TURKISH AVIATION ACADEMY

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# Airport Demand Management

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# Alternatives for Relieving Airport and Terminal Airspace Congestion

1. Increased airport capacity
   - second, third, … airports
   - new, larger airports to replace older ones
   - more runways, etc. at existing ones
   - *improved ATM*
2. Demand management ("strategic")
   - total operations
   - by time-of-day
3. Air traffic flow management (ATFM): reduces cost and impact of unavoidable delays
4. Substitute other modes of transportation; use substitutes for transportation (communications); forego travel altogether

# Airport Demand Management

- Objective
  - Review the characteristics, advantages and disadvantages of alternative approaches to demand management
- Topics
  - Rationale for Demand Management
  - Current International Practices
  - Description of Market-Based Approaches
  - Practical Difficulties
  -

***Reference: Chapter 12***

# Basic Precept

- Airport capacity expansion should be the principal means of accommodating growth of demand
- Demand management should be used to address:
  - short- and medium-term problems
  - long-term problems when capacity expansion:
    - becomes unreasonably expensive; or
    - is constrained by challenging political, social or environmental barriers
- In the latter case (long-term use), the forms of demand management that should be considered are the ones that least interfere with a deregulated and competitive market

# Brief Introduction to Slot Coordination

- Slot Coordination attempts to "ration" scarce airport capacity among airlines, with the dual objective of achieving high utilization of the airport while keeping delays at reasonable levels
- Essentially, it tries to:
  - "smoothen" peaks and valleys in daily demand profiles
  - keep demand below a target level specified by the airport's "declared capacity"
- Important to estimate capacities accurately and to understand the relationship and tradeoffs between number of flights served and delay

# Declared Capacities – Brussels, 2009

| times / period | | 05 min | | | 10 min | | | 30 min | | | 60 min | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| from | until | arr | dep | total | arr | dep | total | arr | dep | total | arr | dep | total |
| 00.00 | 05.55 | 5 | 5 | 8 | 9 | 9 | 9 | 16 | 16 | 16 | 30 | 30 | 30 |
| 06.00 | 06.55 | 5 | 5 | 9 | 10 | 9 | 13 | 24 | 27 | 35 | 35 | 40 | 45 |
| 07.00 | 22.55 | 6 | 5 | 10 | 10 | 9 | 15 | 30 | 27 | 40 | 48 | 44 | 74 |
| 23.00 | 23.55 | 5 | 5 | 8 | 9 | 9 | 9 | 16 | 16 | 16 | 30 | 30 | 30 |

**Source: Morisset, 2010**

# Determining Declared Capacity

- No standard methodology for determining declared capacity (= the number of "slots" available at an airport)
  - some sophisticated approaches with detailed simulations and extensive consultation with stakeholders
  - many *ad hoc*, "back-of-the-envelope" approaches with limited inputs and "politicized" considerations
- Declared capacities are typically set with reference to IMC capacity of the airport:
  - Lower than IMC capacity in most cases (MUCH lower in some)
  - Very close to (and sometimes slightly above) estimated IMC capacities at some of the busiest airports (e.g., Heathrow, Frankfurt, Gatwick, Munich)

# IATA Schedule Coordination Process

- Level 1 (“non-coordinated”)
- Level 2 (“schedules facilitated”) *(~ 75 airports)*
- Level 3 (“fully coordinated”)
  - ~ 170 international airports (73 in Europe, practically all busiest ones outside US)
  - Coordinator appointed by appropriate authority, usually assisted by a coordination committee
  - IATA Schedule Coordination Conferences (SCC); in June and November for subsequent season
  - Attended by ~300 air carriers, coordinated airport reps, schedule coordinators, etc.

# IATA Schedule Coordination Process [2]

- Carriers must submit slot requests 27 days before SCC
- During SCC and post -SCC, coordinators resolve conflicts, finalize schedules
- ***Historical precedent is over-riding criterion***
- Carriers may change use of slots or exchange slots
- Use-it-or-lose-it clause (80% use required)
- New entrants may be allocated up to 50% of "free" slots
- ***Restrictive definition of "new entrant"***
  - ***Maximum of 4 slots in a day after being awarded new slots***
- Other allocation criteria: size and type of market, length of period of operation, curfews, etc.
- "Transparent" slot buying/selling permitted in some EU countries (authorized as an option by EU Commission in 2008)

