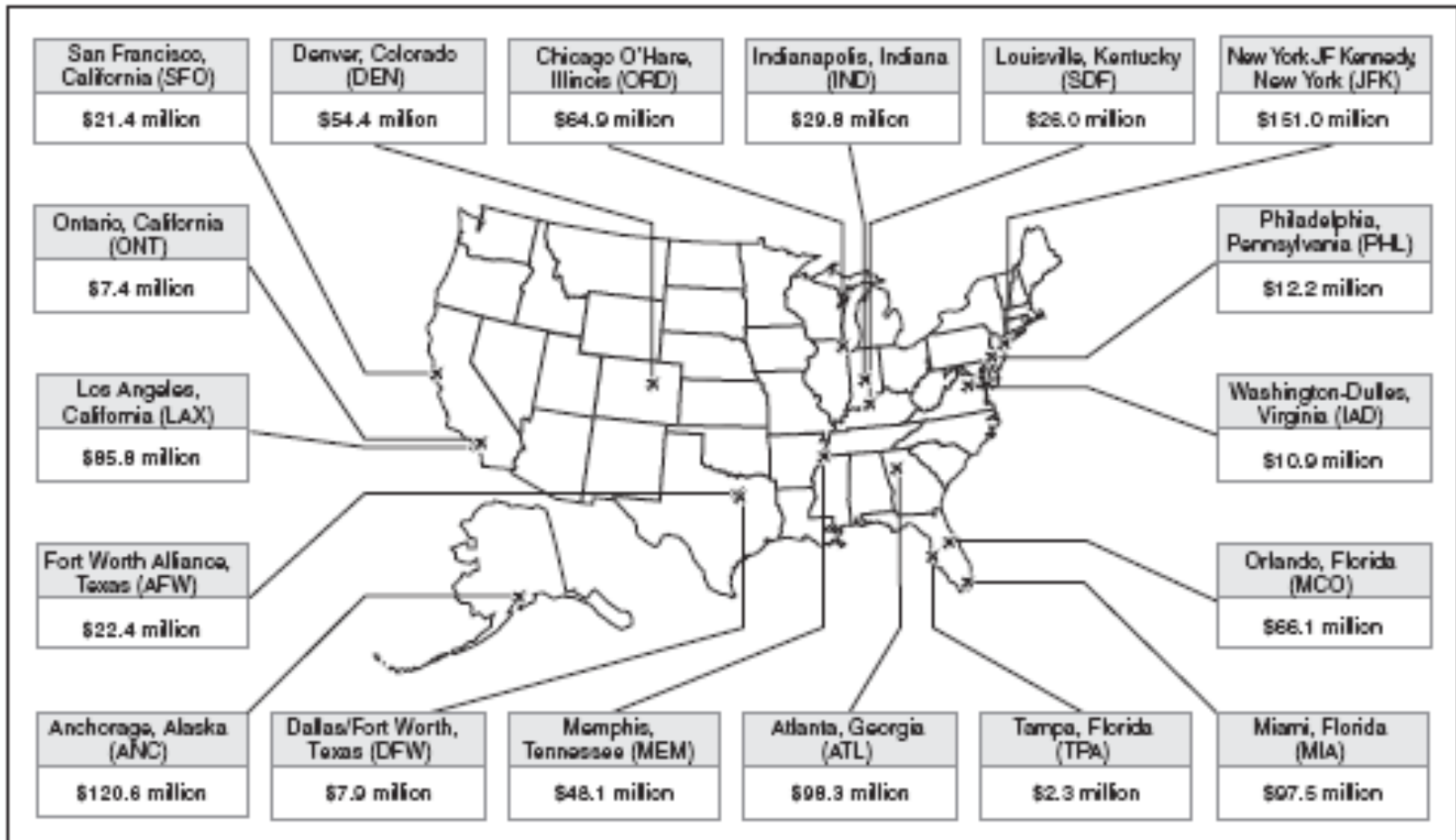# Background on Current A380 Operations in the U.S.

■ Primary Users Worldwide (as of Jan08)

Carrier	Current Quantity	Scheduled Operations in the U.S.	Start Date
Singapore Airlines(SIA)	6	-	-
Qantas(QFA)	3	Melbourne, Sydney to LAX	October 20, 2008
Emirates Airline(UAE)	4	Dubai to JFK	August 1, 2008

■ Limited No. of A380 Operations in the U.S.

*ASPM Individual Flight database

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Source: http://www.gao.gov/new.items/d06571.pdf

- ## Takeoff Separation

  - On departure behind an A380, time-based separation is required.
    - ◆ "Heavy" aircraft: 2 minutes
    - ◆ "Medium"/"Light" aircraft: 3 minutes

- ## Landing Separation

  - The latest ICAO approach separations (Aug08):
    - ◆ 4 nmi for Super (another A380),
    - ◆ 6 nmi for Heavy,
    - ◆ 7 nmi for medium/small and
    - ◆ 8 nmi for light.
  - These compared with the 4 nmi, 5 nmi and 6 nmi spacing applicable to other "Heavy" aircraft.

- During A380 landing, service roads, taxiways and runways must be closed to airfield trucks, cars and other commercial aircraft.

- The runway closures can last three to five minutes.

- Air traffic controllers give it priority so it doesn't have to wait for takeoff.

- Although A380s create impact, there are only one or two A380s a day. Also, the airport isn't as busy as it once was.
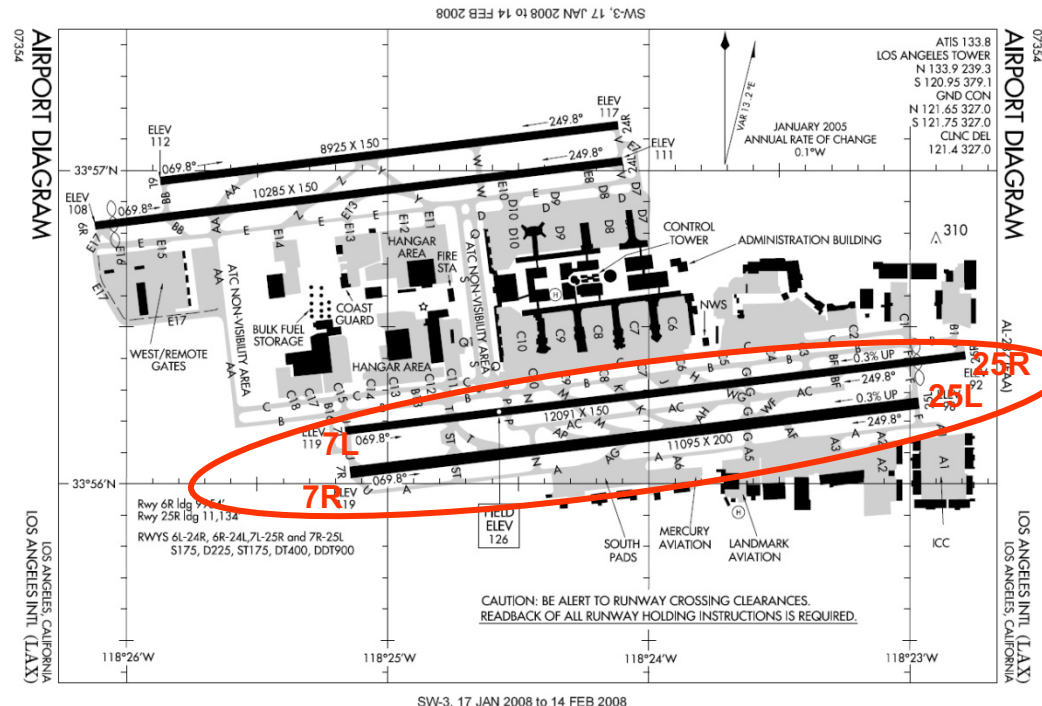
A380 Impact at JFK

