Airport Evolution and Capacity Forecasting

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1. Motivation for this Paper

- Giving Introduction on Capacity and Demand Issues

- Making Capacity and Demand Calculations and Forecasts consistent

- Analysing Land- and Airside together, however not <u>static</u>, but

- aim is to provide a <u>flexible</u> "model", which can be adjusted to different assumptions with regard to own or published forecasts and master plans and future developments

1. Framework and Future Challenges

- Airlines: (Low Cost) Carrier Competition over Prices on Comparable Routes and Markets (secondary networks)

Choice	Before Deregulation	After Deregulation	Implications of Deregulation
Routes	Strictly controlled	Freedom to change	Loss of secure tenure
Prices	Set by formula	Freedom to change	Price wars
Frequency of flights	Controlled	Freedom to set schedules	Capacity wars
Aircraft type	Often controlled	Freedome to choose	Capacity wars

(Source: De Neufville)

- Airports: Primary Hubs versus Secondary Airports over attractive Charges on comparable Catchment Areas

- Air Traffic Control: Single European Sky with Consolidation of Airspace Blocks beyond national boundaries

Common Uncertainties and Risks:

- Rising Costs with simultaneous diminishing Returns, thereby

- Less available Capital for the Provision of Infrastructure and other major Investments

-> Long-Term Outlook: If Markets work well, Reduction of Monopolistic Powers, reduction of costs and fares and increase of welfare

2. Stakeholder Interdependencies

Passengers	Airlines		Airports	
Costs	Revenues	Costs	Revenues	Costs
Ticket fare	Passenger & baggage >90%	**Direct Costs 60%**	**Aeronautical revenues 47%**	**Operating Expenses 71%**
Taxes & Fees	Freight <10%	Fuel & Oil 37%	Passenger-related 58%	Security (incl. staff) 32%
Additional services		Maintenance & Overhaul 17%	Aircraft-related 42%	Personell (excl. security) 25%
		Flight Deck Crew 13%	**Non-Aeronautical revenues 53%**	Maintenance 10%
		Depreciation 9%	Retail Concessions 25%	Energy & Waste 7%
		Airport Charges 8%	Car Parking 14%	Sales & marketing 2%
		Navigation Charges 8%	Property Income or Rent 14%	Insurance 1%
		Rentals 8%	Subsidies & Grants 5%	Other Costs 24%
		Flight Equipment Insurance 0%	Advertising 3%	**Capital Costs 26%**
		Indirect Costs 40%	Food & Beverage 3%	**Taxes & Other fees 3%**
		Station & Ground 29%	Rental Car Concessions 2%	
		Ticket Sales & Promotion 28%	Others (Asset divestment & other exceptional items, Interests, utility charges & other service provisions, fuel concessions, ground transport) 34%	
		Cabin Attendants 18%		
		Passenger Services 13%		
		General & Administration 11%		
		Load Insurance 1%		

(Source: Own Illustration; Data from ACI Europe, AEA)

Highlights:

- >90% of Airline Revenue is from Passenger Ticket Fares
- 45% of Airline Costs are Fuel, Crew, Maintenance and Airport Charges
- ~50%/50% Aeronautical and Non-Aeronautical Revenues of Airports
- ~70% Airport Operating cost for Labour (Security and Personnel)

3. Economies of Scale and Airport Demand

- Analyzing Capacity and Demand in Aircraft Movements (usually on an hourly basis) for the Airside

- Analyzing Capacity and Demand in Annual and Hourly Passengers for the Landside

(Source: Own Illustration; Data from CAA UK)

- Trend shown over two decades at London-Heathrow

-> Question: How to check trends over time for consistency?