# LHR Slots – Summer 2011

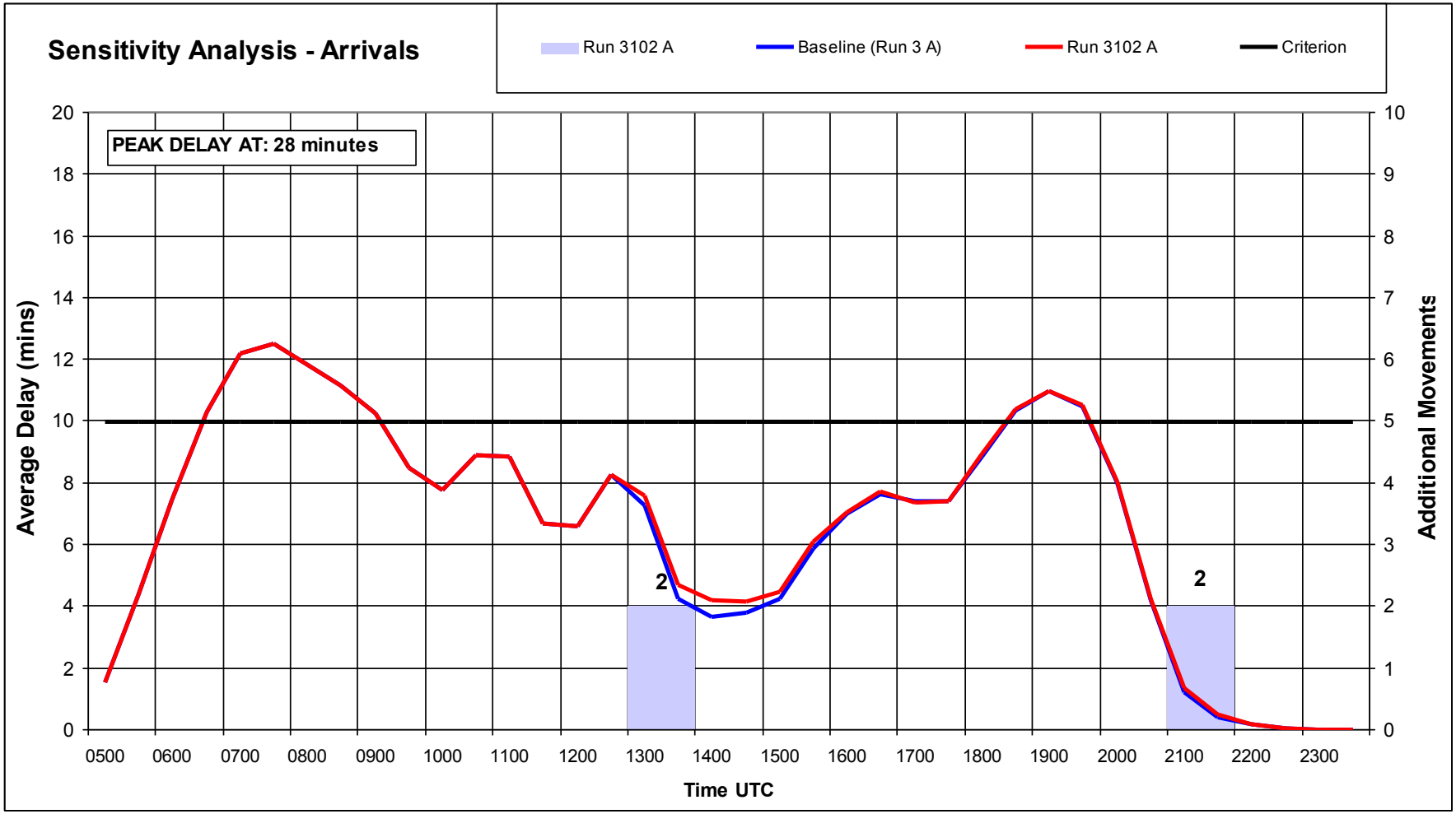
## ARRIVAL Capacity Profile

| Start of Hour UTC | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | Tota |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arrival Capacity | 38 | 39 | 37 | 40 | 40 | 41 | 39 | 43 | 43 | 41 | 42 | 43 | 44 | 43 | 38 | 44 | 21 | 676 |

## DEPARTURE Capacity Profile

| Start of Hour UTC | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | Tota |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Departure Capacity | 25 | 46 | **44** | 43 | 41 | 42 | 41 | 43 | **43** | 44 | **42** | 43 | 44 | 44 | 38 | **37** | 31 | 691 |

