Benchmarking Airport Terminals: A Simplified Toolkit for Estimating Peak Capacity

Dipl. Wirt.-Ing. Branko Bubalo
GAP Research Project
branko.bubalo@googlemail.com

partner/sponsor:
HOCHSCHULE BREMEN
UNIVERSITY OF APPLIED SCIENCES
Internationale Fachhochschule
Bad Honnef · Bonn
International University of Applied Sciences
Fachhochschule für Wirtschaft Berlin
Berlin School of Economics
Bundesministerium für Bildung und Forschung

German Aviation Research Society Workshop (G.A.R.S.) at HWR 2010
Berlin, November 26th 2010

Personal Background

- Graduate in Business Administration and Engineering from Berlin School of Economics and Law and University of Applied Sciences Berlin
- Diploma Thesis (2009): “Benchmarking Airport Productivity and the Role of Capacity Utilization – A Study of selected European Airports”
- 4th year in German Airport Performance Research Project at Berlin School of Economics and Law
- Conducted Benchmarking studies of European Airports and Airlines (over 70 Airports, 30 individual Airlines)
- Consultation work in MIME Project (study on noise mitigation around airports by the means of permit trading), funded by EU Commission
- Looking for a University for writing my Dissertation and doing Research

Contents

The Airport Process Chain

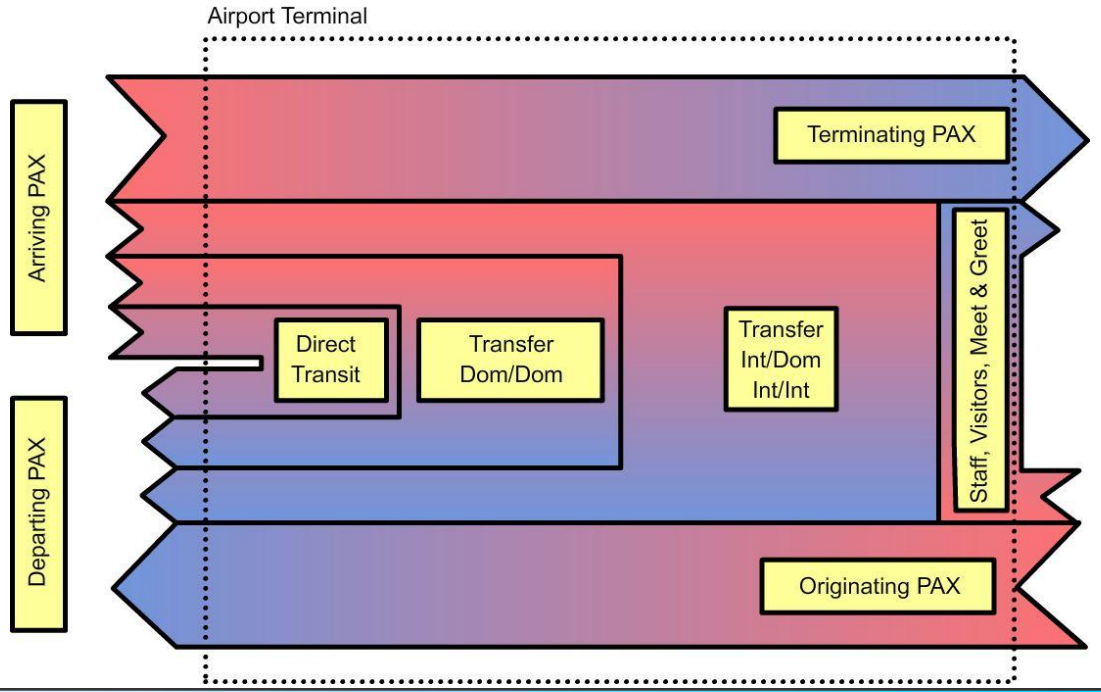
- Strong interrelations between Airport Processes
- A combination of Queues and Servers
- Certain capacity limitations exist
- Capacity Bottlenecks influence Passenger flows up- and downstream
- Each flow and therefore airport client has different infrastructure requirements

Difficulties with Airport Terminal Benchmarking

- Passenger and baggage flows in the airport facilities show highly dynamic behaviour
- Benchmarking of terminals has not been adequately included in past research
- Particularly difficult to divide different flows of PAX inside the terminal from available data