- There are no special restrictions on other aircraft ground movements when the A380 is taxiing in or out.

- A380s arrive on 31L and depart on any of 31L, 13R, 22R or 4L.
  - Two-minute delay behind a departing A380.

- Air France, Singapore and Lufthansa are scheduled to start A380 flights into JFK in 2009; Korean Air in 2010; and Qantas are scheduled to start in 2012.
 - Air France, Singapore, Lufthansa and Korean Air are all in Terminal 1

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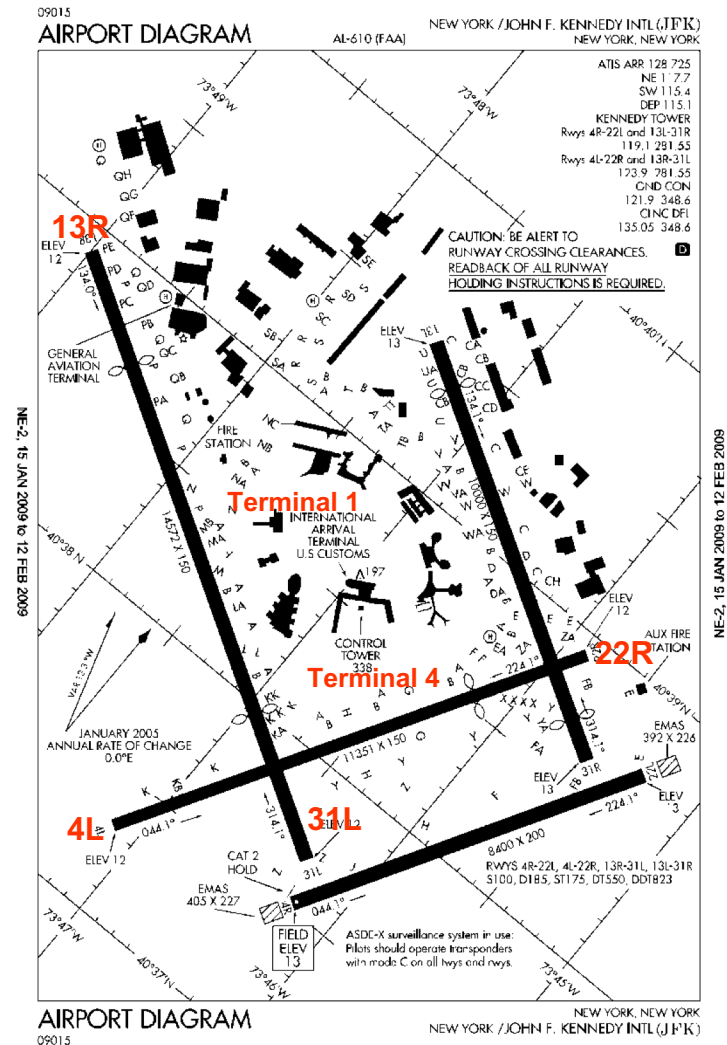
- **Potential interruptions**
  - When an A380 uses taxiway A (segment between K and E), there is no other movement on taxiway B.
  - When an A380 is on taxiway B between (E and Q), nothing can land on 28L
- **Further restrictions have to be made when more than one flight arrives/departs around the same time.**
  - There have been only three A380 flights into SFO and each has been treated as a special airplane.
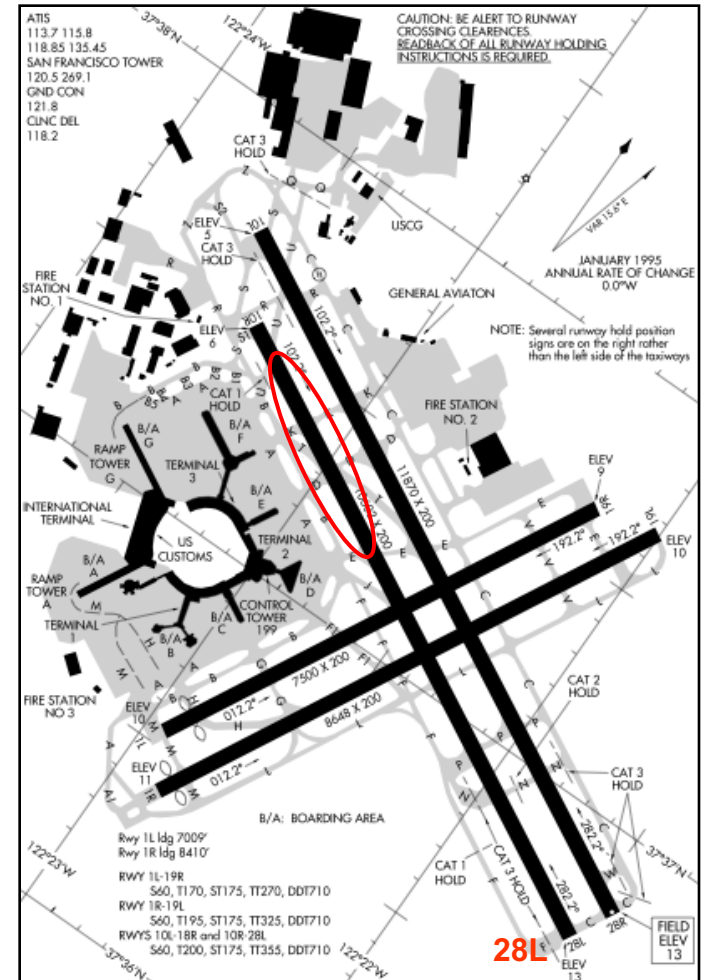
- **A380s currently operate at not-so-busy periods**
  - LAX: arrivals usually around 7~8; departure around 22~23.
  - JFK: arrivals usually around 2~3; departure around 23~24.

