



# **European Idle Network Capacity – An Assessment of Capacity, Demand and Delay at 33 congested Airports**

GAP pre-Infraday Workshop

Branko Bubalo – Berlin October 9<sup>th</sup>, 2009

Graduate of Berlin School of Economics and Law

And University of Applied Sciences Berlin

Member of GAP research project

Working for Envisa transportation consulting firm

# Why Airport Benchmarking?

- **Finding the „best-in-class“** based on performance and efficiency
- **Giving answers to stakeholders of the industry:** operators, owners, stock market, government, users and regulators
- Problem: **How to compare „like with like“** in a cross country comparison and across airports of different size?
- Problematic for difference in prices, accounting standards, services provided, outsourced labor, stage in investment cycle, service quality etc. (Forsyth 2004)

# Motivation of the study

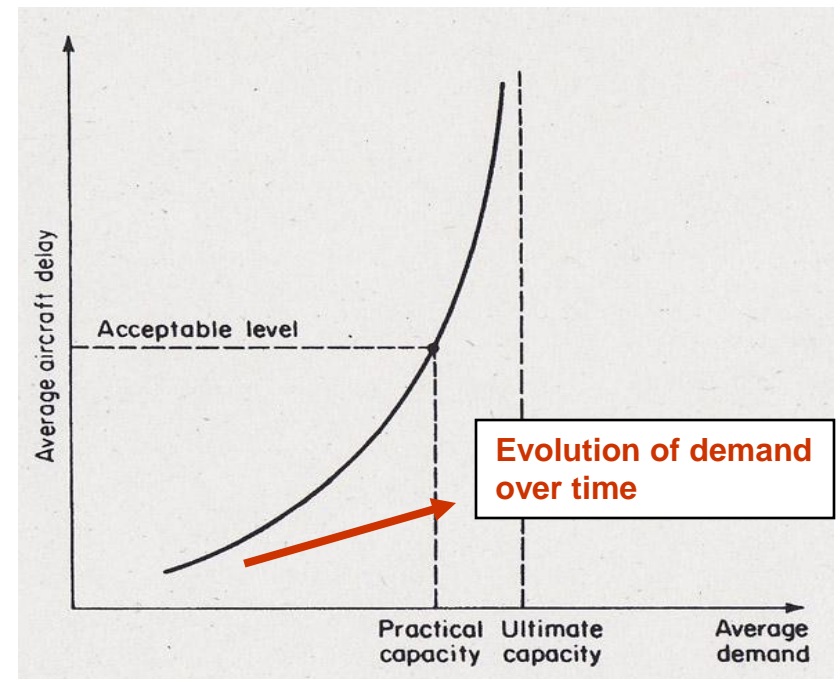
- **Development of a Key Performance Indicator based on operations/flights** taking capacity utilization into account, which could serve as a measure for **(DEA)** Benchmarking analysis
  - >**Avg. Delay per aircraft** seems adequate, but hard to predict
- **What is the right timeline?** Year, month, week, day, hour, 30 min, 20 min, 15 min or flight-by-flight
- **Aircraft mix** and **runway configuration** should be taken into account.
- Reduction of complexity and time effort to a minimum („**Keep it simple**“)
- **Development of airport peer groups or categories.**
- **Establishing a basis for (peak) pricing schemes**, approx. PAX numbers for facility planning and management, forecasts, ground handling staff planning, investments and slot auctioning.

# Introductory Literature

- IATA „Airport Capacity/Demand Management“ 1981
- IATA „Airport Development Reference Manual“ 1995 & 2004
- ICAO Annex 14 „Aerodromes“ 2004
- ICAO „Aerodrome Design Manual“ 1985 and „Airport Planning Manual“ 1987
- FAA AC 150/5060-5 „Airport Capacity and Delay“ 1983/1995
- Milan Janic: “The Sustainability of Air Transportation” 2007
- Ashford, N., Wright P. (1992), “Airport Engineering”, 3rd ed. New York: McGraw-Hill
- Horonjeff, R., McKelvey, F. X. (1994), “Planning and Design of Airports”, 4th ed. New York: McGraw-Hill
- De Neufville, R., Odoni, A. (2003), “Airport Systems: Planning, Design, and Management”, The McGraw-Hill Companies, Inc., 2003

# Introduction and Scope

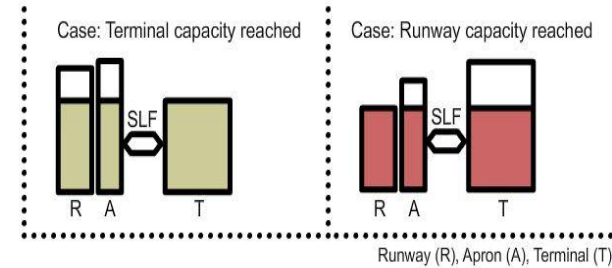
- **Capacity** represents the maximum throughput per unit of time of a specific system
- **Capacity Utilization = Demand/Capacity**
- For Europe **only IFR flights** are relevant (“99% of all commercial flights”)
- **Weight-based separation standards** between succeeding aircrafts are the **main capacity limitation**
- Focus **only** on **runway capacity**
- Looks **only** at **aircraft movements**
- **Practical (hourly) capacity** ~ **80% of ultimate CAP**
- **Delays increase strongly beyond an acceptable level** (e.g. 4 min average delay per Flight) as demand approaches ultimate CAP
- -> **need to find ultimate CAP**



# Understanding the system

## Limiting Factors for Capacity and Interdependencies at Airports

Capacity limit dictated by:



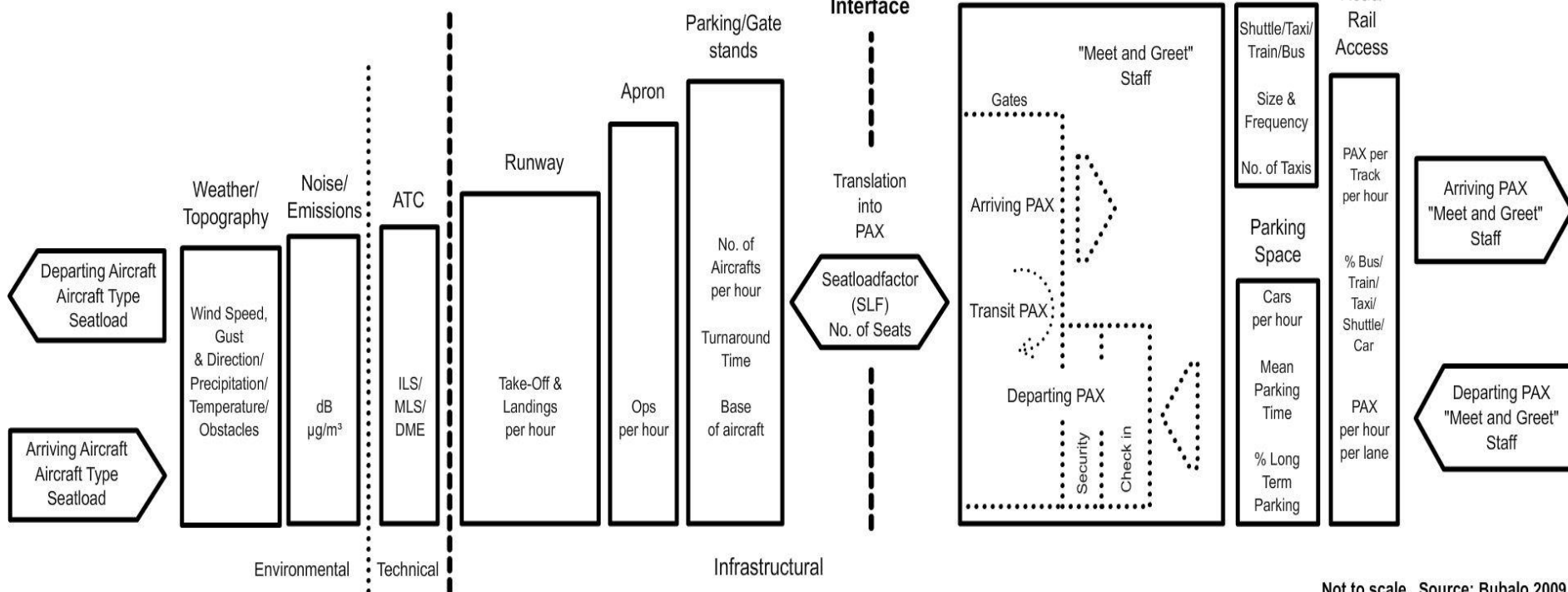
### Airport Interface

### Airside / Landside Interface

### Terminal

### Modality

### Road/ Rail Access



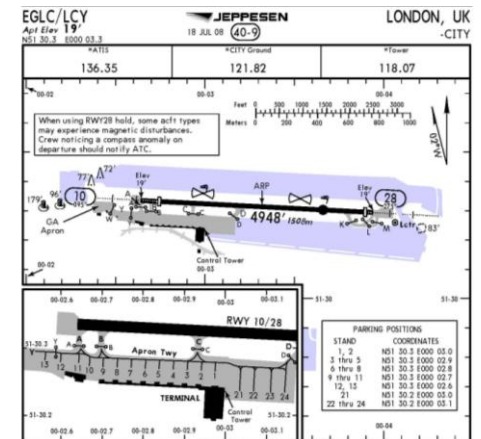
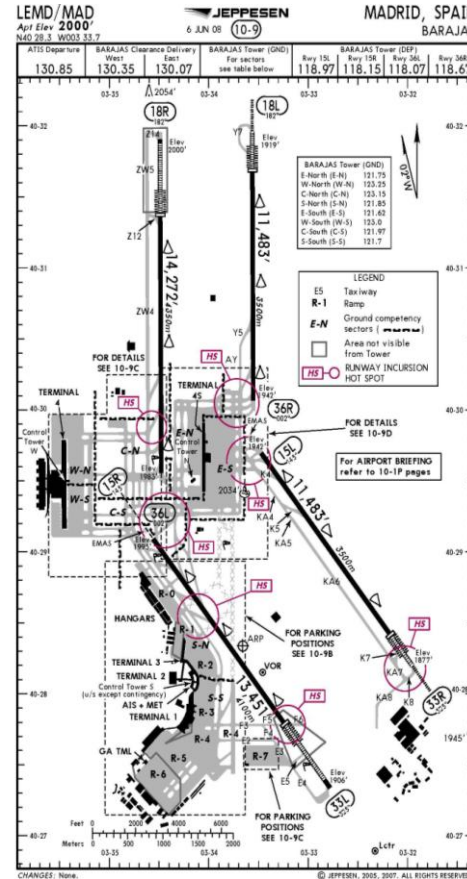
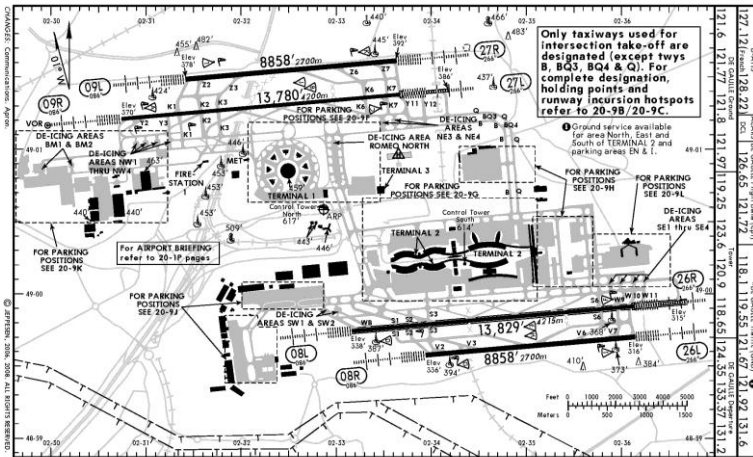
Not to scale. Source: Bubalo 2009

# How to calculate and benchmark runway capacity for these airports?

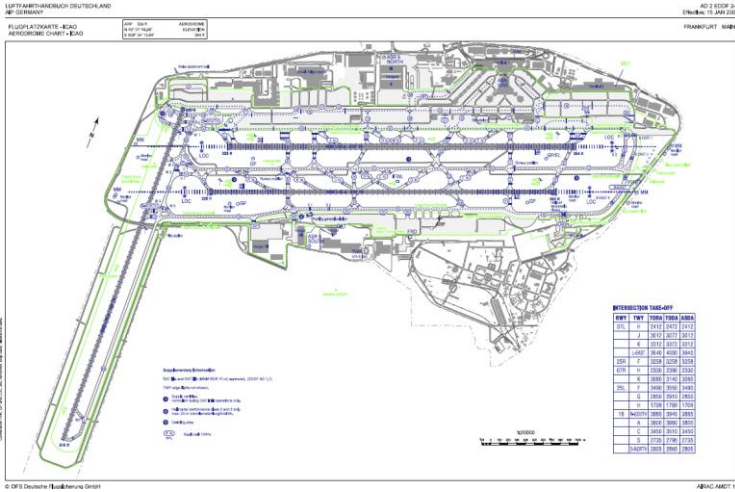
Madrid Barajas (MAD)

London-City (LCY)

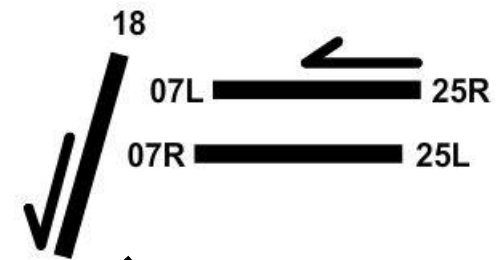
Charles-de-Gaule (CDG)



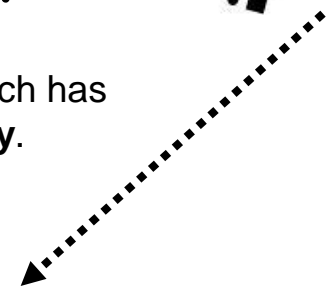
# Capacity Example: Frankfurt Airport



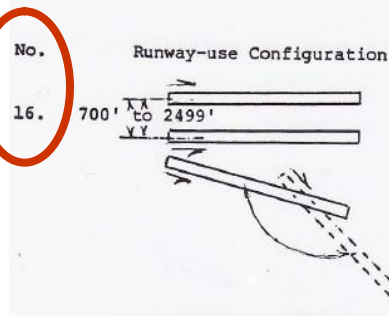
Information on **Preferential Runway System** comes from the **AIP's**.



Choose Preferential Runway System which has the **highest capacity**.



**Runway-use Configuration No. 16**

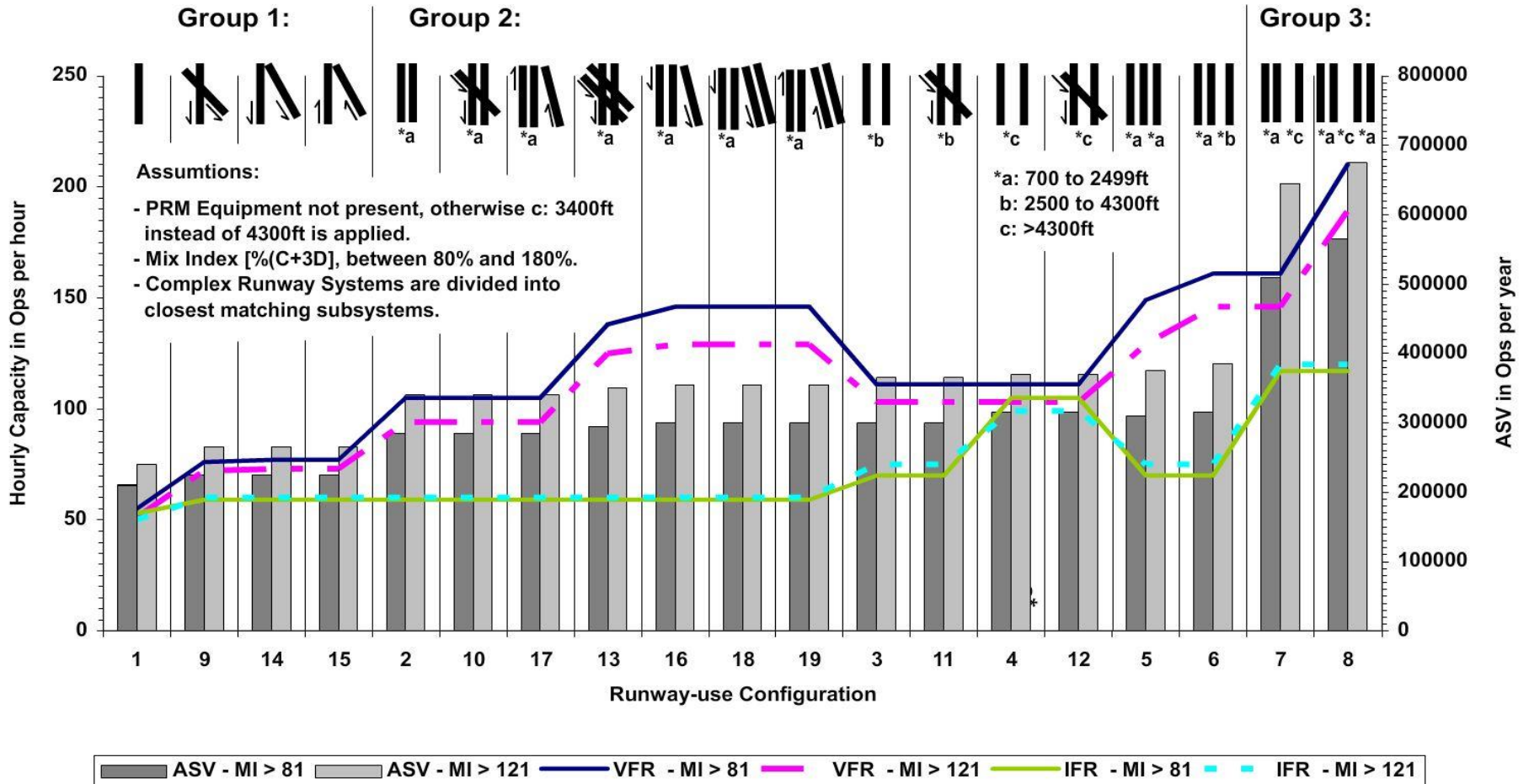


Mix Index %(C+3D)	Hourly Capacity Ops/Hr		Annual Service Volume Ops/Yr
	VFR	IFR	
0 to 20	295	59	385,000
21 to 50	210	57	305,000
51 to 80	164	56	275,000
81 to 120	146	59	300,000
121 to 180	129	60	355,000