# Example: Sensitivity of Delay at LHR




Source: Manager, Slot Coordination, Airport Coordination UK

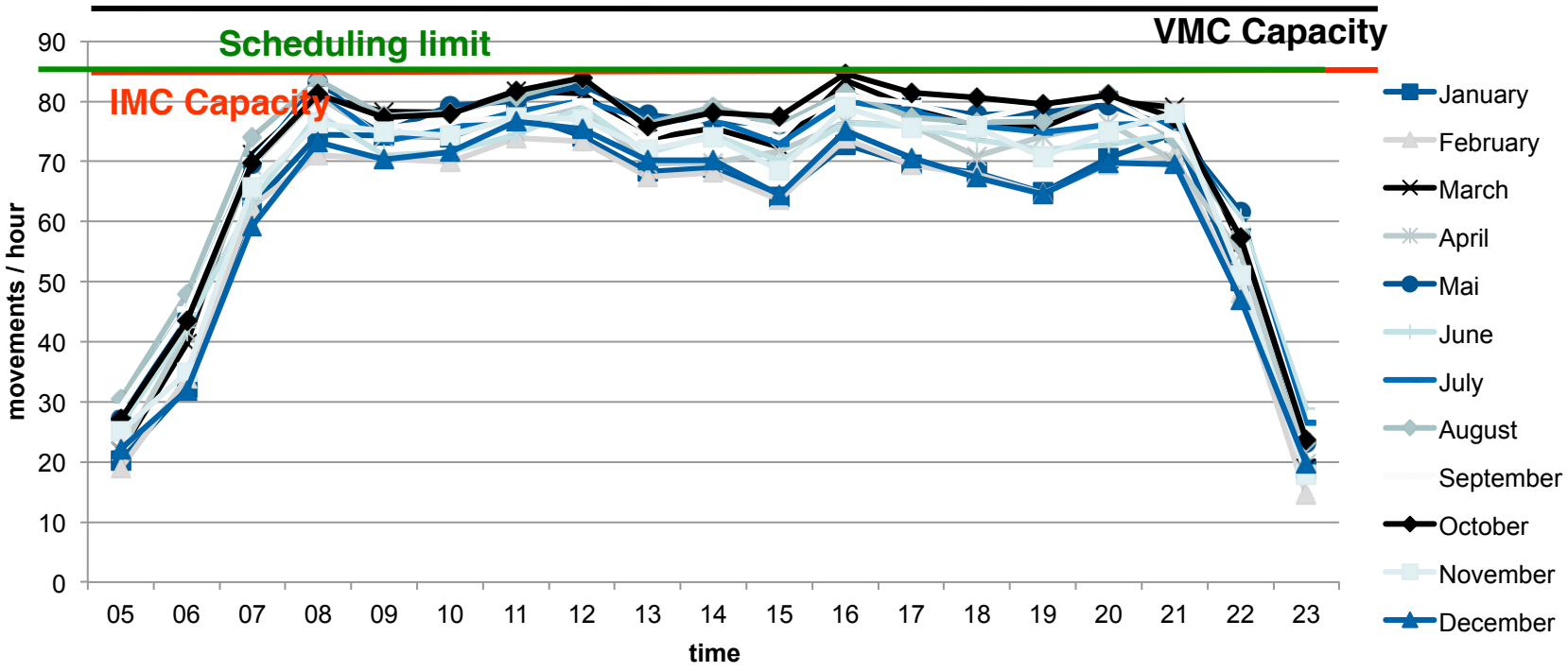
# Slot Availability at LHR

| ARRIVALS | | | | | | | |
|---|---|---|---|---|---|---|---|
| HOUR | Mon | Tue | Wed | Thu | Fri | Sat | Sun |
| 0600 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0700 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0800 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 0900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1100 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1200 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1300 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1400 | 2 | 1 | 2 | 0 | 3 | 0 | 4 |
| 1500 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1700 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1900 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 2100 | 0 | 0 | 0 | 0 | 0 | 15 | 1 |
| 2200 | 4 | 3 | 1 | 2 | 2 | 12 | 3 |

| DEPARTURES | | | | | | | |
|---|---|---|---|---|---|---|---|
| HOUR | Mon | Tue | Wed | Thu | Fri | Sat | Sun |
| 0600 | 0 | 0 | 0 | 0 | 0 | 3 | 12 |
| 0700 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| 0800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| 2100 | 8 | 1 | 1 | 0 | 0 | 12 | 0 |
| 2200 | 0 | 2 | 2 | 1 | 0 | 5 | 0 |