Arriving PAX/hr = Terminating PAX/hr + Direct Transit PAX/hr + Transfer PAX/hr

Departing PAX/hr = Originating PAX/hr + Direct Transit PAX/hr + Transfer PAX/hr



Methods for Measuring Terminal Processes

Methods:

- (Particle) Passenger Flow Simulation
- “Handbooks” (e.g. FAA AC 150/5360-13 or IATA Airport Development Reference Manual 1995 & 2004)
- Books and Papers (e.g. by Kanafani, de Neufville, Horonjeff, Odoni, de Barros)
- Spreadsheet models (e.g. by TRB ACRP 2010)

Methods for Measuring Terminal Processes

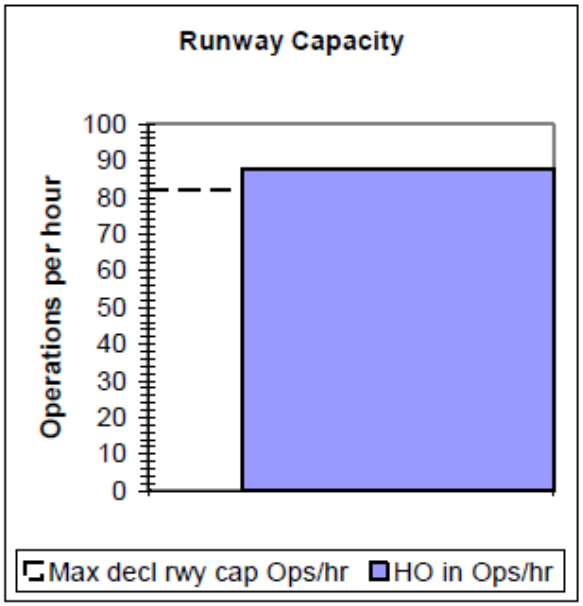
Level of Service and Maximum Waiting Time Guidelines (in Minutes)		Check-In Economy	Check-In Business class	Passport Control Inbound	Passport Control Outbound	Baggage Claim	Security
A	An Excellent level of service. Conditions of free flow, no delays and excellent levels of comfort.	0-12	0-3	0-7	0-5	0-12	0-3
B	High level of service. Conditions of stable flow, very few delays and high levels of comfort.						
C	Good level of service. Conditions of stable flow, acceptable delays and good levels of comfort.						
D	Adequate level of service. Conditions of unstable flow, acceptable delays for short periods of time and adequate levels of comfort.	12-30	3-5	7-15	5-10	12-18	3-7
E	Inadequate level of service. Conditions of unstable flow, unacceptable delays and inadequate levels of comfort.						
F	Unacceptable level of service. Conditions of cross-flows, system breakdowns and unacceptable delays; an unacceptable level of comfort.						

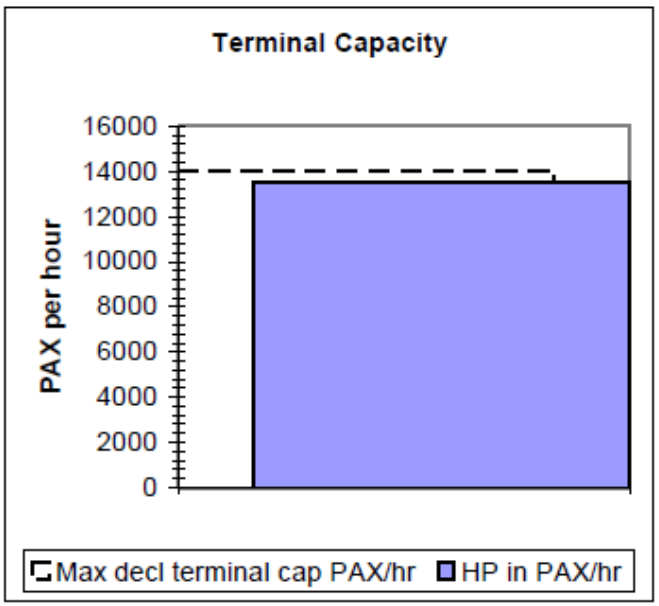
Levels of Service Framework and Maximum Waiting Times (IATA 2004)