Chart legend:
- Index of International Passengers
- Index of Annual Flights
- Index of Passengers per Flight

X 2.5
X 1.8
X 1.4

LHR 1982:
26.4 million Passengers
255,000 Flights
104 Passengers per Flight

LHR 2009:
65.9 million Passengers
460,000 Flights
143 Passengers per Flight

Y-axis: Index
X-axis: Years (1982–2009)
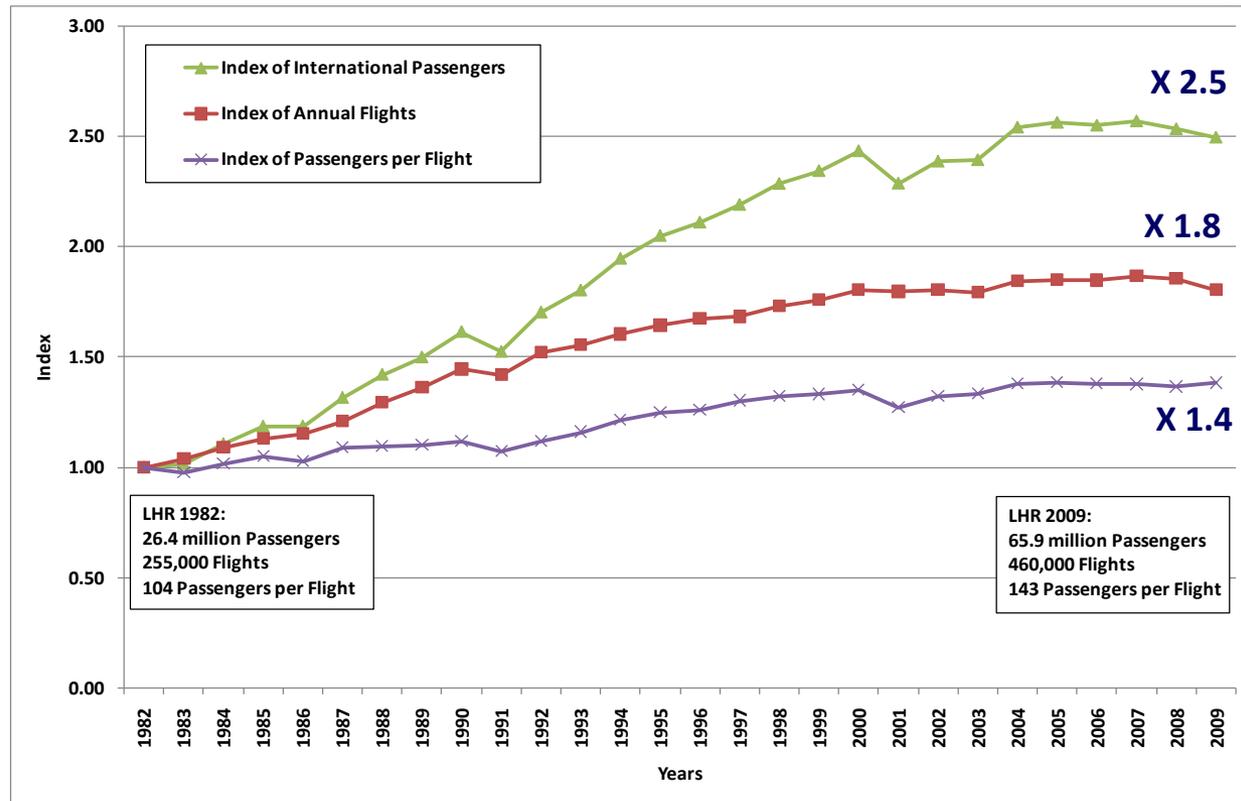
3. Economies of Scale and Airport Demand