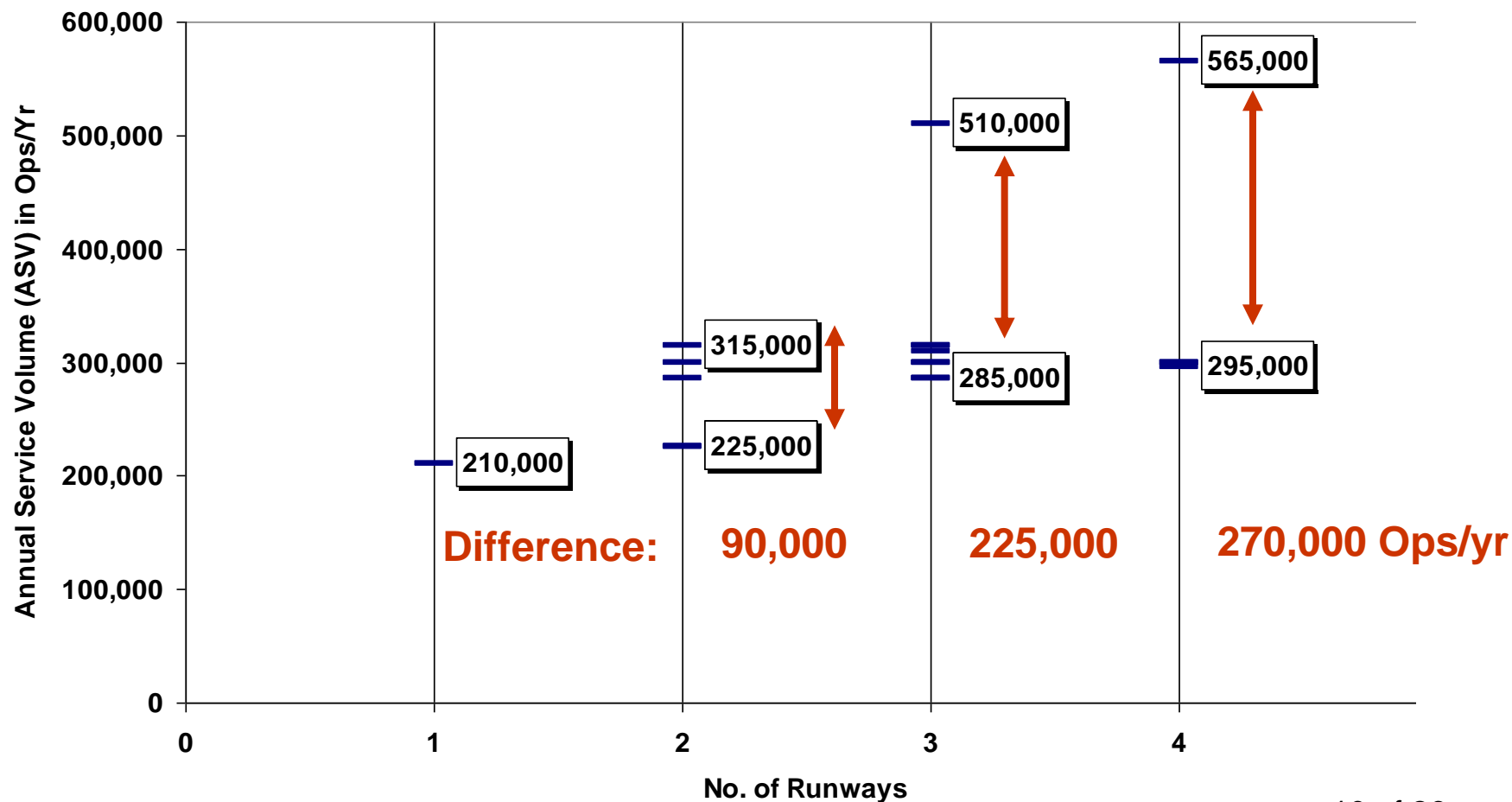
# Find the right scheme for preferential runway system

Annual Service Volume (Ops/yr), Hourly Capacity for IFR and VFR flights (Ops/hr)  
by Runway-use Configuration for Traffic Mix Index (MI) > 80  
(Source: Bubalo 2009 based on FAA 1985, ranked by ASV)



# Drawbacks of previous performance benchmarking studies: Number AND Configuration of Runways must be considered together

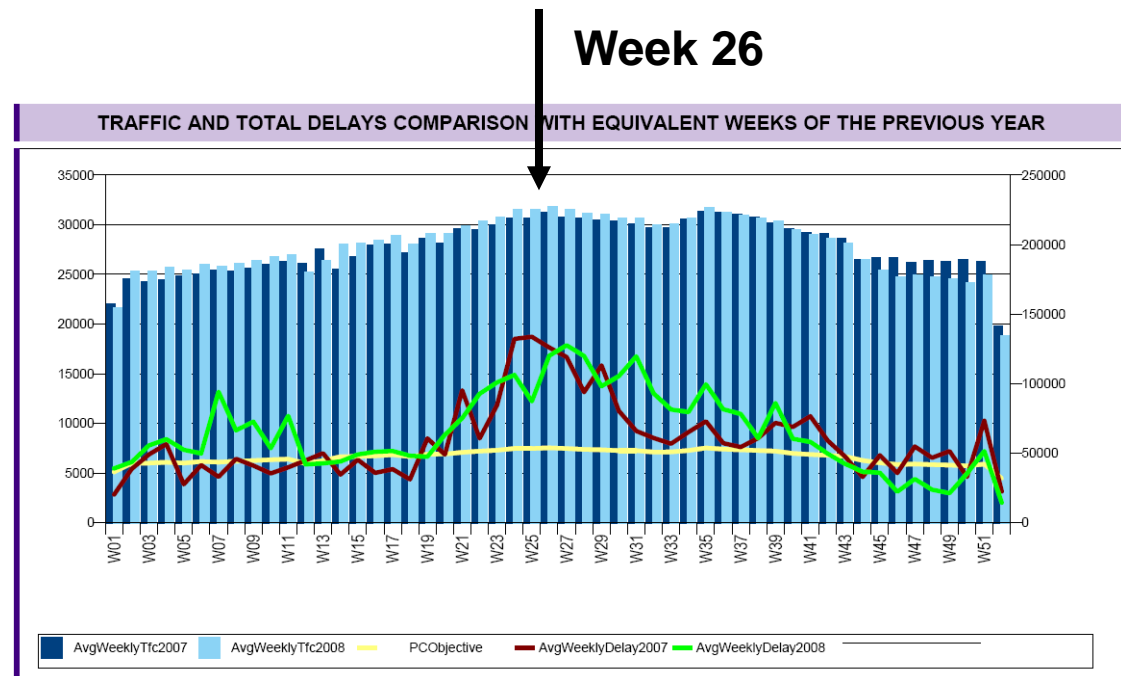
**Number of Runways not suitable for Productivity Analysis**  
(Range of ASV by Number of Runways for MI = 81-120%)



# Simplification regarding Design Peak Hour (DPH) Definition

- Pattern shows that **Peaks are mostly in Week 25/26/35/36**
- **Friday is usually the busiest day of the week (MON or THU 2<sup>nd</sup>)**
- **Friday of Week 26 is always in the top 5 peak days**
- to meet IATA DPH definition, not absolute PH was chosen, but **representative DPH of Peak Day, Thursday of Week 26 (PDTHUW26)**
- **PH of PDTHUW26 should be in the range of 2<sup>nd</sup> to 30<sup>th</sup> PH**

2005			2006			2007			2008		
Day	Week of the year	Flights	Day	Week of the year	Flights	Day	Week of the year	Flights	Day	Week of the year	Flights
Fri 17/06/2005	24	30663	Fri 15/09/2006	37	31914	Fri 31/08/2007	35	33506	Fri 27/06/2008	26	34476
Fri 01/07/2005	26	30569	Fri 01/09/2006	35	31841	Fri 29/06/2007	26	33480	Thu 26/06/2008	26	33895
Fri 02/09/2005	35	30469	Fri 30/06/2006	26	31686	Fri 14/09/2007	37	33371	Fri 13/06/2008	24	33833
Fri 16/09/2005	37	30338	Fri 08/09/2007	36	31553	Fri 07/09/2007	36	33279	Thu 19/06/2008	25	33383
Fri 09/09/2005	36	30169	Fri 22/09/2006	38	31550	Fri 21/09/2007	38	32971	Fri 04/07/2008	27	33342