- **The impact to airport capacity does not last long because of infrequent operations, i.e. 1 or 2 per day.**

- **Need runway usage information for identifying operations using same runways/taxiway with A380s.**

Average Ratio of Actual to Nominal Taxi Time

- **ASPM Individual Flight Database**
  - **Actual taxi-in time** is the difference between actual wheels-on time and actual gate-in time.
  - **Nominal (unimpeded) taxi-in time** is the estimated taxi-in time for an aircraft, by carrier under optimal operating conditions (when congestion, weather, or other delay factors are not significant).
  - Similar definition for taxi-out time.
- **Data preparation procedures:**
  - For each flight, compute the ratio of actual to nominal taxi time.
  - Take average of all the flights in the pre-defined time bin.
- **Formula:**

$$\text{Avg. Ratio} = \frac{1}{N} \sum_{i=1}^{N} \frac{\text{Actual Taxi Time}_i}{\text{Nominal Taxi Time}_i}$$

where i is the index of flights.

LAX A380 Arrival
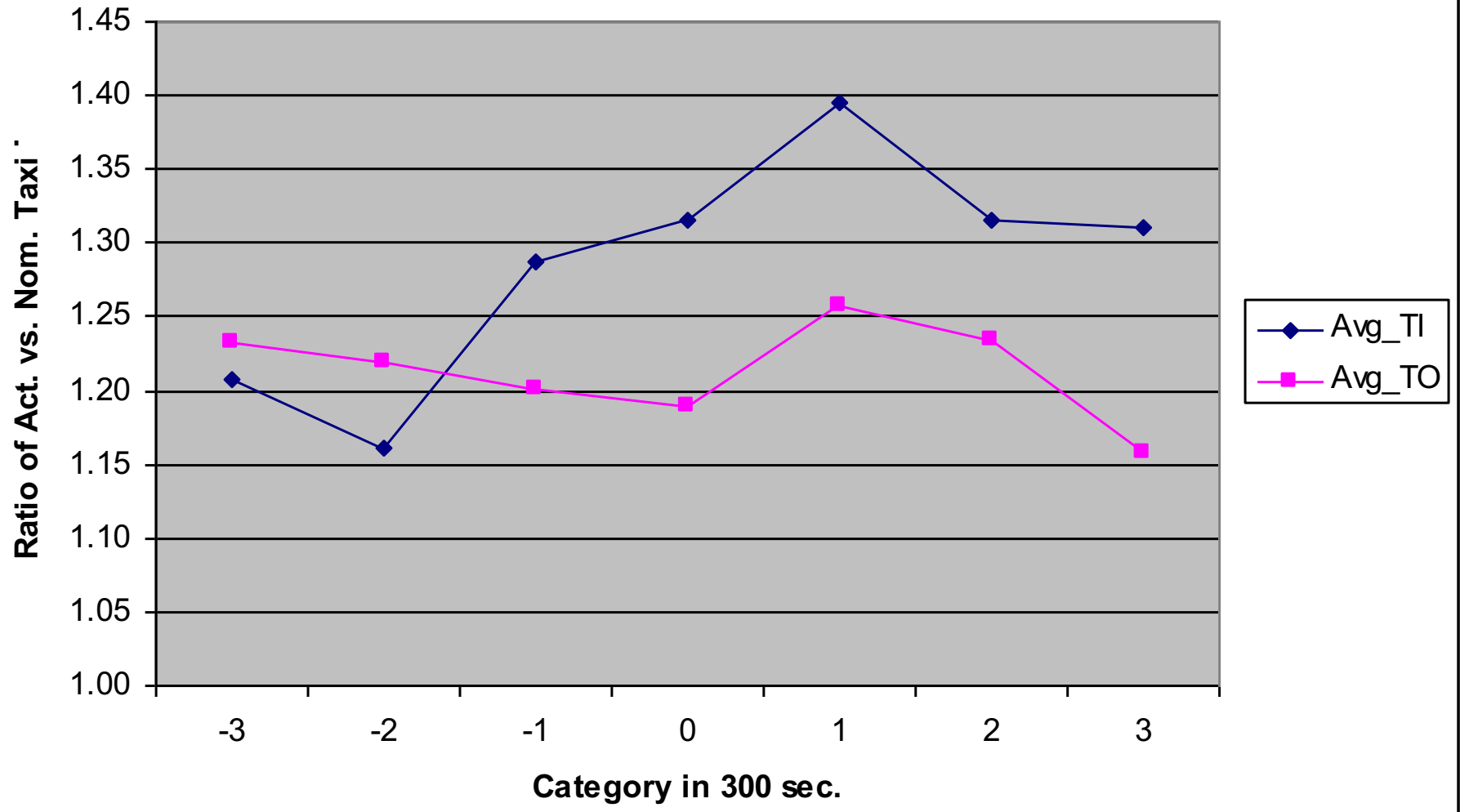
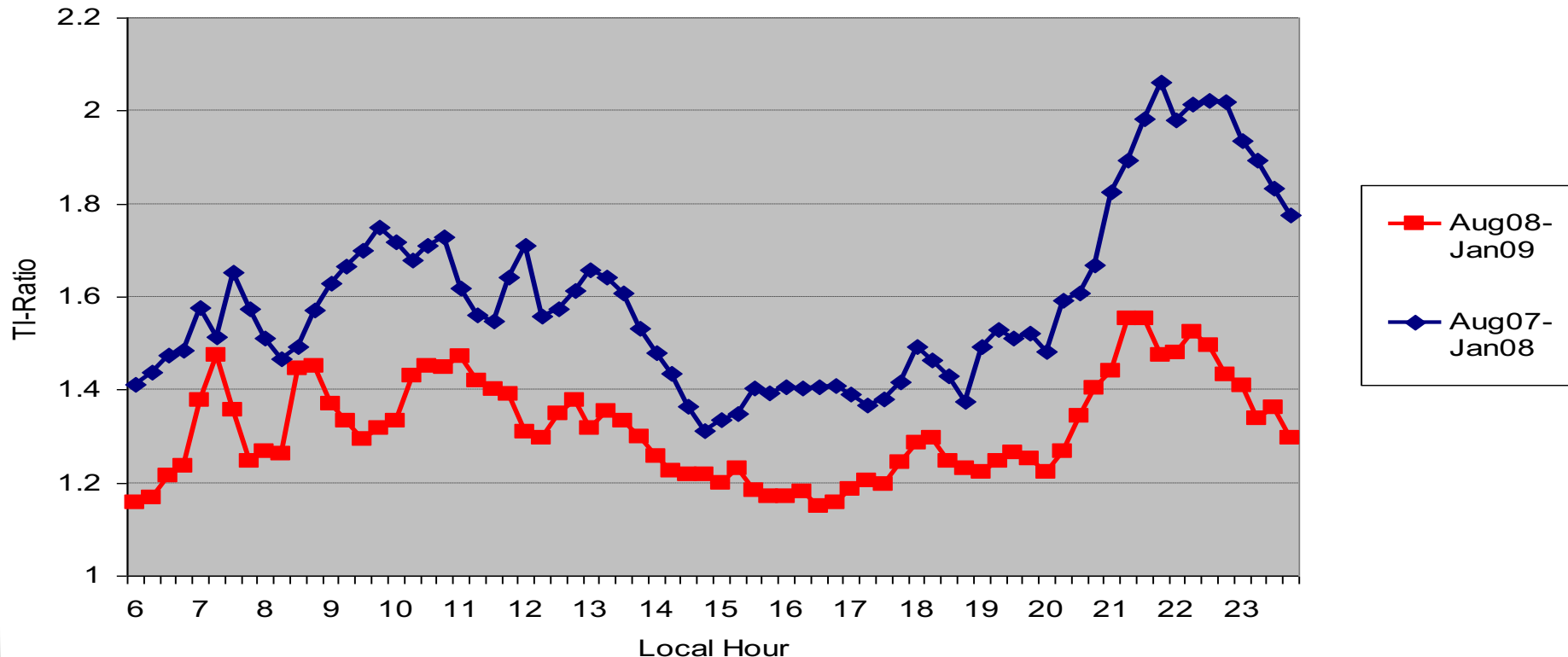Category 0 has A380 arrival; All operations at LAX are included.