Methods for Measuring Terminal Processes

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

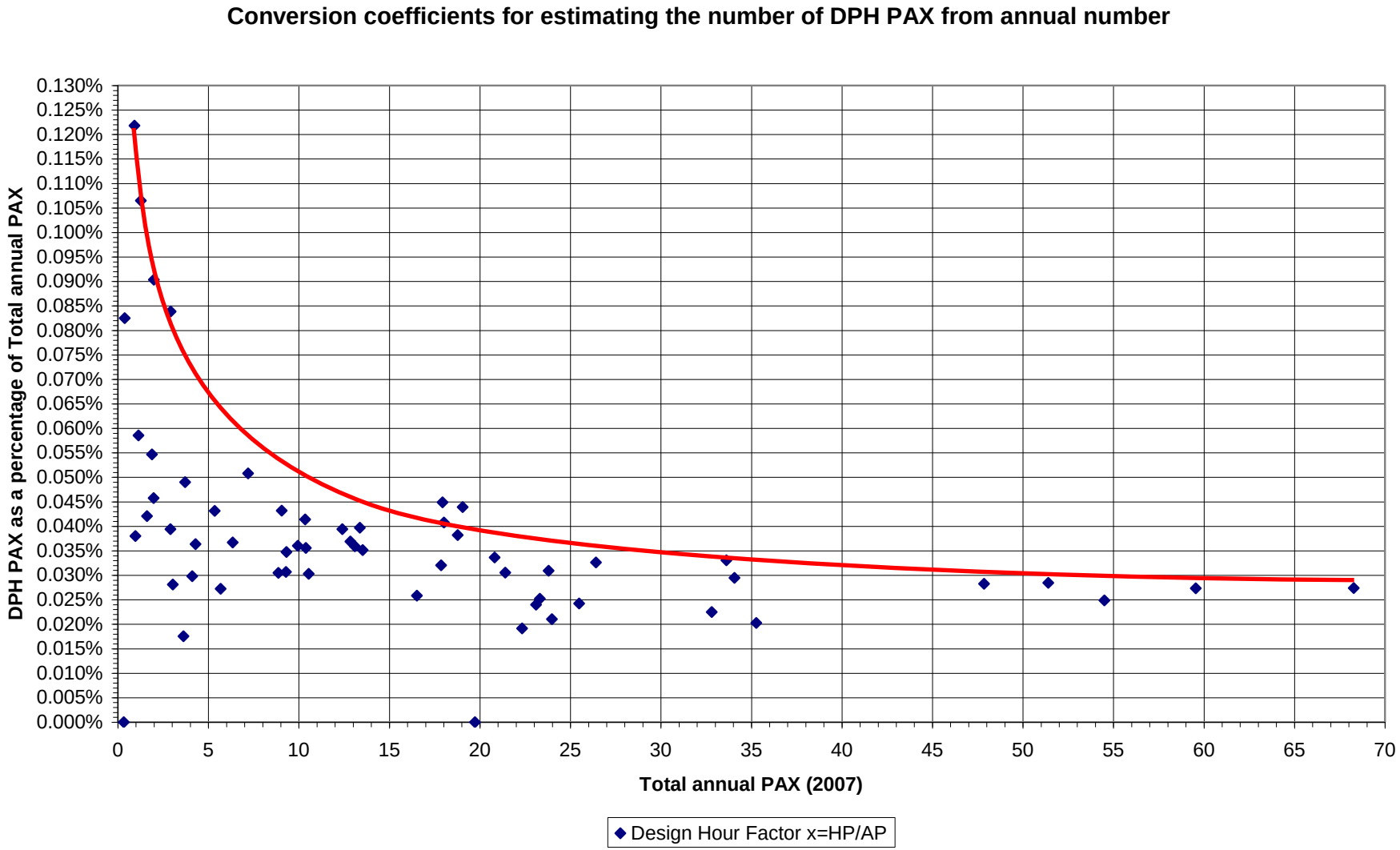
Annual Operations (AO)=	486195	n= 112 PAX/Ops	Annual Passengers (AP)=	54501001	
y=	0.01810%		x=	0.02487%	
Hourly Operations (HO)=	88	m= 154 PAX/Ops	Hourly Passengers (HP)=	13552	
				hourly	annually
Maximum Declared Capacity=	82		Max Decl. Terminal Capacity=	14000	0
					(AP/MCTC)
Runway Utilization (HO/MCD)=	107%		Terminal Utilzation (HP/MCTC)=	97%	