-> **Get PDTHUW26 traffic data**

# Basic Indicators of Airport Sample

Rank	Airport	Operating Hours	No. of Runways	Mix Index in %	FAA Runway-use Config. No.	Group	2007 Annual PAX in million	2007 Annual Ops
1	CDG	24/7	4	140	8	3	59.55	569,281
2	MAD	24/7	4	118	8	3	51.40	470,315
3	AMS	24/7	5.5	136	4 + 9	3	47.85	443,677
4	FRA	6-23	3	149	16	2	54.50	486,195
5	LHR	24/7	2	170	4	2	68.28	475,786
6	MUC	6-23	2	112	4	2	34.07	409,654
7	BCN	24/7	3	103	12	2	32.81	339,020
8	FCO	24/7	3	114	12	2	33.62	328,213
9	LGW	24/7	2	118	2	2	35.27	258,917
10	CPH	24/7	2.5	109	12	2	21.40	250,170
11	BRU	24/7	3	123	12	2	17.93	240,341
12	ORY	6-23:30	2.5	112	12	2	26.42	238,384
13	OSL	24/7	2	101	4	2	19.04	226,221
14	ZRH	6-23	3	121	10	2	20.81	223,707
15	DUS	6-23	2	107	2	2	17.85	223,410
16	MAN	24/7	2	116	2	2	22.33	206,498
17	IST	24/7	3	117	16	2	25.49	206,188
18	ARN	24/7	3	106	12	2	18.01	205,251
19	PMI	24/7	2	100	4	2	23.10	184,605
20	HEL	24/7	3	107	12	2	13.10	174,751
21	NCE	24/7	2	55	2	2	10.38	173,584
22	TXL	6-23	2	107	2	2	13.37	145,451
23	LYS	24/7 6-23 coord	2	102	2	2	7.19	132,076
24	VIE	24/7	2	109	14	1	18.77	251,216
25	DUB	24/7	3	108	14	1	23.31	200,891
26	STN	24/7	1	102	1	1	23.80	191,520
27	PRG	24/7	2	102	9	1	12.40	164,055
28	HAM	6-23	2	106	9	1	12.85	151,752
29	WAW	24/7	2	103	9	1	9.29	147,985
30	LIS	6-24	2	117	1	1	13.52	141,905
31	STR	6-23	1	101	1	1	10.35	139,757
32	BHX	24/7	1	104	1	1	9.32	104,480
33	LCY	6-22	1	100	1	1	2.91	77,274
	Total						810	8,182,530
	Mean		2	112			25	247,955

German airports have a clear disadvantage regarding operating hours

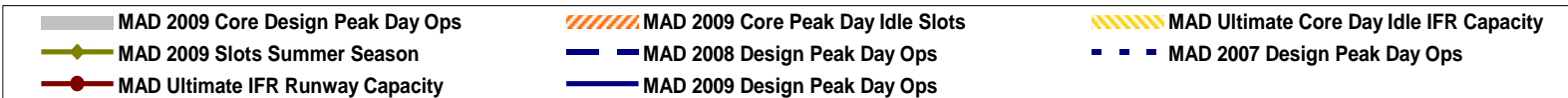
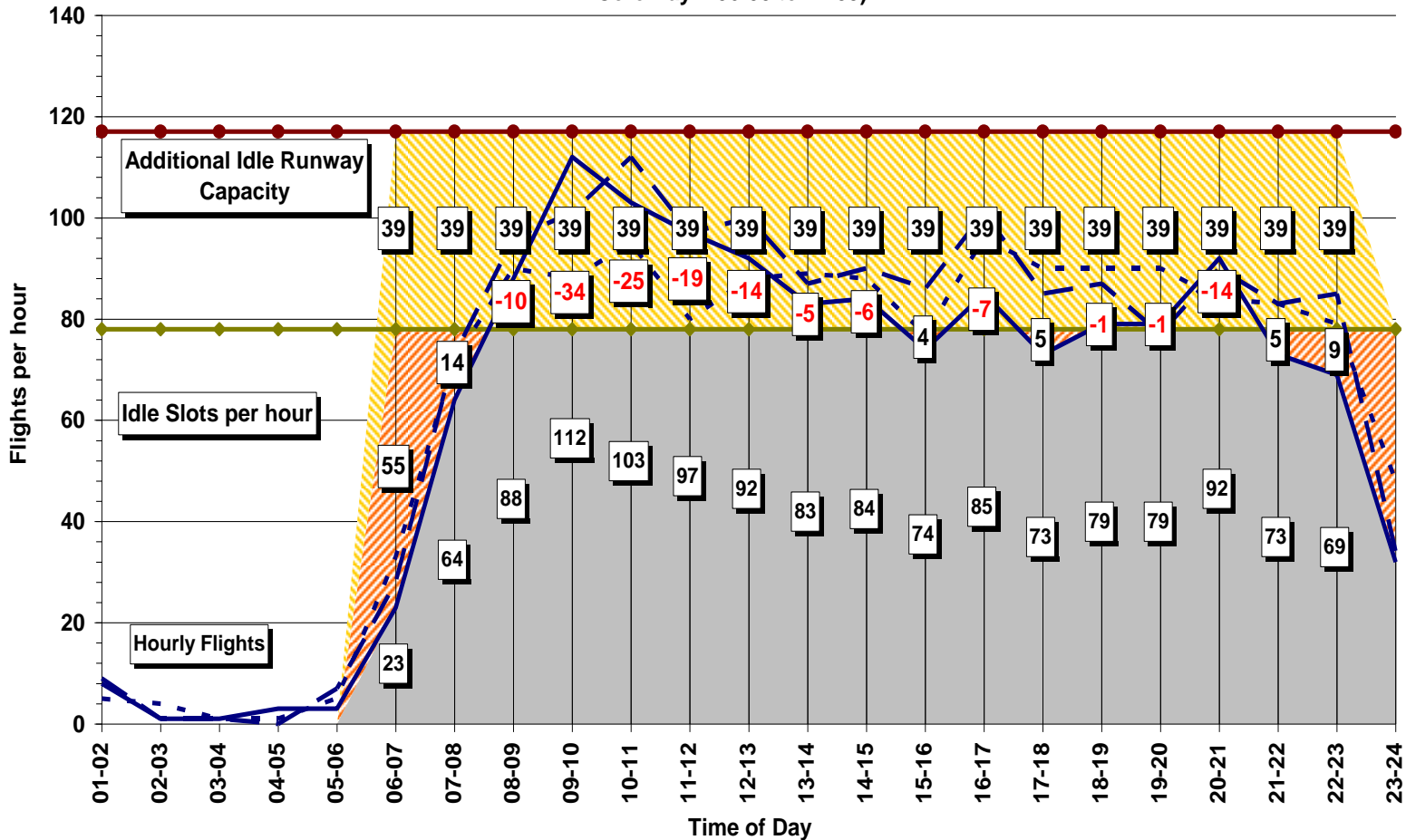
Some Restrictions during night time are common

High MI Due to Mostly heavy a/c at LHR

Low MI at Nice due to mainly helicopter Ops

# Example: MAD Peak Day Traffic

Capacity, Peak Demand and Idle Capacity on PDTHUW26 2009  
 (PDTHUW26 = Thursday of Week 26 as representative Peak Day  
 Core Day = 06:00 to 22:59)