JFK A380 Arrival
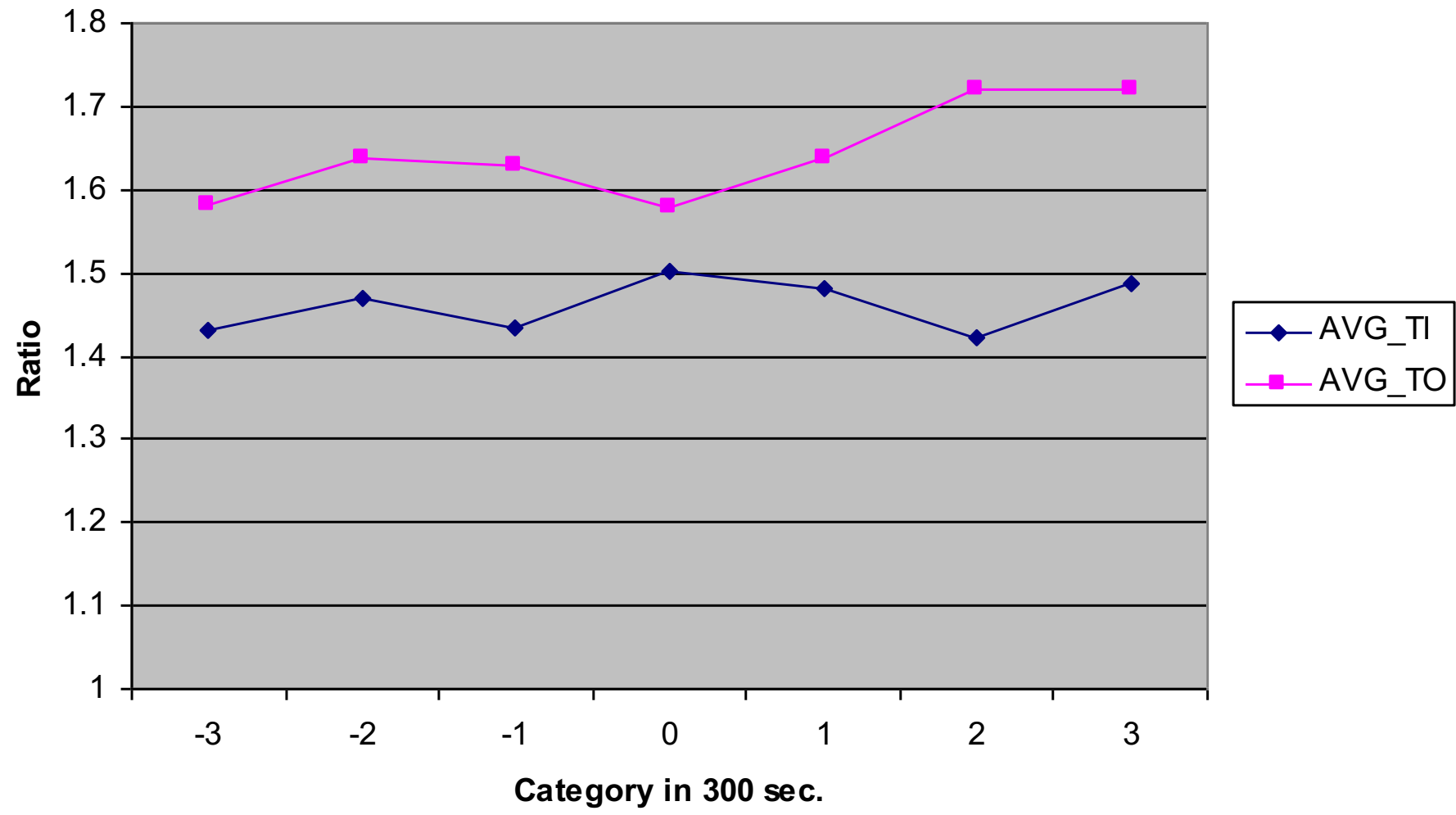
Category 0 has A380 arrival; All operations at JFK are included.