Source: Kanafani 1981; Bubalo 2009

Methods for Measuring Terminal Processes

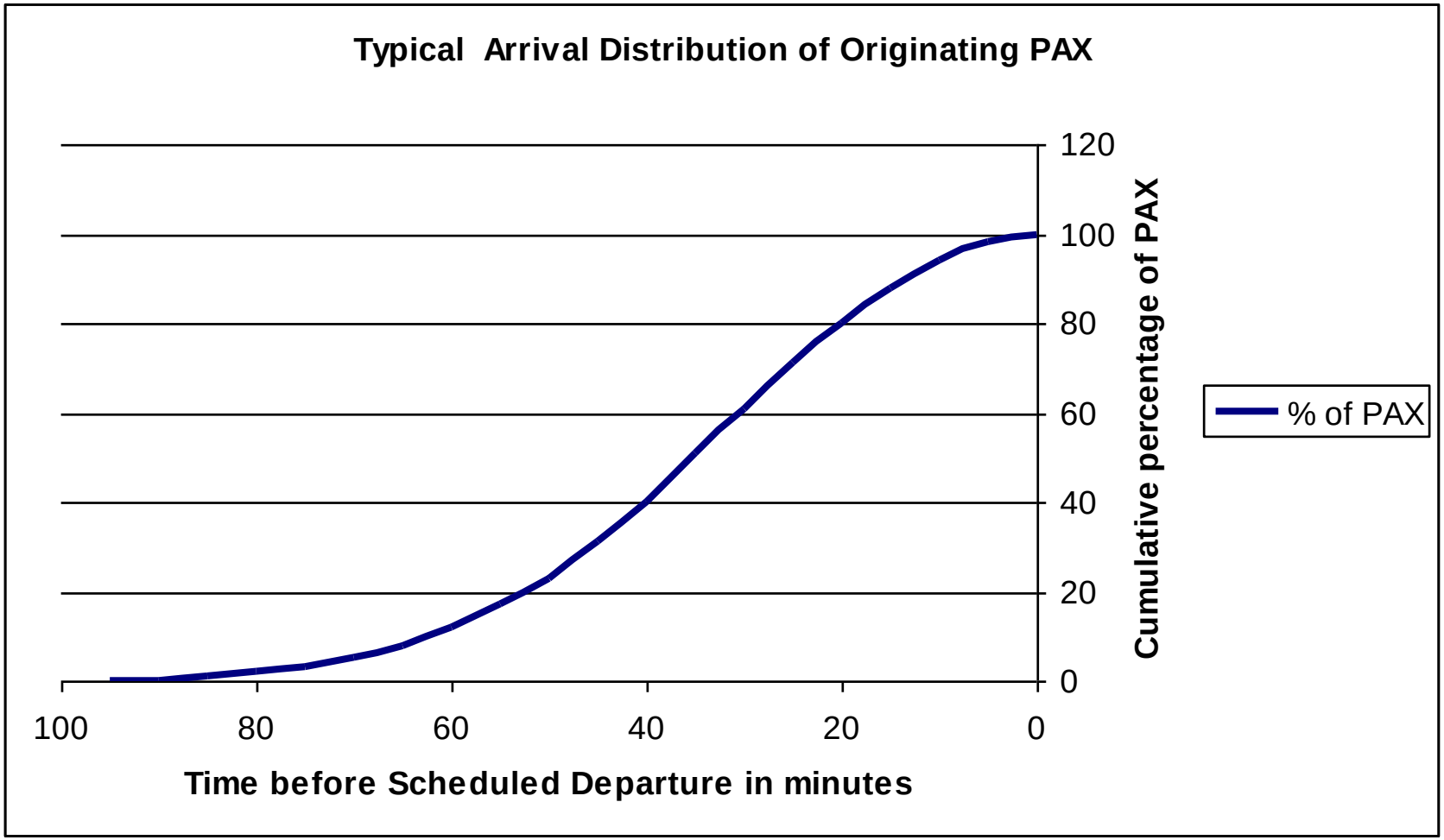


Methods for Measuring Terminal Processes

Airport	MIN MCT	MAX MCT	Airport	MIN MCT	MAX MCT
AMS	00:40	01:20	LGW	00:45	01:15
ARN	00:15	01:00	LHR	00:45	02:00
ATH	00:55	00:55	LIS	01:00	01:00
BCN	00:45	00:45	LYS	00:45	00:45
BHX	00:45	00:45	MAD	00:45	02:45
BRU	00:40	00:50	MAN	00:45	00:50
BSL	00:30	00:30	MUC	00:30	00:45
CDG	01:30	02:00	MXP	00:50	02:00
CGN	00:30	00:30	NCE	00:30	01:00
CIA	01:00	01:00	NUE	00:30	00:30
DRS	01:00	01:00	OSL	00:50	00:50
DUB	00:45	00:45	PMI	00:45	00:45
DUS	00:35	00:35	PRG	00:45	00:55
EDI	01:00	01:00	PSA	00:45	00:45
FMO	00:20	00:20	RHO	01:00	01:00