# European Airport Demand Overview

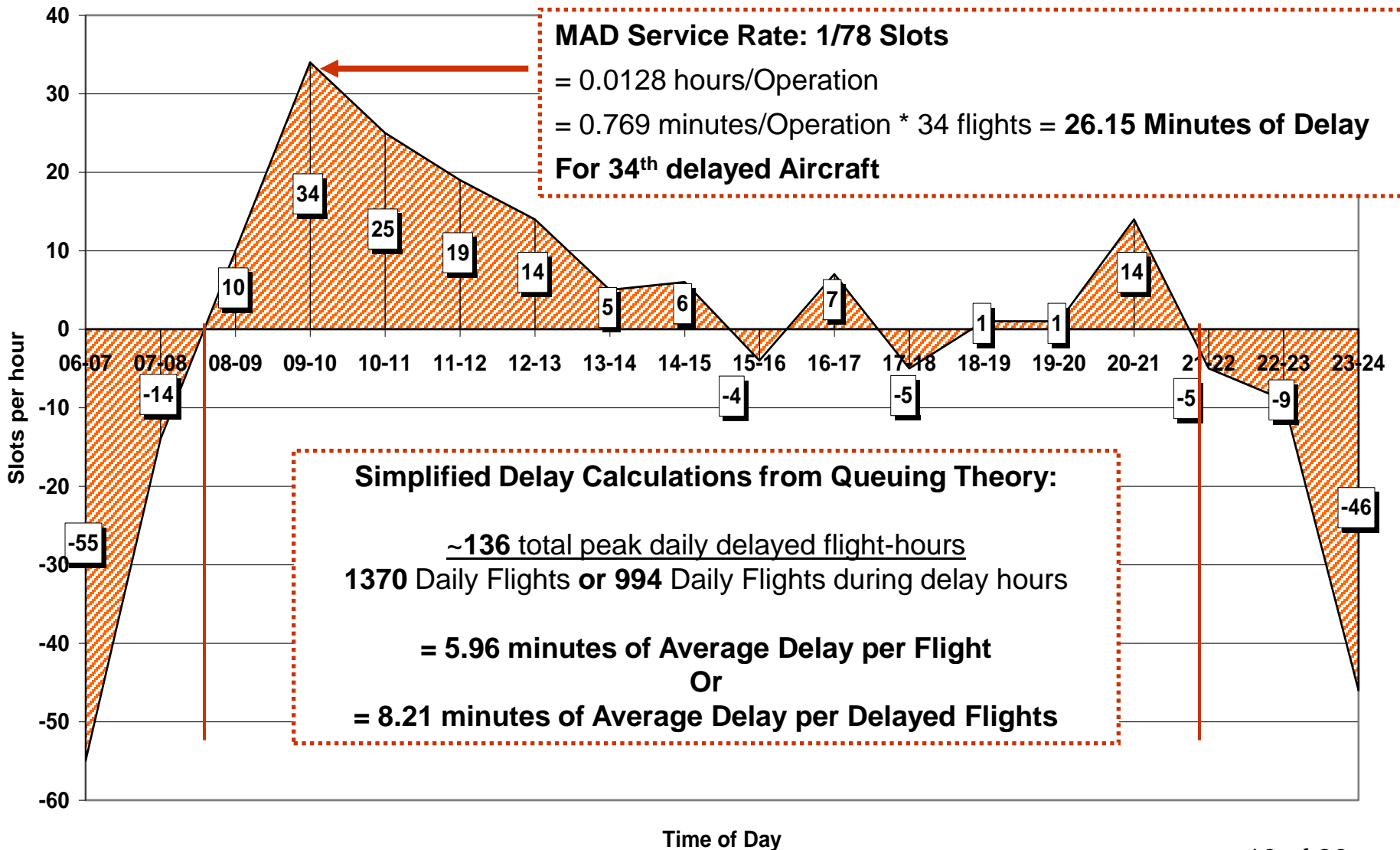
Rank	Airport	Annual Demand				Daily Demand				Hourly Demand			
		2007		2008		2009		2007		2008		2009	
		Annual Ops *2007 EUROSTAT	Design Peak Day (DPD) Ops	Design Peak Day (DPD) Ops	Design Peak Day (DPD) Ops	Design Peak Day (DPD) Ops	Design Peak Day (DPD) Ops	Design Peak Hour (DPH) Ops	DPH Ops	DPH Ops	DPH Ops	DPH Ops	DPH Ops
1	CDG	569,281	1624	1657	1424	114	126	107					
2	MAD	470,315	1412	1478	1370	96	112	112					
3	AMS	443,677	1321	1392	1188	109	111	106					
4	FRA	486,195	1373	1342	1274	92	89	87					
5	LHR	475,786	1530	1530	1386	103	103	90					
6	MUC	409,654	1258	1277	1144	99	93	92					
7	BCN	339,020	1071	940	866	86	80	74					
8	FCO	328,213	1076	1338	1110	109	103	100					
9	LGW	258,917	757	802	678	55	56	49					
10	CPH	250,170	811	776	712	67	70	62					
11	BRU	240,341	784	800	736	77	71	67					
12	ORY	238,384	765	749	710	62	63	60					
13	OSL	226,221	678	693	577	66	60	49					
14	ZRH	223,707	754	681	654	69	57	57					
15	DUS	223,410	713	718	701	58	51	58					
16	MAN	206,498	671	669	499	60	69	51					
17	IST	206,188	593	607	663	42	44	47					
18	ARN	205,251	666	727	528	61	61	50					
19	PMI	184,605	529	551	502	50	44	45					
20	HEL	174,751	497	496	434	47	41	44					
21	NCE	173,584	515	610	469	47	52	48					
22	TXL	145,451	496	531	482	43	42	42					
23	LYS	132,076	411	351	376	47	44	43					
24	VIE	251,216	794	795	726	66	67	59					
25	DUB	200,891	545	560	467	42	44	43					
26	STN	191,520	549	516	408	51	47	38					
27	PRG	164,055	529	573	445	48	57	39					
28	HAM	151,752	516	509	458	46	44	38					
29	WAW	147,985	422	425	322	35	32	26					
30	LIS	141,905	405	350	326	38	37	34					
31	STR	139,757	656	427	370	54	41	35					
32	BHX	104,480	340	348	307	32	29	28					
33	LCY	77,274	298	332	239	34	36	36					
	<b>Total</b>	<b>8,182,530</b>	<b>25,359</b>	<b>25,550</b>	<b>22,551</b>	<b>2,105</b>	<b>2,076</b>	<b>1,916</b>					
	<b>Mean</b>	<b>247,955</b>	<b>768</b>	<b>774</b>	<b>683</b>	<b>64</b>	<b>63</b>	<b>58</b>					

# European Airport Capacity Overview

Annual Capa Daily Capacity 2009      Hourly Capacity 2009  
Core Hours: 06:00 - 22:59

Rank	Airport	Annual Service Volume (ASV)	DPD Core Hours Ultimate IFR CAP	DPD Core Hours Summer Season	DPD ultimate IFR CAP Ops/hr	Slots per hour Summer Season	Runway Service Rate (based on Slots per hour) in Seconds per Ops
1	AMS	635,000	2703	1652	159	108	33.3
2	CDG	675,000	2040	1742	120	105	34.3
3	MAD	565,000	1989	1326	117	78	46.2
4	MUC	315,000	1785	1530	105	90	40
5	FCO	315,000	1785	1530	105	90	40
6	LHR	370,000	1683	1354	99	86	41.9
7	FRA	355,000	1360	1395	80	83	43.4
8	CPH	315,000	1785	1411	105	83	43.4
9	ARN	315,000	1785	1356	105	80	45
10	HEL	315,000	1785	1336	105	80	45
11	BRU	370,000	1683	1229	99	74	48.6
12	ORY	315,000	1785	1131	105	70	51.4
13	ZRH	340,000	1020	1122	60	66	54.5
14	BCN	315,000	1785	1020	105	60	60
15	OSL	315,000	1785	1025	105	60	60
16	PMI	315,000	1785	1020	105	60	60
17	TXL	285,000	1003	884	59	52	69.2
18	LYS	285,000	1003	867	59	51	70.6
19	NCE	260,000	952	794	56	50	72
20	DUS	285,000	1003	771	59	47	76.6
21	LGW	285,000	1003	797	59	46	78.3
22	MAN	285,000	1003	883	59	46	78.3
23	IST	300,000	1003	680	59	40	90
24	VIE	225,000	1003	1044	59	66	54.5
25	HAM	225,000	1003	901	59	53	67.9
26	DUB	225,000	1003	703	59	46	78.3
27	PRG	225,000	1003	676	59	46	78.3
28	STR	210,000	901	714	53	42	85.7
29	BHX	210,000	901	680	53	40	90
30	STN	210,000	901	733	53	38	94.7
31	LIS	210,000	901	612	53	36	100
32	WAW	225,000	1003	578	59	34	105.9
33	LCY	210,000	901	384	53	24	150
	<b>Total</b>	<b>10,305,000</b>	<b>45,033</b>	<b>33,880</b>	<b>2,649</b>	<b>2,030</b>	<b>2,187</b>
	<b>Mean</b>	<b>312,273</b>	<b>1,365</b>	<b>1,027</b>	<b>80</b>	<b>62</b>	<b>66</b>

# Demand - Capacity on PDTHUW26 2009



■ MAD Demand - Capacity



# Delay Overview

Rank	Airport	Minimum estimate		Avg. Delay per Aircraft		Delay > 4 minutes per Aircraft			Max. Delay per Aircraft on DPD			Average Delay per Aircraft on DPD		
		Annual Delay 2007		Annual Delay 2007		Annual Delay 2007		2007	2008	2009	2007	2008	2009	
		Annual Delay Medium ('000 minutes)	Annual Delay High ('000 minutes)	Avg. Delay per Aircraft Medium in minutes	Avg. Delay per Aircraft High in minutes	Max. Delay per Aircraft in min	Max. Delay per Aircraft in min	Max. Delay per Aircraft in min	Avg. Delay per Aircraft in min	Avg. Delay per Aircraft in min	Avg. Delay per Aircraft in min			
1	AMS	752	1146	0.25	1.02	11.11	11.67	8.89	2.5	1.98	2.02			
2	CDG	626	968	1.15	1.75	4.57	11.43	0	0.63	2.53	0			
3	MAD	470	752	1	1.6	13.85	26.15	26.15	5.86	8.44	5.96			
4	LHR	1795	2856	4.4	7	25.81	30.7	22.33	7.57	7.22	2.99			
5	FRA	1725	2744	4.4	7	6.51	4.34	2.89	1.57	0.76	0.33			
6	MUC	1531	2436	4.4	7	6	2	1.33	1.38	0.47	0.1			
7	BCN	1254	2034	3.69	6.03	26	20	14	6.16	2.87	1.87			
8	FCO	985	1608	3.02	4.88	12.67	8.67	6.67	1.45	2.24	0.76			
9	LGW	388	621	1.48	2.36	7.83	7.83	0	1.19	2.24	0			
10	CPH	225	350	0.93	1.43	0	0	0	0	0	0			
11	DUS	201	313	0.91	1.38	14.04	7.66	14.04	1.85	1.34	1.97			
12	ORY	191	310	0.83	1.26	0	0	0	0	0	0			
13	OSL	158	249	0.73	1.1	1	0	0	0.09	0	0			
14	MAN	145	227	0.75	1.13	3.91	15.65	0	0.36	1.08	0			
15	BRU	144	216	0.58	0.89	2.43	0	0	0.23	0	0			
16	IST	144	206	0.66	0.99	3	6	10.5	0.3	0.49	2.62			
17	ZRH	134	201	0.6	0.91	2.73	0	0	0.24	0	0			
18	ARN	123	185	0.59	0.89	0	0	0	0	0	0			
19	NCE	104	156	0.62	0.94	0	2.4	0	0	0.39	0			
20	PMI	92	129	0.47	0.72	0	0	0	0	0	0			
21	HEL	70	105	0.43	0.64	0	0	0	0	0	0			
22	TXL	58	73	0.36	0.53	0	0	0	0	0	0			
23	LYS	40	53	0.31	0.43	0	0	0	0	0	0			
24	VIE	1091	1736	4.4	7	8.18	0.91	4.55	0.68	0.15	0.58			
25	STN	287	460	1.51	2.4	4.74	1.58	0	0.66	0.12	0			
26	DUB	281	442	1.37	2.16	3.91	0	0	0.33	0	0			
27	PRG	131	180	0.76	1.15	35.22	36.52	27.39	6.81	7.64	5.8			
28	HAM	91	152	0.63	0.95	0	0	0	0	0	0			
29	LIS	85	142	0.63	0.96	3.33	1.67	0	0.59	0.17	0			
30	WAW	89	133	0.6	0.91	1.76	0	0	0.14	0	0			
31	STR	84	126	0.61	0.93	17.14	0	0	3.75	0	0			
32	BHX	31	52	0.35	0.5	0	0	0	0	0	0			
33	LCY	15	23	0.23	0.27	25	30	30	6.85	9.94	5.52			
Total		13,543	21,385											
Mean		410	648	1.32	2.09	7.3	6.82	5.11	1.55	1.52	0.92			