- Peak Period Assumptions in support of Data Collection
- Pattern of Demand and Seasonality should be looked at in detail at each airport, but overall European trend is persistent
- We'll usually find Peak (hourly/daily) Demand during summer weeks
- Side note: April 2010 Ash Cloud Airport Closures can be identified
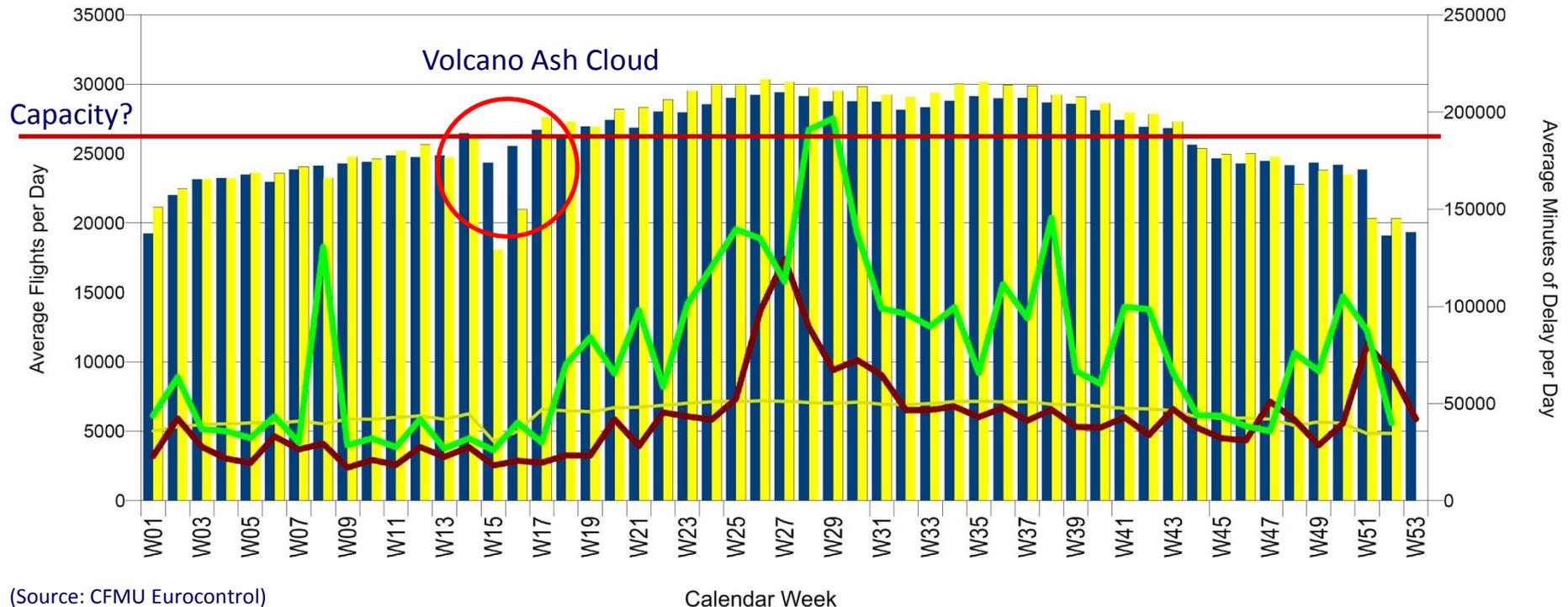
(Source: CFMU Eurocontrol)

3. Economies of Scale and Airport Demand

Assumption Rectangle and Capacities of FRA Airport Traffic for the year 2007/8

Annual Operations (AO)= 486195	n= 112 PAX/Ops	Annual Passengers (AP)= 54501001
y= 0.01810%		x= 0.02487%
Hourly Operations (HO)= 88	m= 154 PAX/Ops	Hourly Passengers (HP)= 13552

		hourly	annually
Maximum Declared Capacity= 82	Max Decl. Terminal Capacity=	14000	0
			(AP/MCTC)
Runway Utilization (HO/MCD)= 107%	Terminal Utilzation (HP/MCTC)= 97%		

Runway Capacity

Legend: ☐ Max decl rwy cap Ops/hr ☐ HO in Ops/hr

Terminal Capacity

Legend: ☐ Max decl terminal cap PAX/hr ☐ HP in PAX/hr

(Source: Own Illustration adapted from Kanafani 1981; Data from EUROSTAT, Flightstats.com and Slot Coordination)

3. Economies of Scale and Airport Demand

- "Assumption Cube": Helps to keep the figures right.
- Checking Assumptions, e.g.