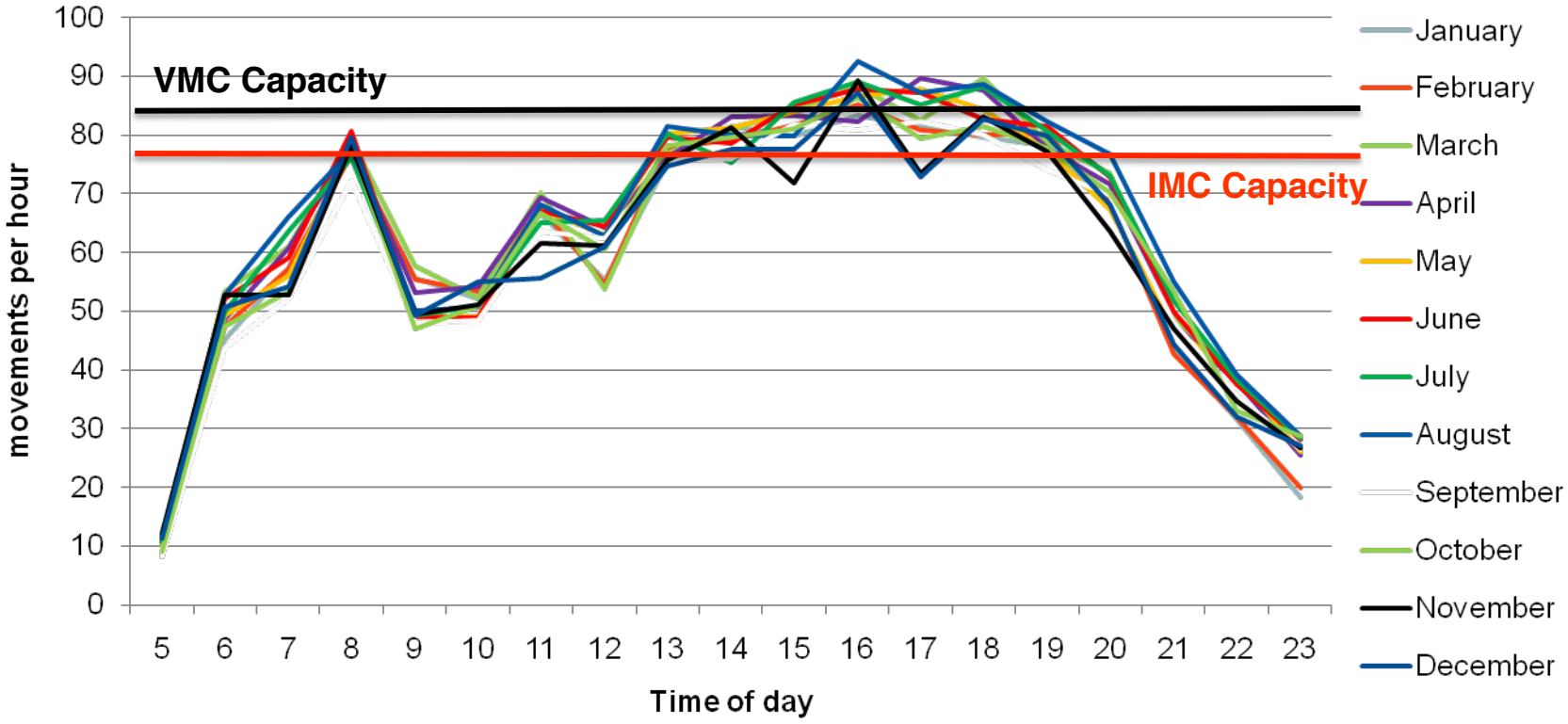
Source: Manager, Slot Coordination, Airport Coordination UK for Summer, 2001