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Profile of Taxi Ratio

- Nominal taxi time by each carrier and aircraft type is updated seasonally.
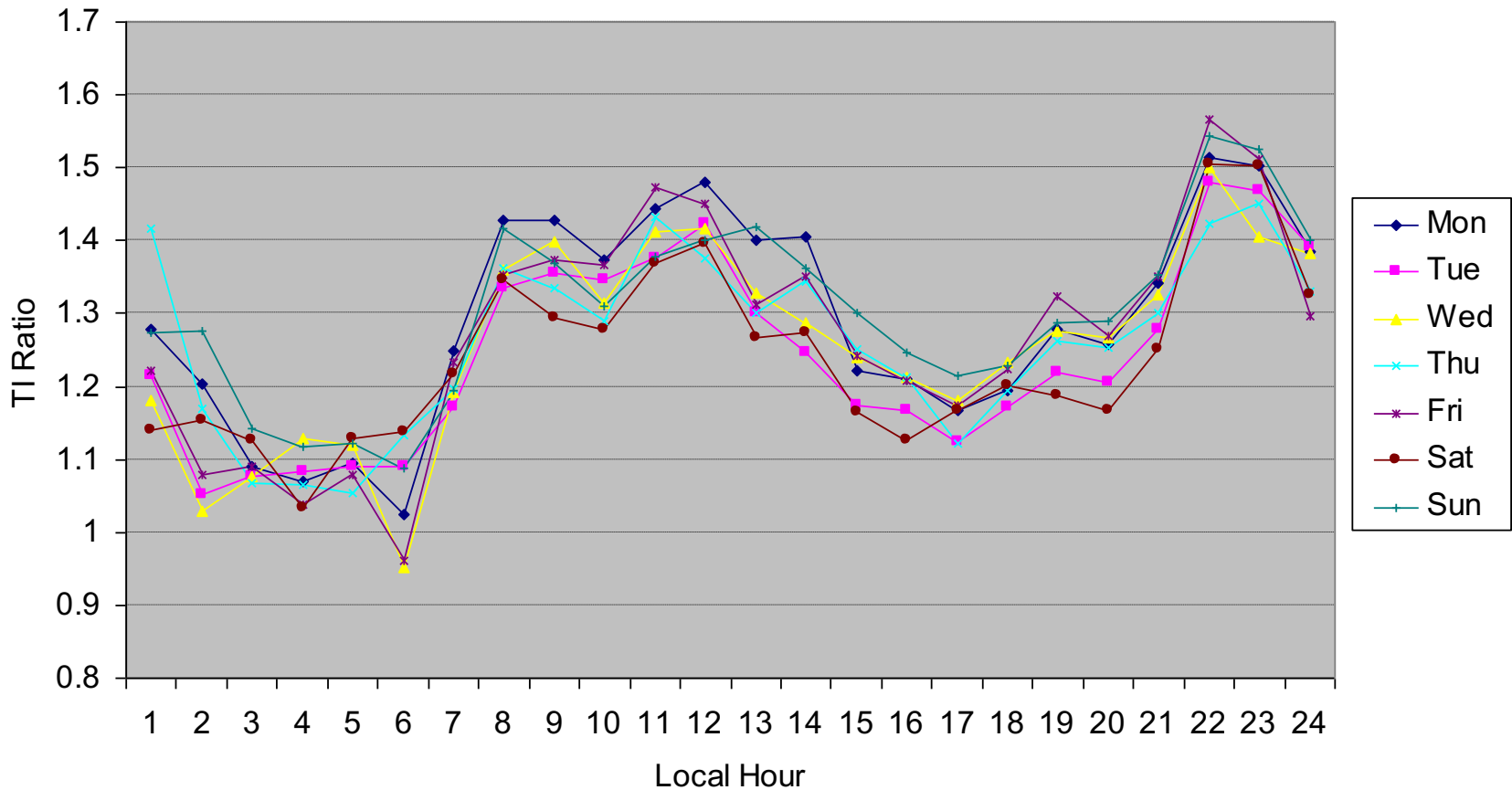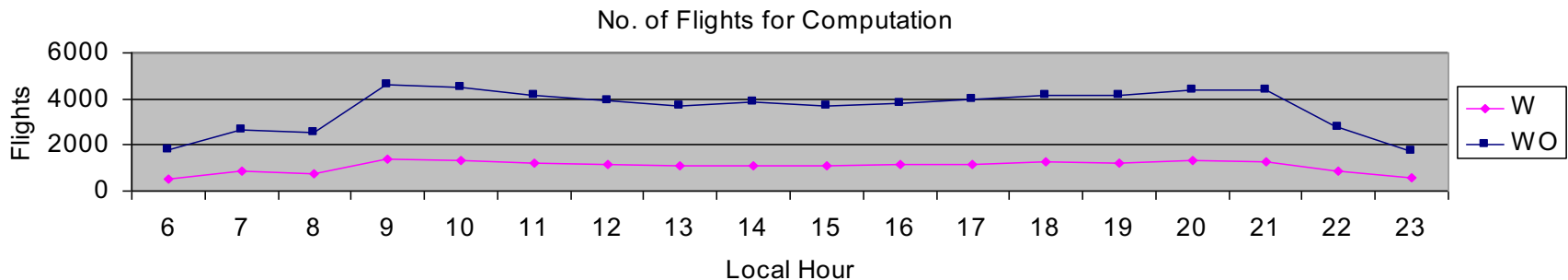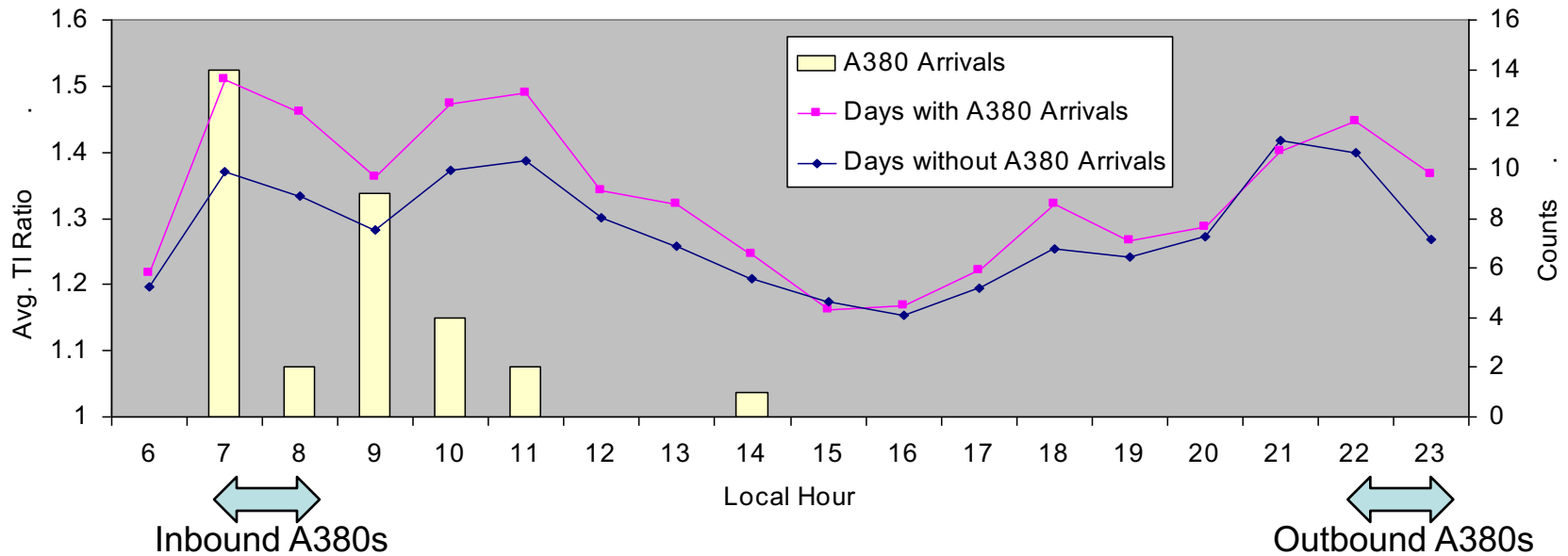- Longer analysis period seems undesirable.