FRA	00:45	00:45	RTM	00:20	01:00
GLA	00:45	00:45	SCN	01:00	01:00
GRZ	00:30	00:30	STN	00:45	00:45
HAJ	00:30	00:30	STR	00:30	00:30
HAM	00:35	00:35	SXF	01:00	01:00
HEL	00:40	00:40	SZG	00:30	00:30
HHN	01:00	01:00	TXL	00:30	00:45
IST	01:30	01:30	VIE	00:30	00:30
LBA	01:00	01:00	WAW	01:00	01:00
LCY	00:30	00:30	WRO	00:40	00:40
LEJ	01:00	01:00	ZAG	00:40	01:00
			ZRH	00:40	00:40

Source: Amadeus

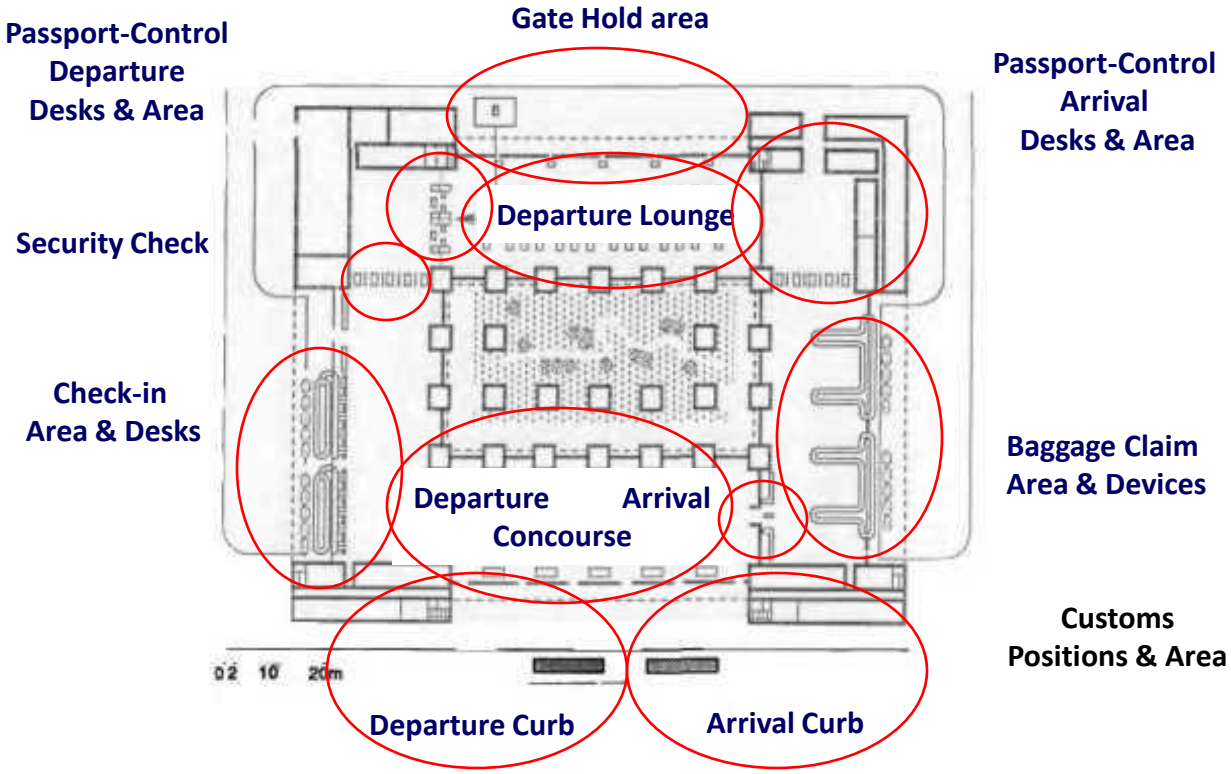
Methods for Measuring Terminal Processes



Source: Horonjeff 2010

A New Approach to Terminal Benchmarking

- Spreadsheet model approach, based on IATA formulae from ADRM 1995
- Basically a reprogramming of IATA CAPASS Software