# FRA – Average daily schedule by month (2007)



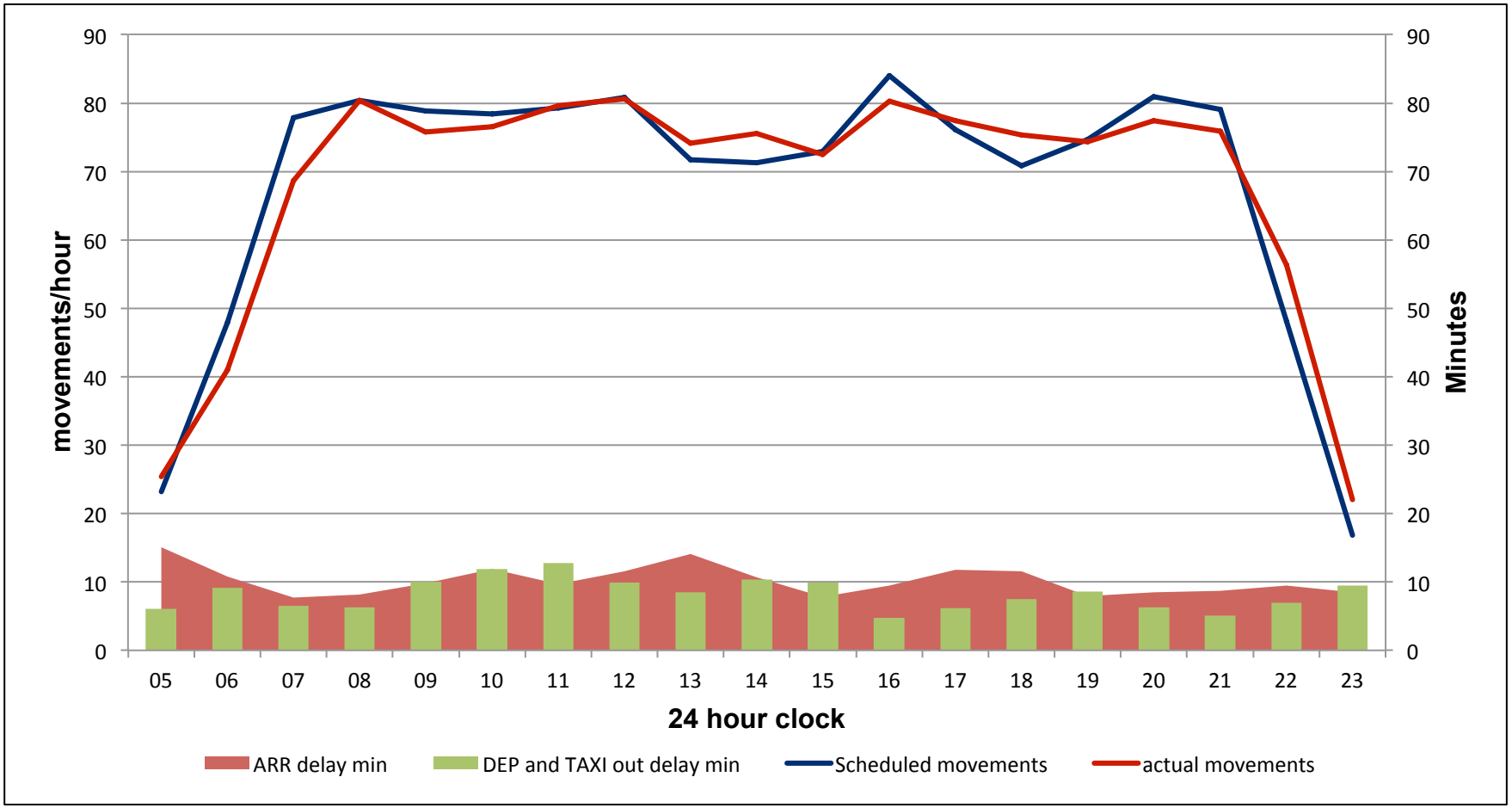

- Evenly distributed demand profile from 07:00 to 21:00
- Hourly demand peaks at 84-movement hourly slot limit