Avg TI Ratio at LAX

TI-Ratio by Day of Week at LAX

- **The patterns are similar across the week.**

Avg. TI Ratio at LAX
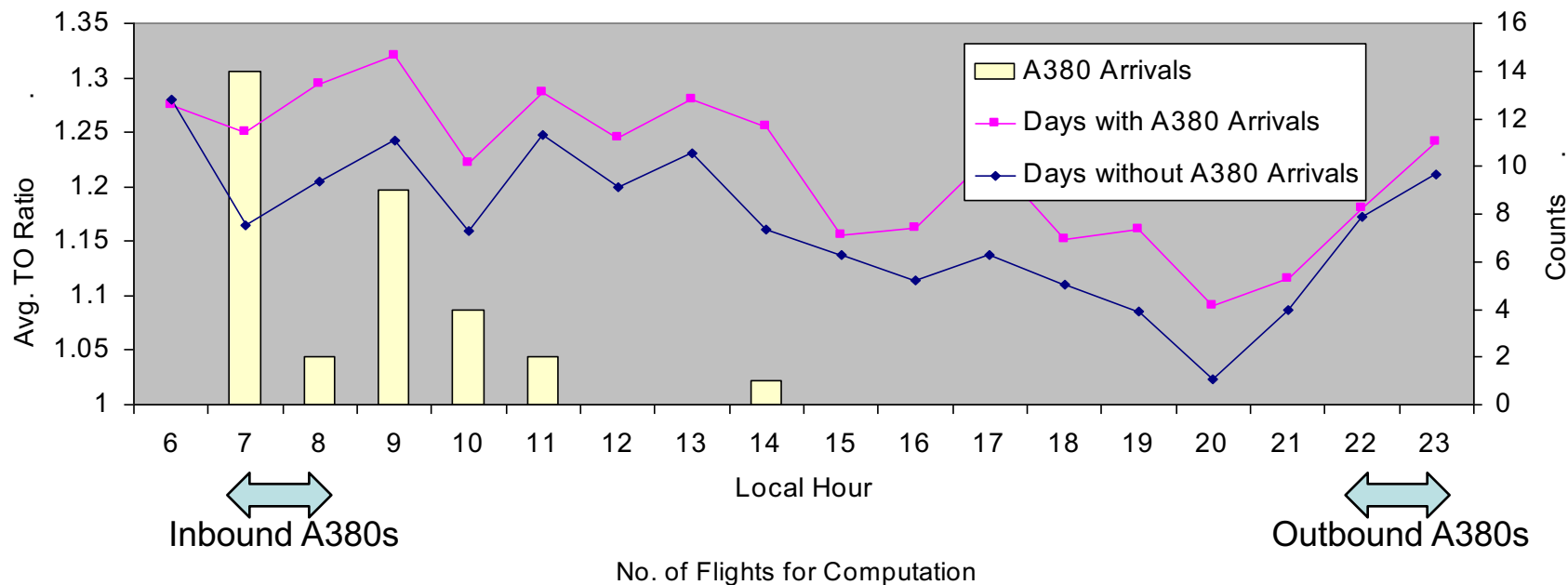
- **Data range: Oct08-Jan09 (by Hour)**

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Avg TI Ratio on Days w/ and w/o A380 arrival at JFK

- **Data range: Aug08-Jan09 (by Hour)**

Inbound A380s

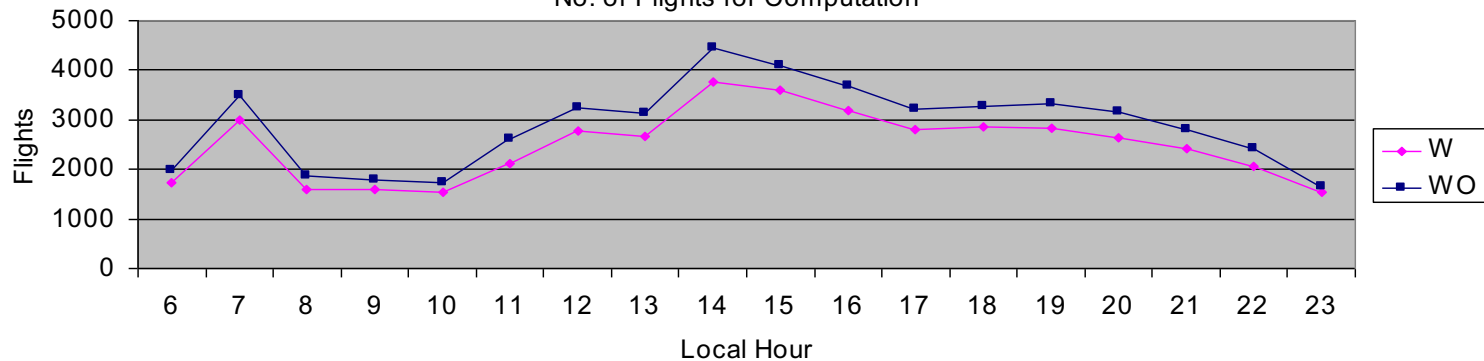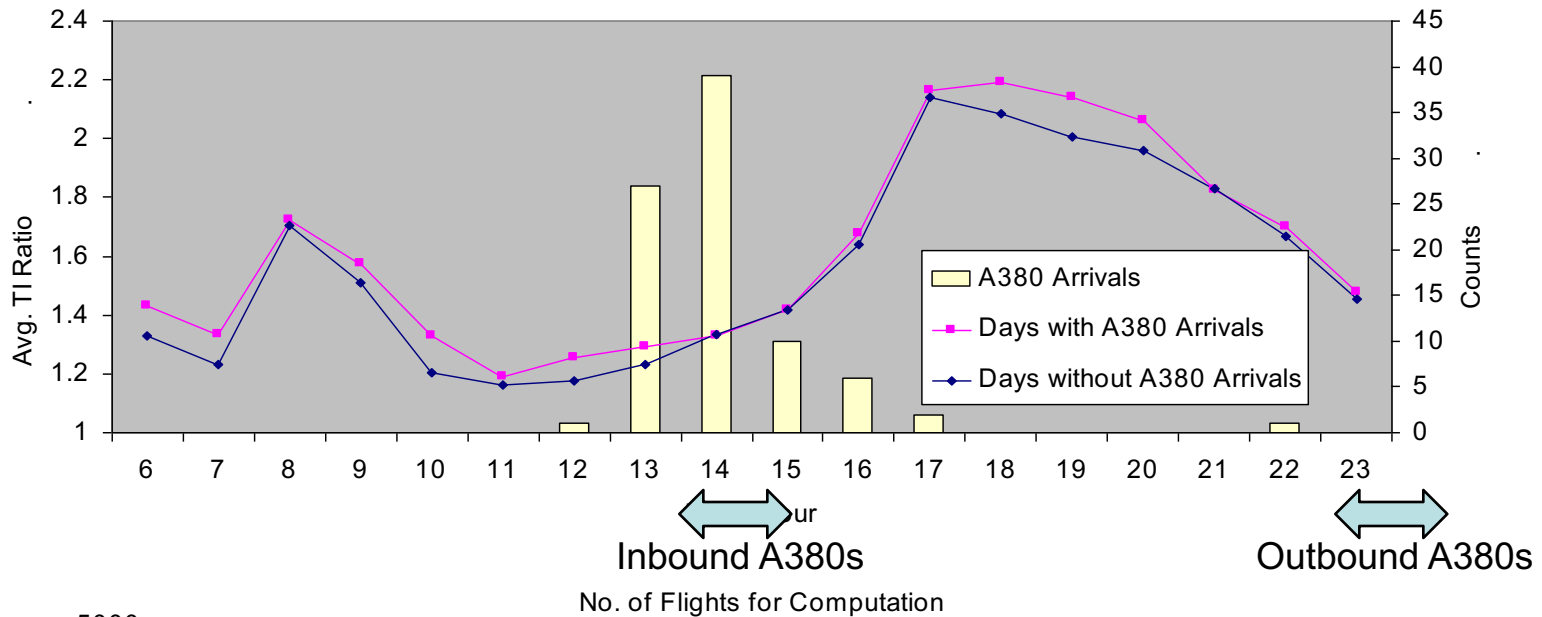Outbound A380s