In Master Plans

- Dimensions:
1. Time
2. Functional Area
3. Utilization
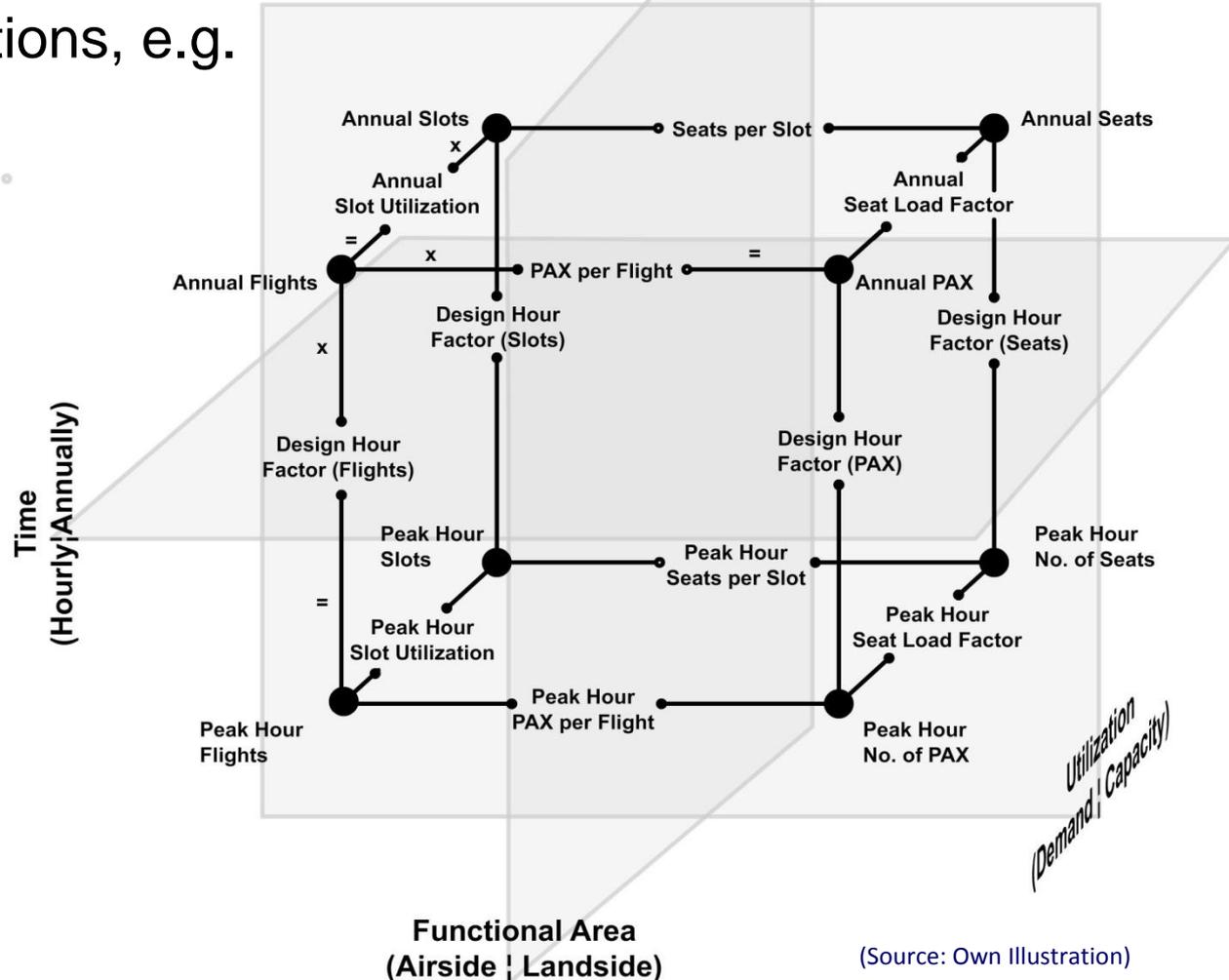
(Source: Own Illustration)