# EWR – Average daily schedule by month (2007)




- Unevenly distributed demand profile with extended afternoon/ evening peak
- Average hourly demand peaks at about 90 movements

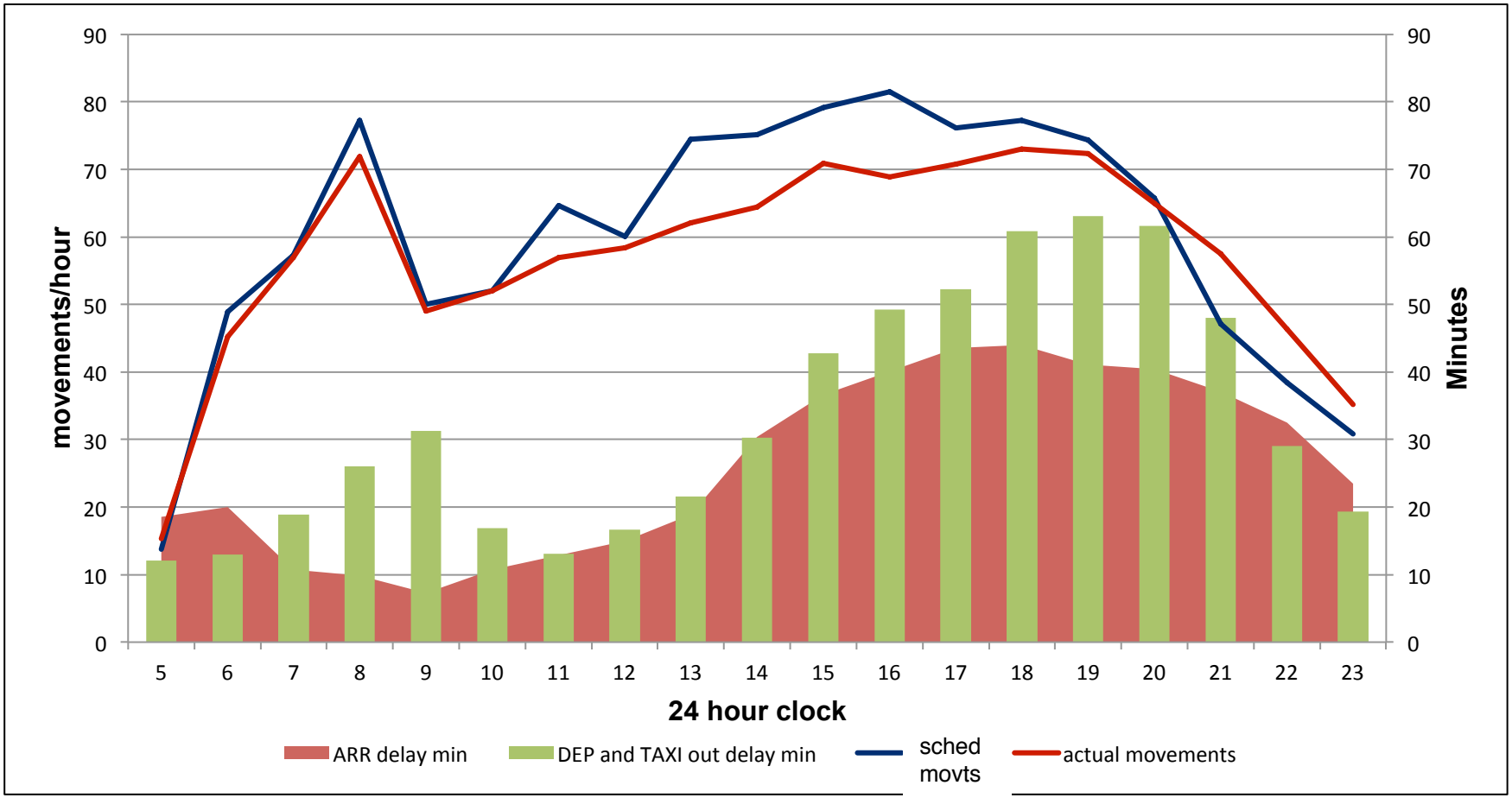
# FRA – 2007 averages: schedule and delays