No. of Flights for Computation

Avg TO Ratio on Days w/ and w/o A380 arrival at JFK

- Data range: Aug08-Jan09 (by Hour)

Module for Taxi Delay under SHT Ops
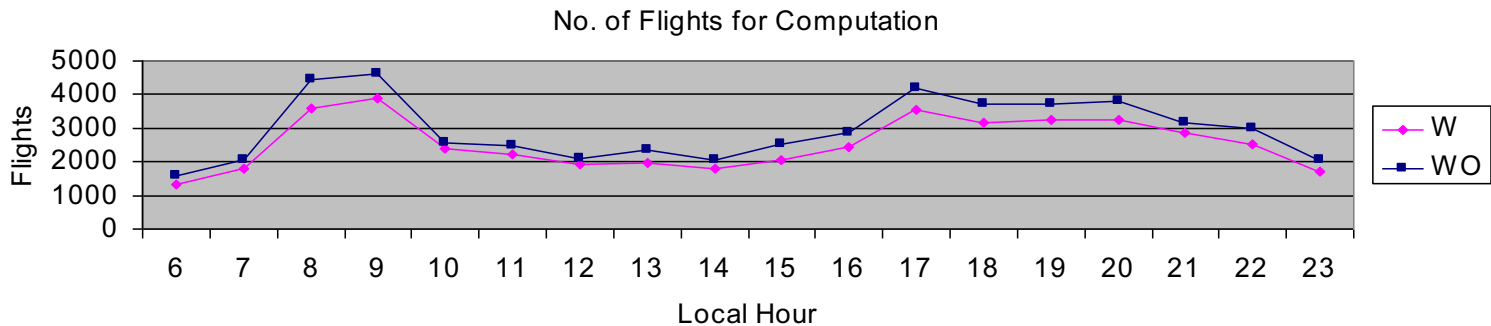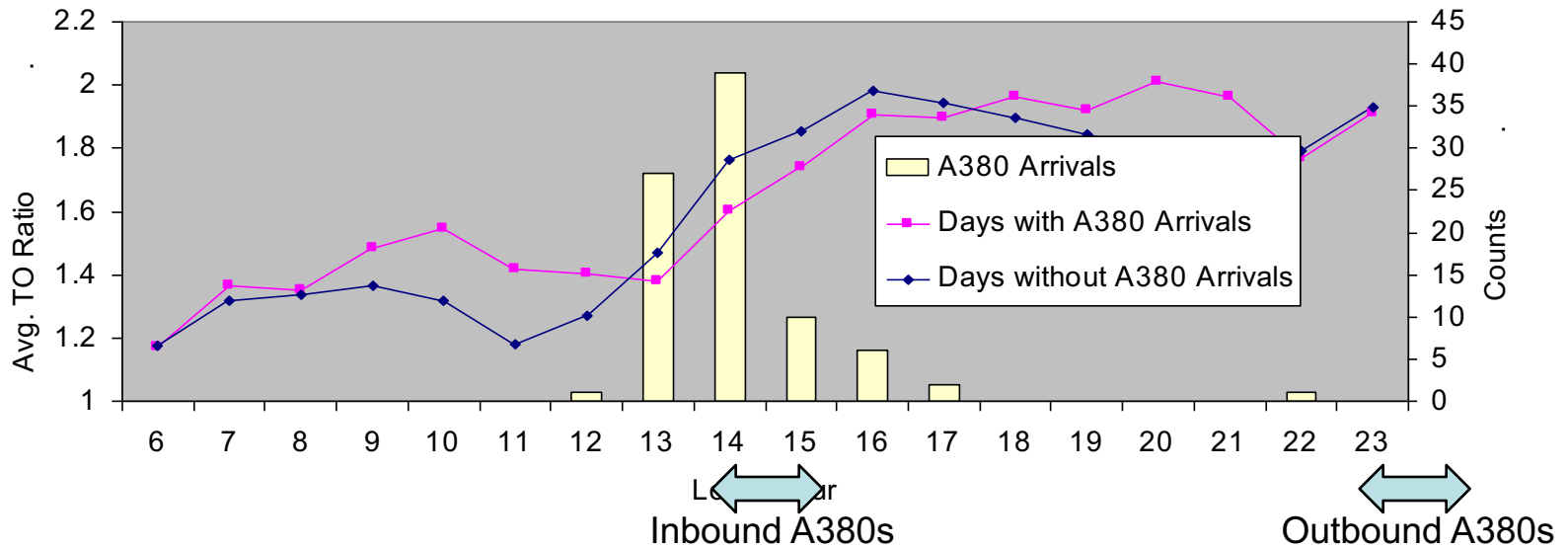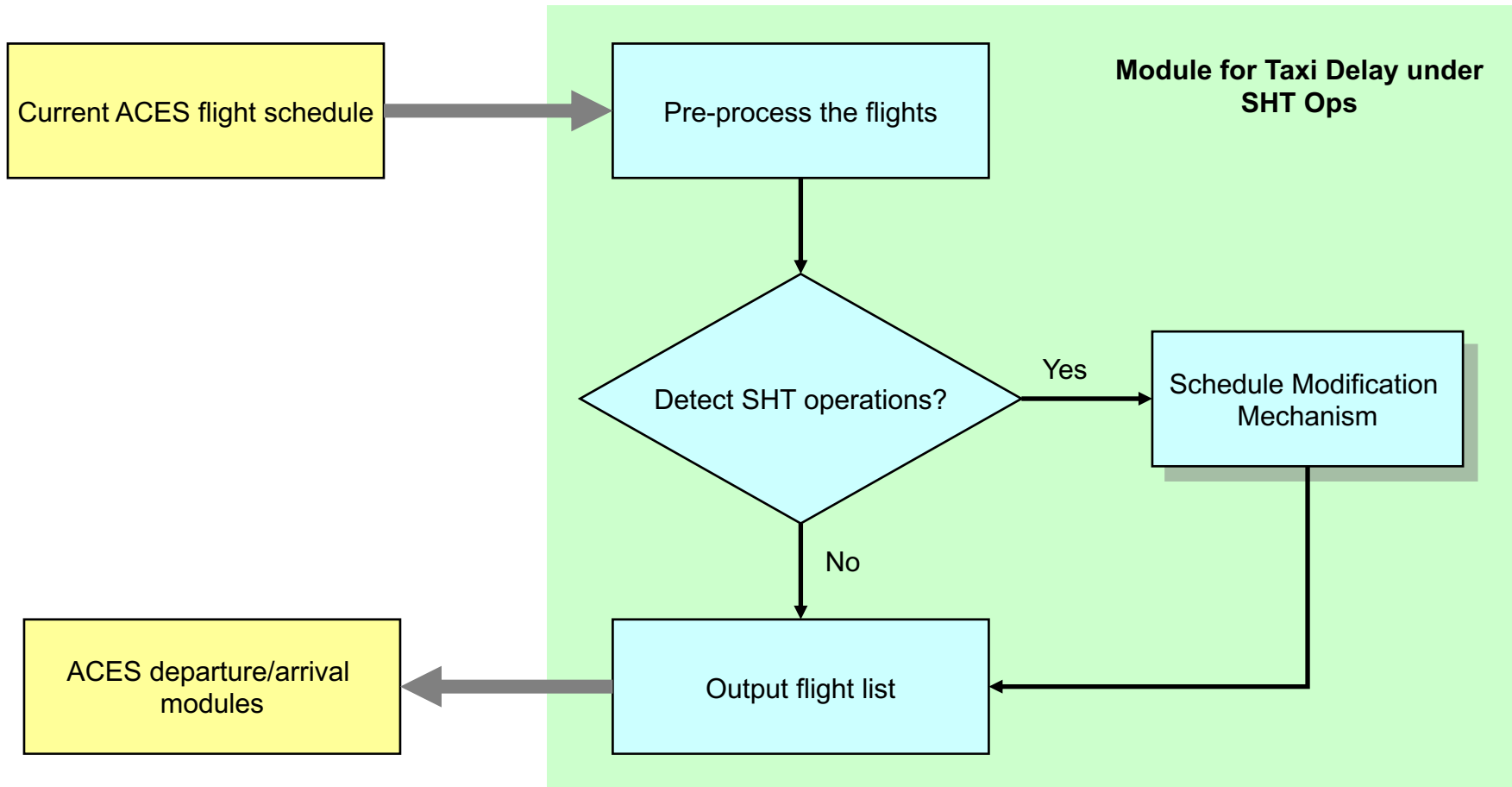
- **Work with runway-specific flight data for delay estimation**
- **Investigate confounding factors**
- **Model specific runway usage**
  - Currently all airports are modeled as "nodal" – move to Surface Traffic Limitations Enhancement (STLE) in the future.