more Ops  
than available  
Slots

Daily Idle Capacity

Hourly Idle Capacity

Rank	Airport	Additional IFR Runway Capacity (IFRCAP - DPD Slots)	Daily Idle Core			Hourly Idle Capacity		
			2009	2007	2008	2009	2007	2008
			Daily Idle Core Hours Slots	Daily Idle Core Hours Slots	Daily Idle Core Hours Slots	DPH Idle Slots	DPH Idle Slots	DPH Idle Slots
1	MAD	663	-86	-152	-44	-18	-34	-34
2	CDG	298	118	85	318	-9	-21	-2
3	AMS	1051	331	260	464	-1	-3	2
4	BCN	765	-51	80	154	-26	-20	-14
5	DUS	232	58	53	70	-11	-4	-11
6	FCO	255	454	192	420	-19	-13	-10
7	IST	323	87	73	17	-2	-4	-7
8	MAN	120	212	214	384	-14	-23	-5
9	FRA	-35	22	53	121	-9	-6	-4
10	LHR	329	-176	-176	-32	-17	-17	-4
11	LGW	206	40	-5	119	-9	-10	-3
12	MUC	255	272	253	386	-9	-3	-2
13	NCE	158	279	184	325	3	-2	2
14	BRU	454	445	429	493	-3	3	7
15	LYS	136	456	516	491	4	7	8
16	ZRH	-102	368	441	468	-3	9	9
17	ORY	654	366	382	421	8	7	10
18	TXL	119	388	353	402	9	10	10
19	OSL	760	347	332	448	-6	0	11
20	PMI	765	491	469	518	10	16	15
21	CPH	374	600	635	699	16	13	21
22	ARN	429	690	629	828	19	19	30
23	HEL	449	839	840	902	33	39	36
24	LCY	517	86	52	145	-10	-12	-12
25	STN	168	184	217	325	-13	-9	0
26	LIS	289	207	262	286	-2	-1	2
27	DUB	300	158	143	236	4	2	3
28	VIE	-41	250	249	318	0	-1	7
29	PRG	327	147	103	231	-2	-11	7
30	STR	187	58	287	344	-12	1	7
31	WAW	425	156	153	256	-1	2	8
32	BHX	221	340	332	373	8	11	12
33	HAM	102	385	392	443	7	9	15
	Total	11,153	8,521	8,330	11,329	-75	-46	114
	Mean	338	258	252	343	-2	-1	3

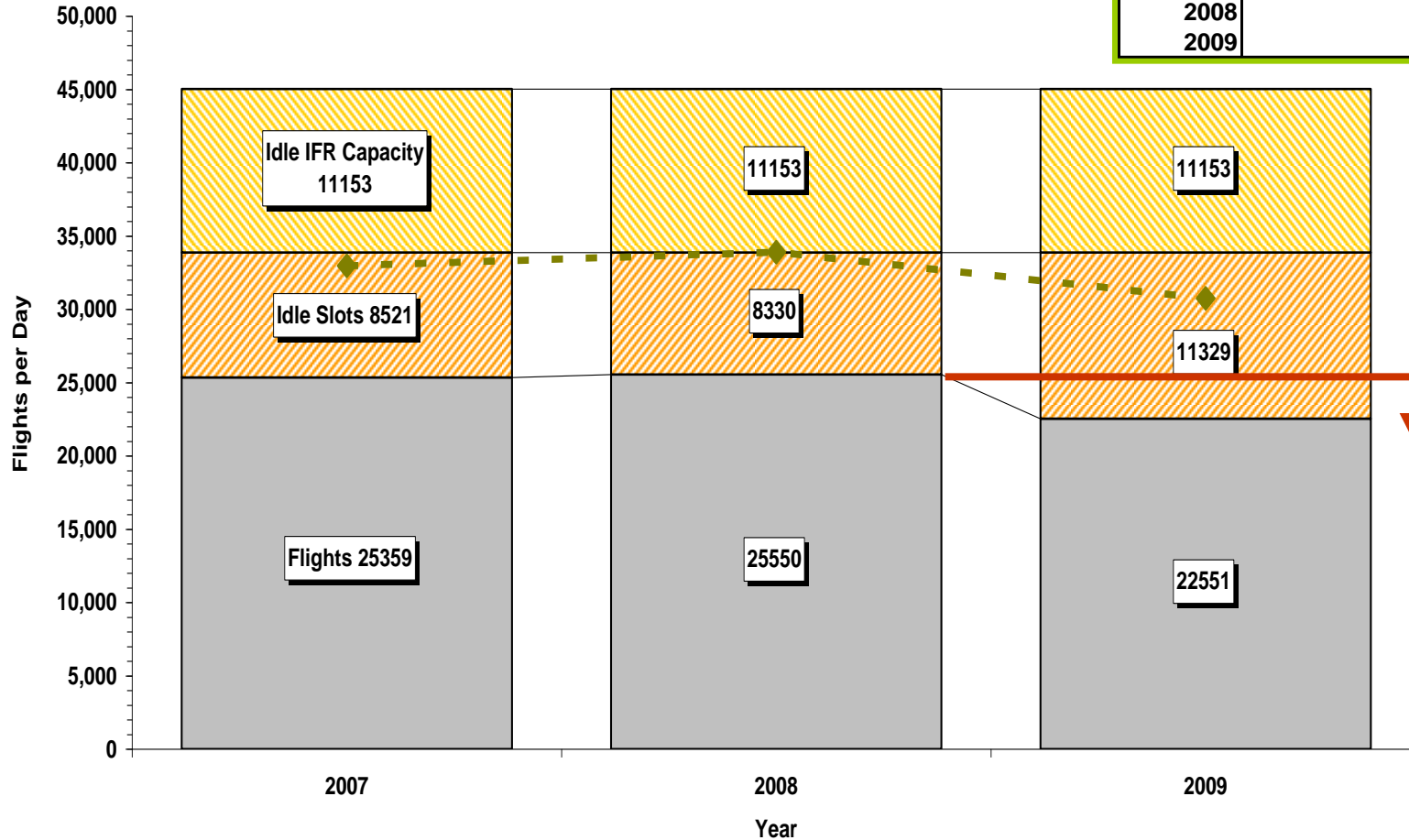
# Slot and Ultimate IFR Capacity Utilization 2007-2009