ARR delays and DEP delays up to +300min (including punctual movements with a delay of 0) are taken into calculation. Average calculation includes hours before 5am. Those are simply not displayed.

Taxi out delays are not in accordance to the standard definition of Eurocontrols PRU, due to lack of data.

# EWR – 2007 averages: schedule and delays

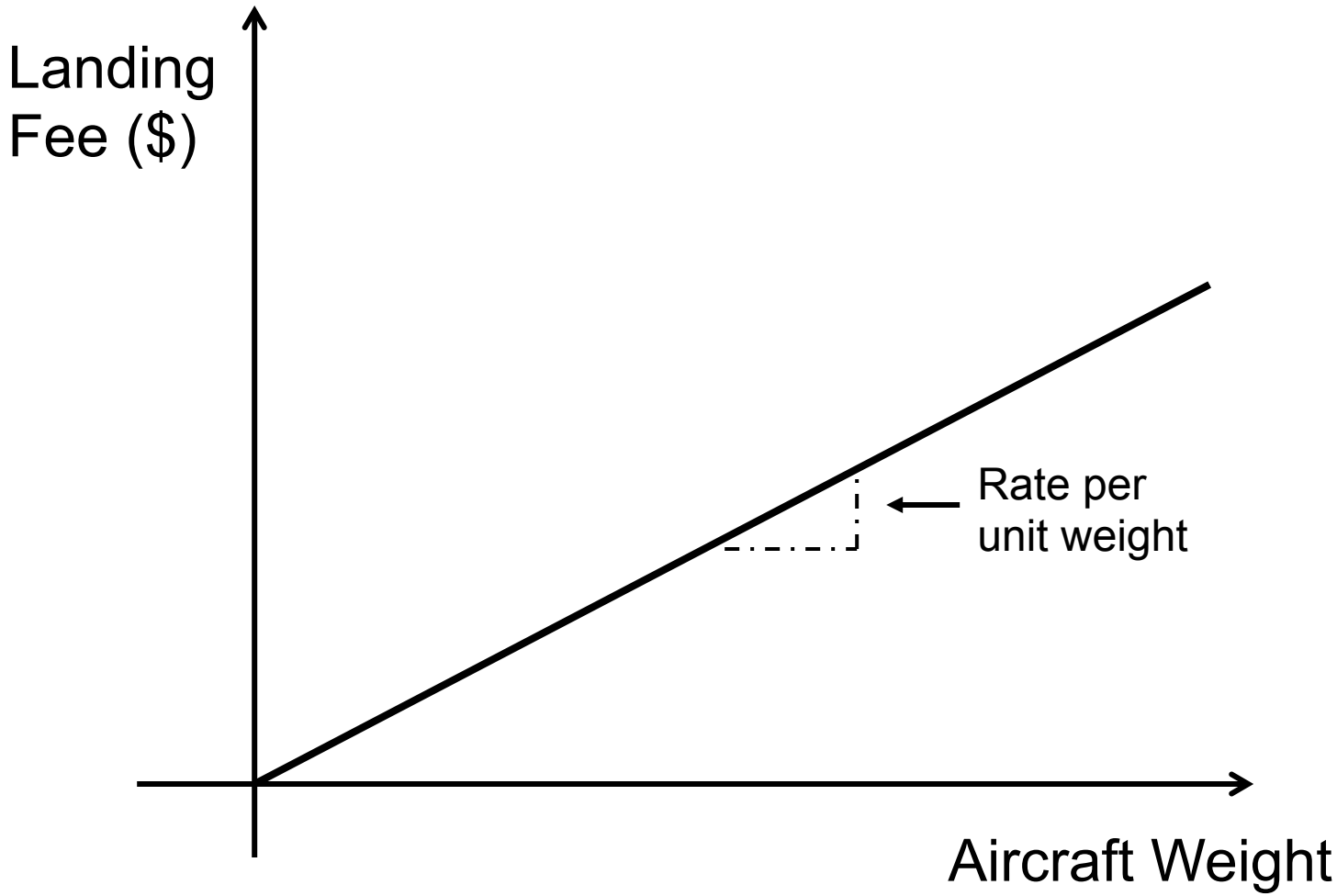



ARR delays and DEP delays up to +300min (including punctual movements with a delay of 0) are taken into calculation.
Average calculation includes hours before 5am. Those are simply not displayed.

# Disadvantages of Slot Coordination

- No consideration of the economic value of a slot; an airline has no way of obtaining a slot to which it assigns high economic value
- By prioritizing punctuality, slot-coordinated airports may often be setting their declared capacity to smaller than optimum values, i.e., may be serving fewer than the optimum number of flights
- Heavy reliance on historical precedent in the allocation of slots and limitations on access by new entrants may inhibit competition
- May mask need for and economic value of additional capacity

# Traditional Weight-Based Landing Fee



# Congestion Pricing: A Key Observation

- The marginal congestion cost associated with an aircraft movement has 2 components:
  - Cost of delay to that movement (***internal*** cost)
  - Cost of additional delay to all other aircraft operators (***external*** cost)
    - At congested airports, this second component can be very large -- often much more than $1000 *per aircraft movement*

❑ *Congestion pricing aims at increasing the efficiency of resource utilization by forcing users to "internalize external costs" by paying a congestion toll*

# Fundamental Principle

- *Optimal use of a congested transportation facility cannot be achieved unless each additional (marginal) user pays for the delay costs that (s)he imposes on all other users* (Vickrey, 1967; Carlin + Park, 1970)

- Application to airports is complicated by difficult technical and sociopolitical issues

- No "pure" application exists to date

# Possible Forms of Congestion Pricing

Due to the many practical difficulties, the realistic possibilities for application of congestion pricing seem limited to charging *during peak periods*:

- A surcharge in addition to the weight-based landing fee
- A flat fee independent of aircraft weight (or variation thereof)
- A multiplier applied to the weight-based landing fee
- A landing fee equal to the larger of a specified minimum charge and of the weight-based landing fee

# Landing Fees, BAA (2005)

| | Heathrow | | Gatwick | | Stansted | |
|---|---|---|---|---|---|---|
| Aircraft weight (tons) | Peak | Off-peak | Peak | Off-peak | Peak | Off-peak |
| MTOW ≤ 16 | £ 590 | £ 250 | £ 385 | £ 110 | £ 95 | £ 85 |
| 16<MTOW≤ 50 | £ 590 | £ 250 | £ 385 | £ 110 | £ 142 | £ 105 |
| 50 < MTOW | £ 590 | £ 425 | £385 | £ 125 | £ 231 | £ 131 |
| For MTOW > 250 | £ 590 | £ 425 | £385 | £ 125 | £ 400 | £ 400 |