3. Demand Conversion Factors

- Should only be used for back of the envelope calculations and assumptions and should be recalculated as fresh numbers arrive!! (E.g. Annually or after adding capacity to the airport)

Design Hour Factor = Design Peak Hour / Annual Passengers
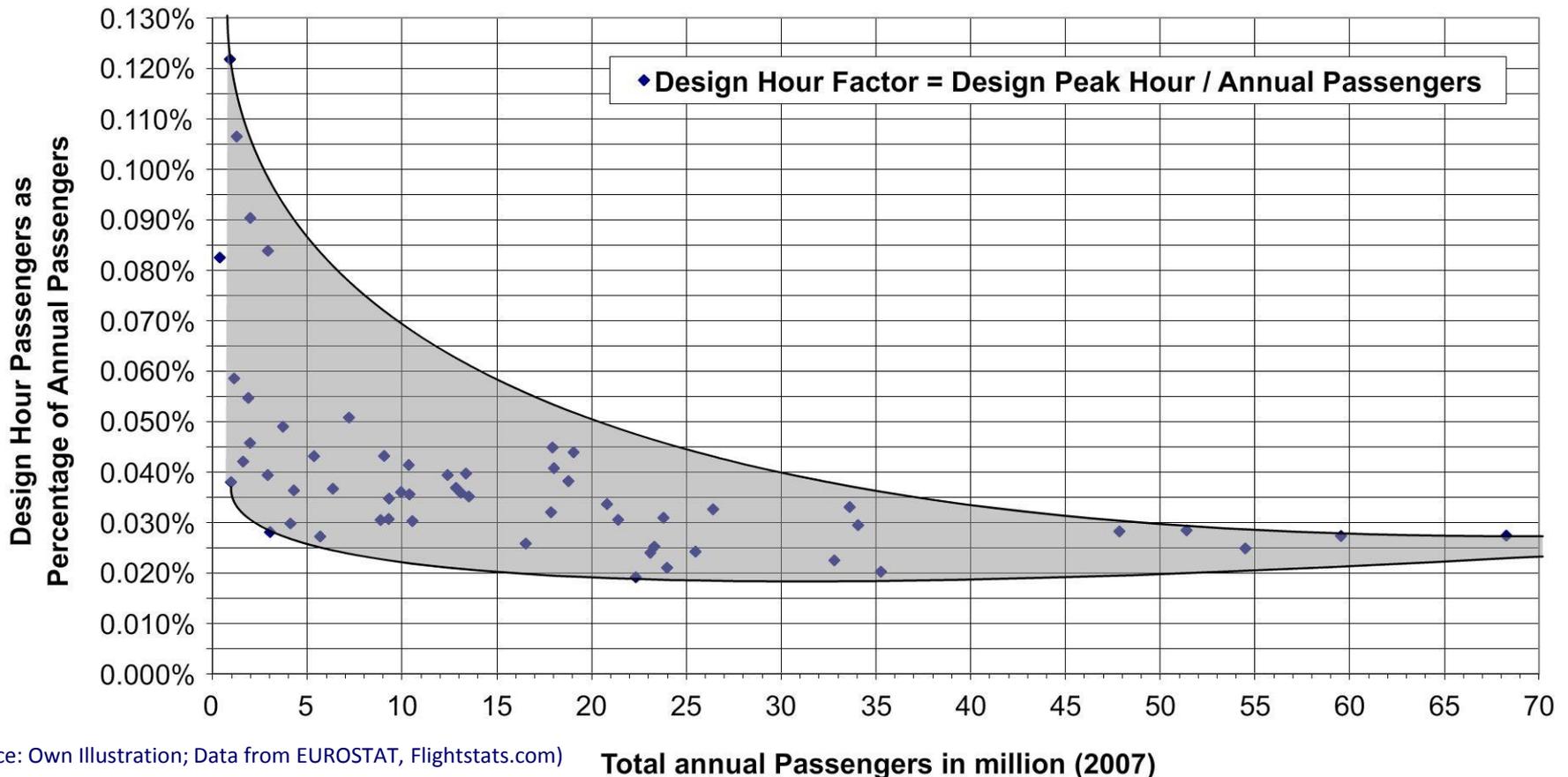
(Source: Own Illustration; Data from EUROSTAT, Flightstats.com)