Rank	Airport	Annual Capacity Utilization		Daily Capacity Utilization						Hourly Capacity Utilization					
		Annual Capacity Utilization	2007 Ultimate Capacity Utilization = DPD Ops/DPD IFR CAP	Slot Utilization = DPD Ops/DPD Slots	2008 Ultimate Capacity Utilization = DPD Ops/DPD IFR CAP	Slot Utilization = DPD Ops/DPD Slots	2009 Ultimate Capacity Utilization = DPD Ops/DPD IFR CAP	Slot Utilization = DPD Ops/DPD Slots	2007 Ultimate Capacity Utilization = DPH Ops/IFR CAP	Slot Utilization = DPH Ops/Slots	2008 Ultimate Capacity Utilization = DPH Ops/IFR CAP	Slot Utilization = DPH Ops/Slots	2009 Ultimate Capacity Utilization = DPH Ops/IFR CAP	Slot Utilization = DPH Ops/Slots	
															Congested >75%
1	MAD	83%	71%	106%	74%	111%	69%	103%	82%	123%	96%	144%	96%	144%	
2	CDG	84%	80%	93%	81%	95%	70%	82%	95%	109%	105%	120%	89%	102%	
3	AMS	70%	49%	80%	51%	84%	44%	72%	69%	101%	70%	103%	67%	98%	
4	DUS	78%	71%	92%	72%	93%	70%	91%	98%	123%	86%	109%	98%	123%	
5	BCN	108%	60%	105%	53%	92%	49%	85%	82%	143%	76%	133%	70%	123%	
6	IST	69%	59%	87%	61%	89%	66%	98%	71%	105%	75%	110%	80%	118%	
7	FCO	104%	60%	70%	75%	87%	62%	73%	104%	121%	98%	114%	95%	111%	
8	MAN	72%	67%	76%	67%	76%	50%	57%	102%	130%	117%	150%	86%	111%	
9	LGW	91%	75%	95%	80%	101%	68%	85%	93%	120%	95%	122%	83%	107%	
10	FRA	137%	101%	98%	99%	96%	94%	91%	115%	111%	111%	107%	109%	105%	
11	LHR	129%	91%	113%	91%	113%	82%	102%	104%	120%	104%	120%	91%	105%	
12	MUC	130%	70%	82%	72%	83%	64%	75%	94%	110%	89%	103%	88%	102%	
13	NCE	67%	54%	65%	64%	77%	49%	59%	84%	94%	93%	104%	86%	96%	
14	BRU	65%	47%	64%	48%	65%	44%	60%	78%	104%	72%	96%	68%	91%	
15	ZRH	66%	74%	67%	67%	61%	64%	58%	115%	105%	95%	86%	95%	86%	
16	ORY	76%	43%	68%	42%	66%	40%	63%	59%	89%	60%	90%	57%	86%	
17	LYS	46%	41%	47%	35%	40%	37%	43%	80%	92%	75%	86%	73%	84%	
18	OSL	72%	38%	66%	39%	68%	32%	56%	63%	110%	57%	100%	47%	82%	
19	TXL	51%	49%	56%	53%	60%	48%	55%	73%	83%	71%	81%	71%	81%	
20	PMI	59%	30%	52%	31%	54%	28%	49%	48%	83%	42%	73%	43%	75%	
21	CPH	79%	45%	57%	43%	55%	40%	50%	64%	81%	67%	84%	59%	75%	
22	ARN	65%	37%	49%	41%	54%	30%	39%	58%	76%	58%	76%	48%	63%	
23	HEL	55%	28%	37%	28%	37%	24%	32%	45%	59%	39%	51%	42%	55%	
24	LCY	37%	33%	78%	37%	86%	27%	62%	64%	142%	68%	150%	68%	150%	
25	STN	91%	61%	75%	57%	70%	45%	56%	96%	134%	89%	124%	72%	100%	
26	LIS	68%	45%	66%	39%	57%	36%	53%	72%	106%	70%	103%	64%	94%	
27	DUB	89%	54%	78%	56%	80%	47%	66%	71%	91%	75%	96%	73%	93%	
28	VIE	112%	79%	76%	79%	76%	72%	70%	112%	100%	114%	102%	100%	89%	
29	PRG	73%	53%	78%	57%	85%	44%	66%	81%	104%	97%	124%	66%	85%	
30	STR	67%	73%	92%	47%	60%	41%	52%	102%	129%	77%	98%	66%	83%	
31	WAW	66%	42%	73%	42%	74%	32%	56%	59%	103%	54%	94%	44%	76%	
32	HAM	67%	51%	57%	51%	56%	46%	51%	78%	87%	75%	83%	64%	72%	
33	BHX	50%	38%	50%	39%	51%	34%	45%	60%	80%	55%	73%	53%	70%	
	Mean	78%	57%	74%	57%	74%	50%	65%	81%	105%	79%	103%	73%	95%	

# Idle Network Capacity and Utilization

Network Idle Capacity at Sample Airports in Core Hours on PDTHUW26 2009  
(Core hours: 06:00-22:59)

Year	DPD European Flights	Change
2007	32961	-
2008	33895	2.8%
2009	30741	-9.3%



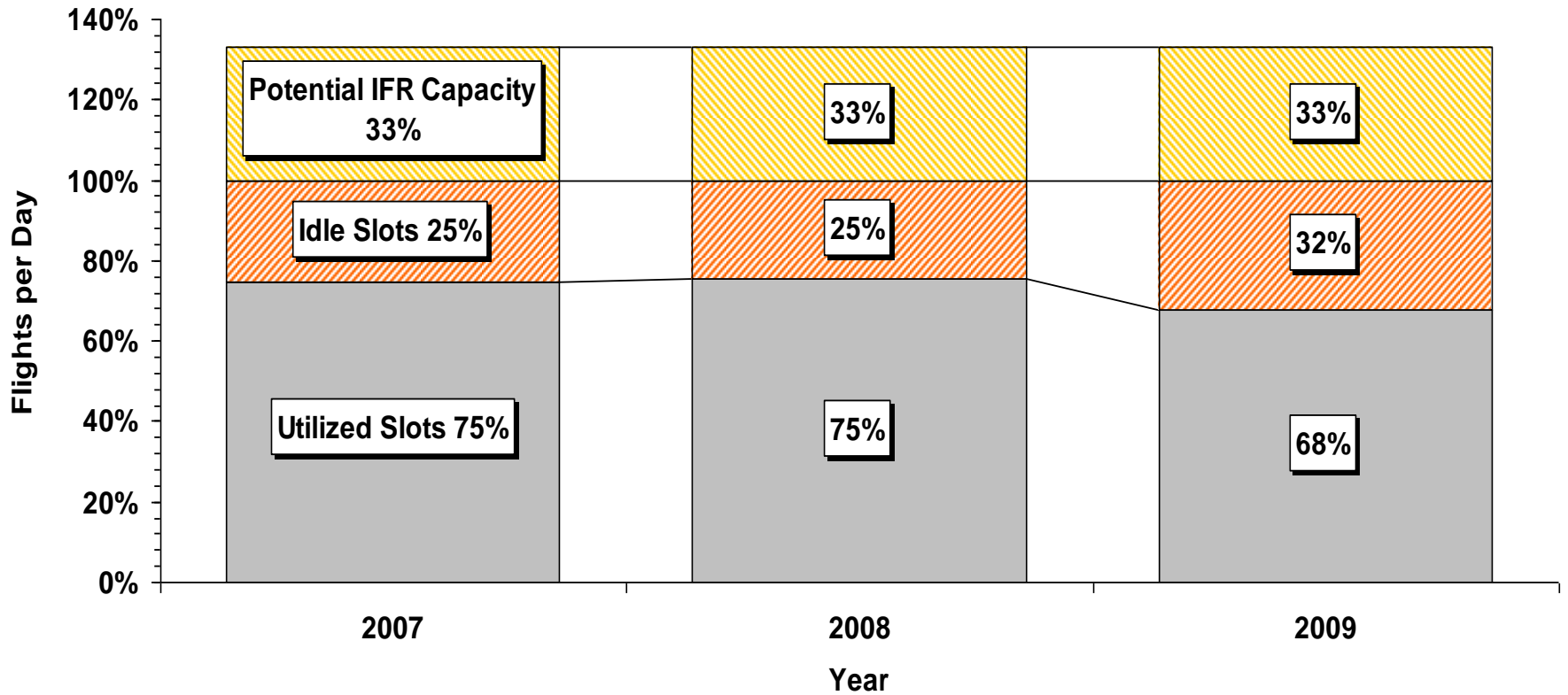
**Peak daily Demand down - 12%, compared to 2008 at congested Airports.**

**-9.3% decrease In all Euro PD flights**

Flights
  Summer Slots
  Ultimate IFR Capacity
   Total European Flights

# Summary

Network Capacity Utilization at Sample Airports in Core Hours on PDTHUW26 2009  
(Core hours: 06:00-22:59)