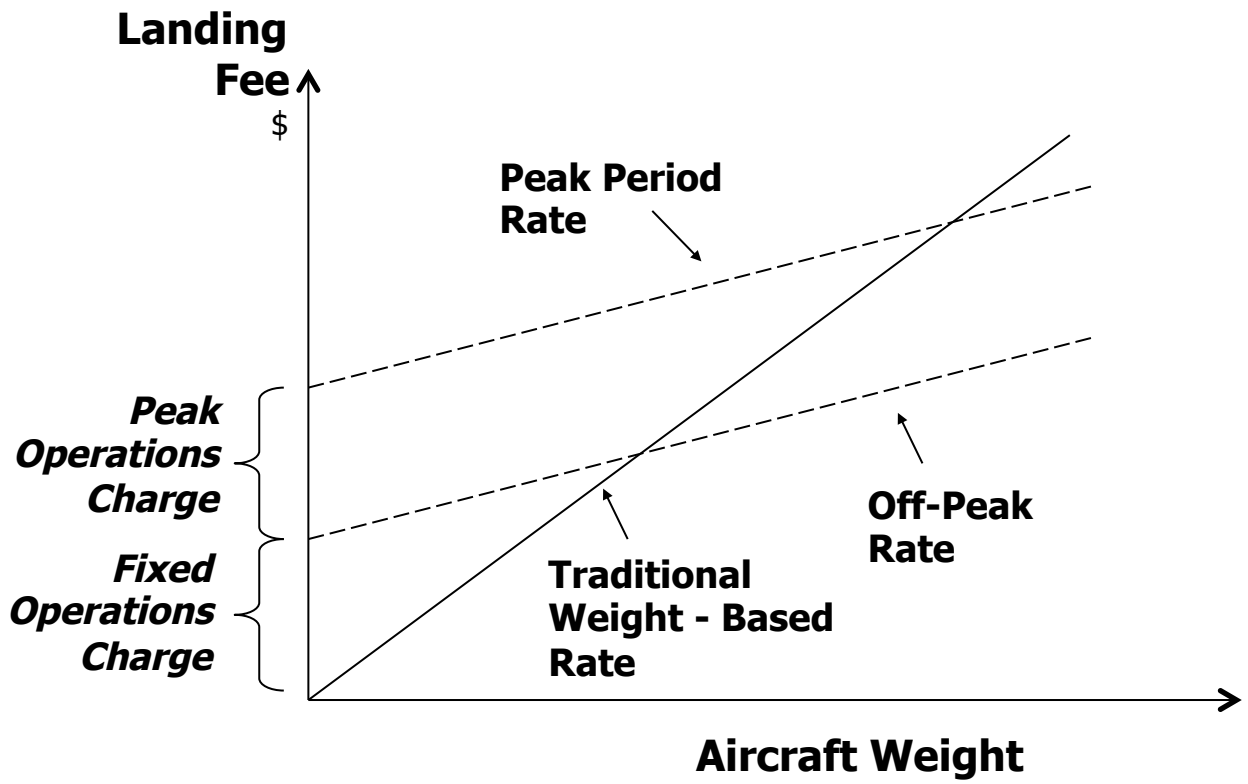
Apply to domestic and international flights

Note: "Peak" varies by airport (e.g., Heathrow peak: 07:00-9:59 and 17:00-18:59 GMT, April 1-Oct. 31)

# Airport Fees, London Heathrow (2010)

- Landing fee for all fixed wing aircraft: £ 776.00 at all times. [*Note:* This is the fee that applies to aircraft meeting "Chapter 3 Base" noise requirements; further adjustments are made for different noise characteristics and late night operations.]
- Air navigation service fee: £ 71.43 + 0.97 per metric tonne of MTOW
- Passenger charge: £ 13.43 per domestic terminal departing passenger; £ 22.97 per international departing passenger
- Aircraft Parking charge: Triple charge for parking between 06:00 and 11:30 in Summer season.

# Boston (1993): Proposed Landing Fee vs. Traditional Weight-Based Fee



# Auctions

- A much-discussed approach for which there is no practical experience to date
- Possible Scenario:
  - Carriers submit sealed bids for any number of slots
  - All slots are auctioned simultaneously

- BUT: How to do this and address all the complexities remains an open question!

# Complexity of Slot Auctions

- Value an airline derives from a slot depends on what other slots it obtains
  - Landings and takeoffs
  - Alternative times for a given flight
  - Slots for connecting flights
- Network effects are also important
  - A slot at a given time at airport A may be useless without a corresponding slot at airport B
- Hence, there is a *huge* number of combinations that each carrier may be interested in at *each* airport.
  - How does one prepare such bids and how does the auction administrator select the best bids?
- A follow-up market is also clearly needed to adjust auctioned slot allocations

# Buying-and-Selling of Slots

- Slots are, temporarily or permanently, the property of current holders
  - May be sold, leased, borrowed against, etc.
- Eligibility to acquire slots may be restricted

- *Key question: Who is the initial owner of an airport's slots?*
- Duration and terms of ownership are important in determining value of slots

# Future Trends: Demand Management

- Innovative slot allocation schemes with emphasis on more efficient use of slots (e.g., incentives for use of large aircraft, "specialized" airports with respect to traffic)

and/or

- Slot allocation schemes that include economic criteria and approaches:
  - Congestion pricing
  - Slot auctions
  - Slot trading

# Questions? Comments?