Gate & Ramp

Non-Runway Taxiway Network

Runway System with crossing & adjoining taxiways

Special Purpose Areas (parking, deicing, other)

Each link is assigned a domain
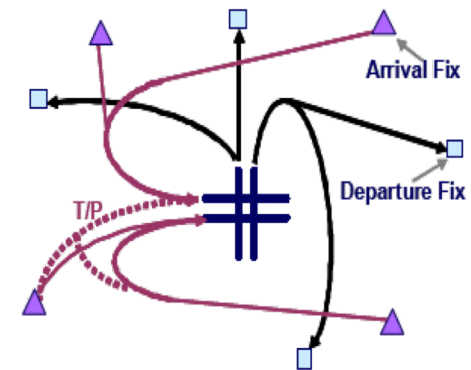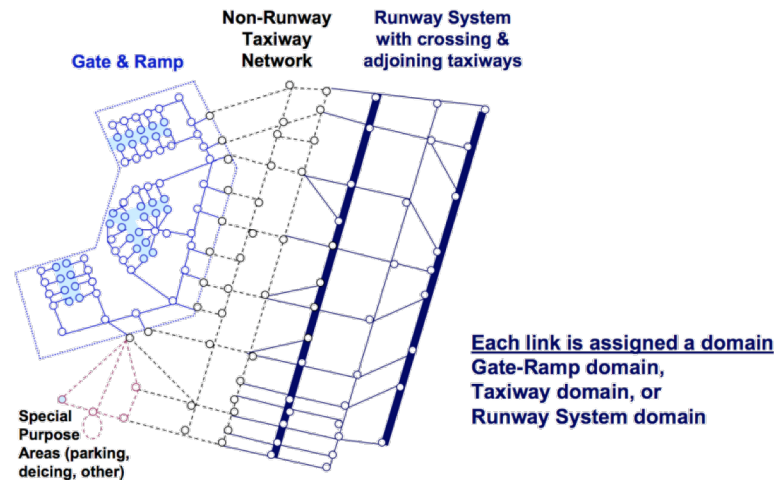Gate-Ramp domain,
Taxiway domain, or
Runway System domain

T/P

Arrival Fix

Departure Fix

Figure 5. Runway Assignment

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