Total annual Passengers in million (2007)

Y-axis: Design Hour Passengers as Percentage of Annual Passengers

4. Airport Capacity Evolution

- How does the Individual Expansion Path look like?

- Here is an Example of Best Practices with Parallel Runway Configurations, spanning from London-City (LCY) to Atlanta-Hartsfield (ATL)

No. of Runways:
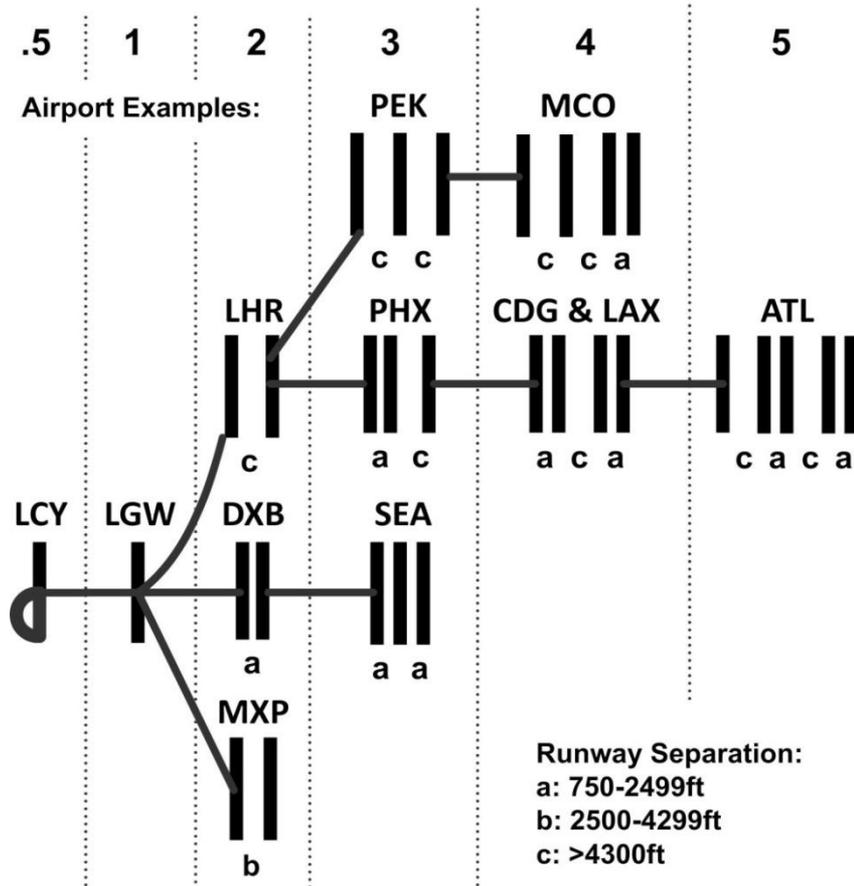
Airport	Peak Hour Flights	Daily Flights	Annual Total PAX in million	Annual Flights
LCY	30	210	3	67,000
LGW	49	600	34	264,000
LHR	95	1250	67	479,000
PHX	90	1280	40	502,000
CDG/LAX	130/106	1400/1600	61/59	560,000/623,000
ATL	200	2650	90	980,000