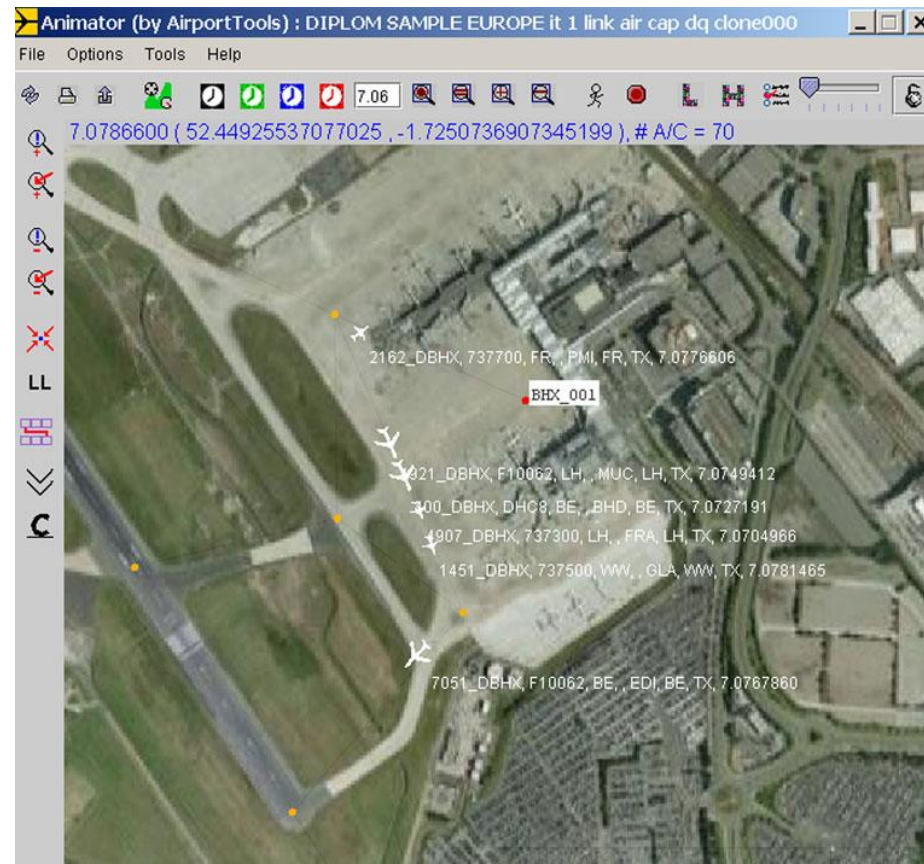
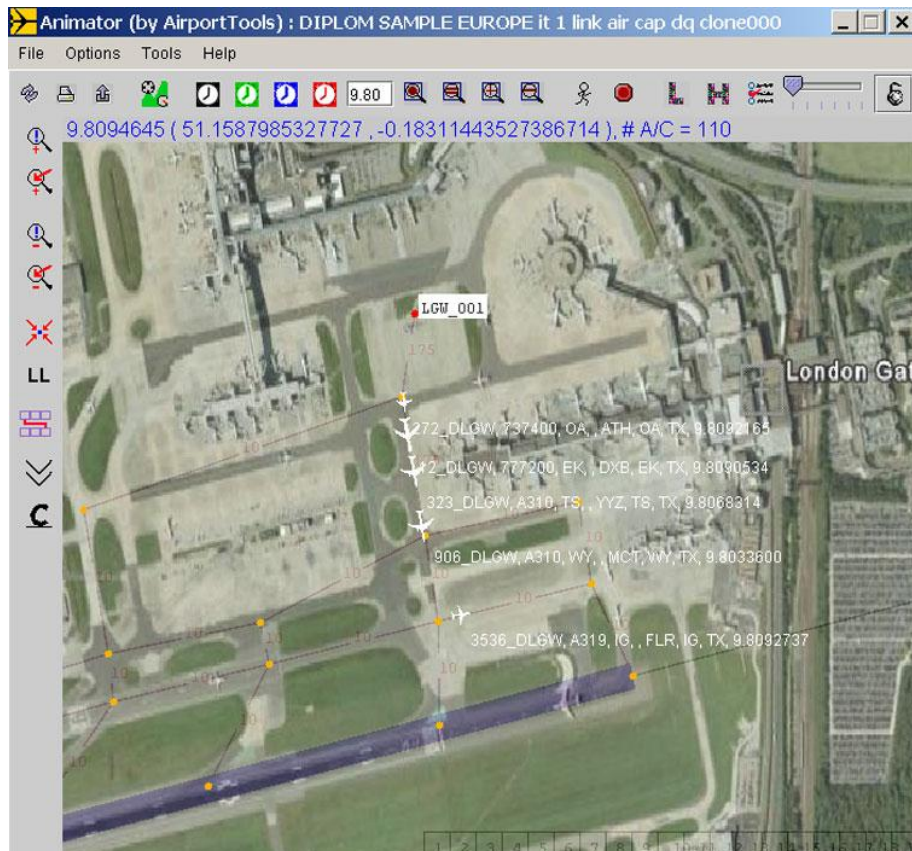


## Outlook and Further research

- **Using FAA's SIMMOD engine for estimating outputs: Ultimate runway capacity and Delay per flight.**
- **SIMMOD inputs are: Airport design data, flight schedule data, aircraft data, flight path data, distances and coordinates as.**
- Gate, link, DQ and holding capacities must be defined
- Flights are „fed“ into the simulated airport system continuously, random factors are applied.
- **Simulate growth and its impact on airport.**
  
- **Fast-time simulation research started with 22 single-runway Airports + 3 „complex“ airports (LHR, FRA & Berlin-Brandenburg International) using AirportTools' VisualSIMMOD -> needs more reconfiguration**
- **Setup-time for new airport for the sample < 1 day!!**
- **Flight Schedule data comes from Flightstats.com (scheduled, actual and cancelled flights + gate delay and en-route delay)**

# Outlook and Further research

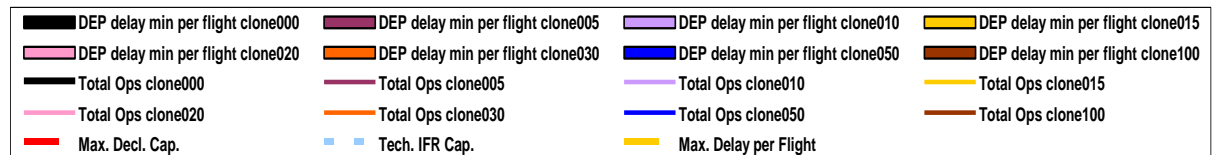
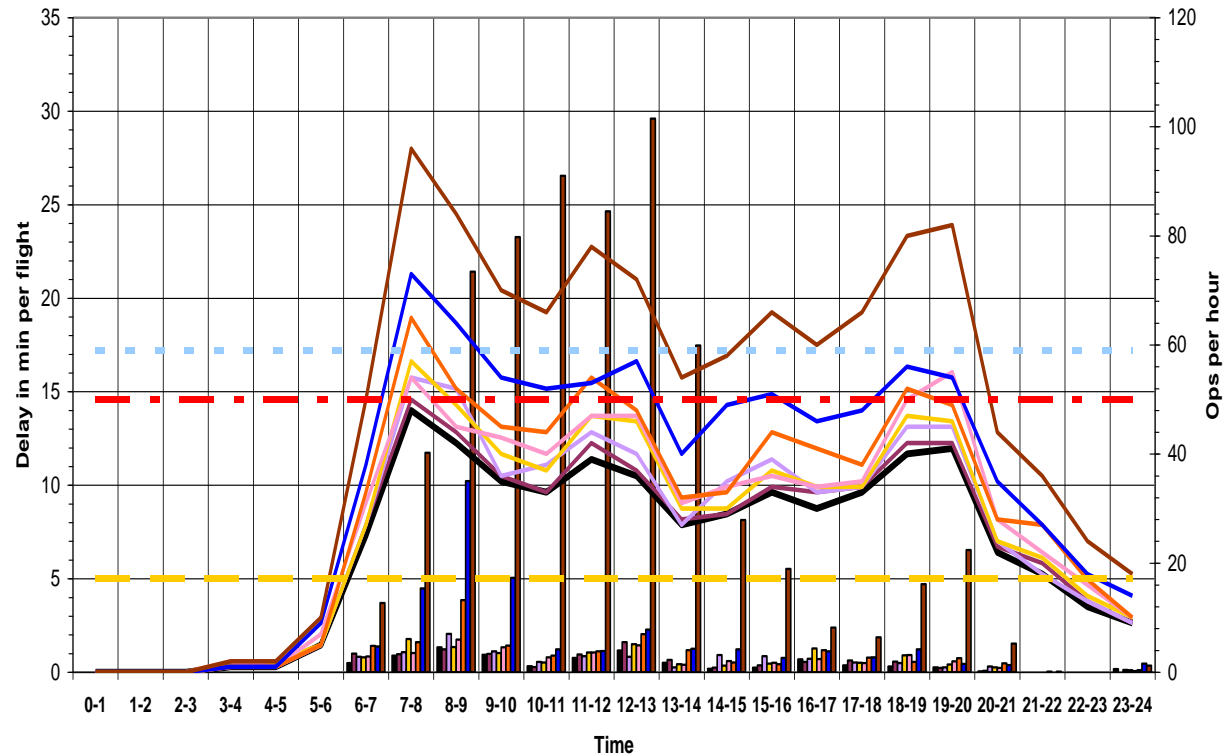
- Isolation of potential „bottlenecks“ at airports which cause delay & reduce productivity



# Outlook and Further research

- Follow the build-up of Delays over the day.
- Isolate critical times and flights in the schedule

LGW Flights and Delays per Flight from SIMMOD  
(Flightplan OAG Thu 03/19/2009)







# Peer Groups and Subgroups by Max. Annual Productivity

- Rare examples Of higher or equal slots per hour as calculated ultimate IFR capacity -> maybe wrong config or operational/technical improvement
- Achieved by best technology and operational changes
- It took 20 years for FRA to evolve from 60 to 80 IFR Ops per hour
- With a 4<sup>th</sup> runway, FRA falls likely into group III with config. no. 7, then 120 IFR Ops per hour or 645,000 Ops per year should be achievable

Group	Subgroup	Runway Config No	MI=81-120		MI=>121		Best-in-class MDRC	Airport
			ASV	IFR Hourly Capacity	ASV	IFR Hourly Capacity		
I	a	1	210,000	53	240,000	50	50	STN
I	b	9	225,000	59	265,000	60	52	CGN
I	b	14	225,000	69	265,000	60	66	VIE
I	b	15	225,000	69	265,000	60		
II	a	2	285,000	59	340,000	60	61	MAN
II	a	10	285,000	59	340,000	60	66	ZRH
II	a	17	285,000	59	340,000	60		
II	b	13	295,000	59	350,000	60		
II	c	16	300,000	59	355,000	60	82	FRA
II	c	18	300,000	59	355,000	60		
II	c	19	300,000	59	355,000	60		
II	d	3	300,000	70	365,000	75	70	MXP
II	d	11	300,000	70	365,000	75		
II	e	4	315,000	105	370,000	99	88	LHR
II	e	12	315,000	105	370,000	99	90	FCO
III	a	5	310,000	70	375,000	75		
III	b	6	315,000	70	385,000	75		
III	c	7	510,000	117	645,000	120		
III	d	8	565,000	117	675,000	120	106	CDG