Runway Separation:
a: 750-2499ft
b: 2500-4299ft
c: >4300ft

(Source: Own Illustration; Data from Flightstats.com, ACI)

(Source: Own Illustration)

4. Airport Capacity Evolution

- Further Examples:

  Madrid-Barajas

London-Heathrow

before 1998   1998   2006
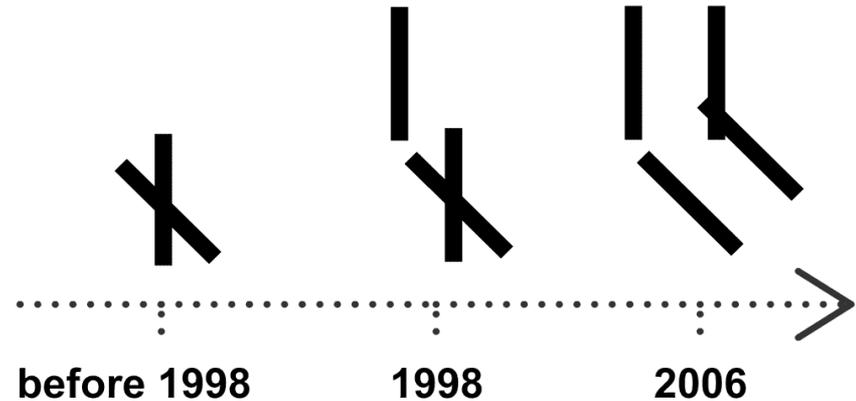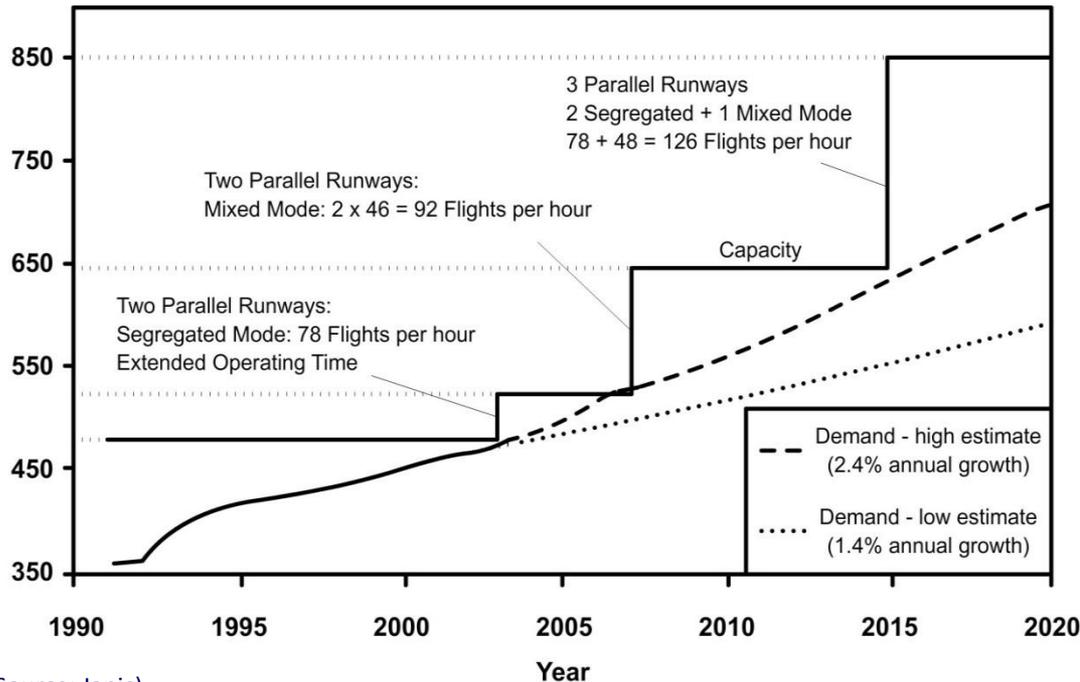
MAD:

<1990: 30 flights per hour

<1998: 50 flights per hour

 1998: 74 flights per hour

2006: 100 flights per hour

(Source: Own Illustration; Data from SRI International, Flightstats.com)

(Source: Janic)

5. Airport Congestion and Level-of-Service

- Setting a LoS ultimately limits the airport capacity

- Waiting times increasingly more important than actual physical infrastructure

- Two airports (here London-Heathrow and Munich with parallel independent runways) set different ranges of Maximum Airside Capacity

- Spectrum results from different modes of operation and aircraft type mixes (segregated mode and high % of HEAVY flights to Mixed mode and high % of MEDIUM flights)

Chart: Average Delay per Flight vs. Flights per Day, with annotations "LOS LHR: 10 min" and "LOS MUC: 5 min"
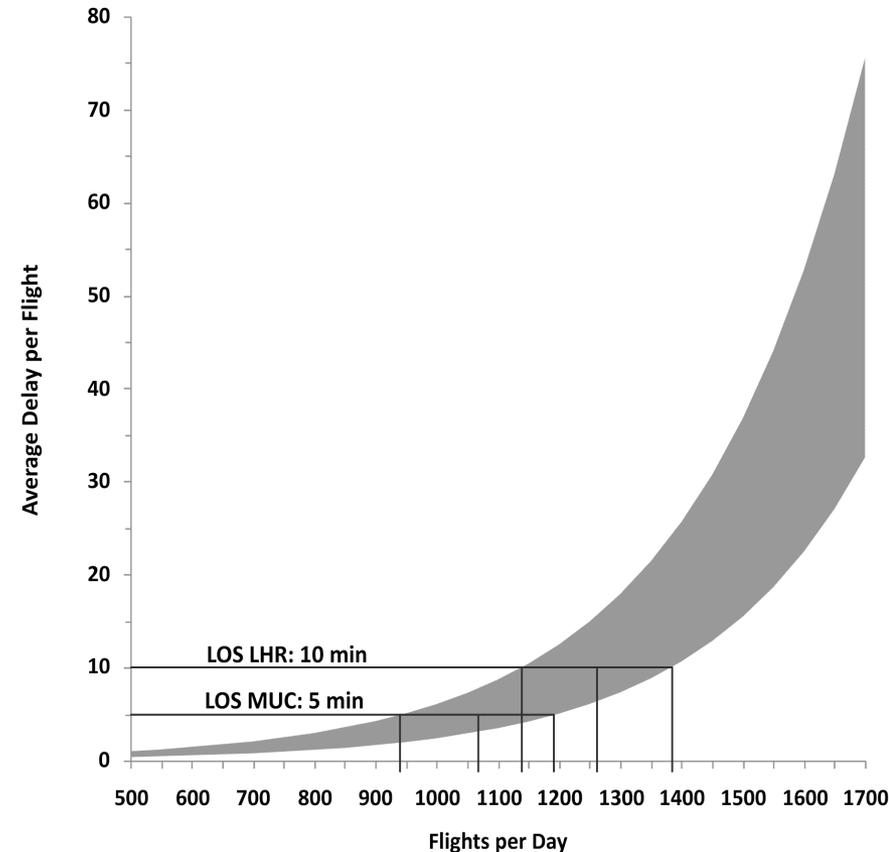
(Source: Own Illustration)

Conclusion and further Research

- New technology will deliver further insights into state of congestion (Demand/ Capacity).

- ADS-B Signals already today show the impact on the nearby environment (as is shown with the holding pattern of nearby London-Heathrow airport)

- This will lead to further assumptions on airspace level-of-service and maximum runway capacity, but also on externalities

(Source: Own Illustration; Track data from Casper.Frontier.nl)

Thank you for your attention! Questions?

Suggestions and Comments are welcome.

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