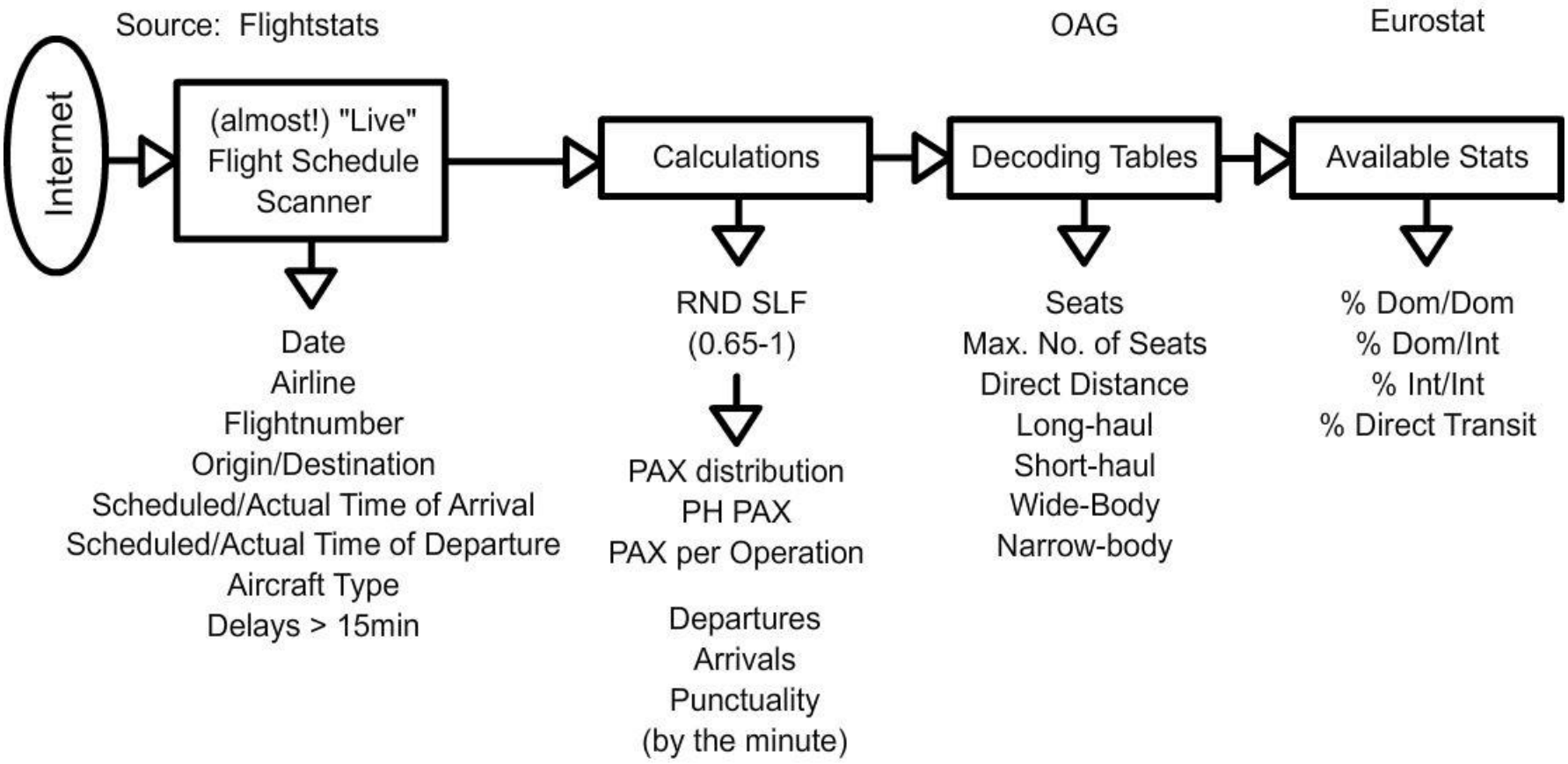
A New Approach to Terminal Benchmarking

Data sources:

- Flightstats -> Airport Schedule
- OAG -> De-/Coding Tables
- Eurostat -> Shares Int/Dom Passengers
- IATA Airport Capacity/Demand Profiles 2003 -> Declared Terminal Capacities
- National Slot Coordination -> Declared Runway CAPs
- Airport Websites -> missing or more recent information

A New Approach to Terminal Benchmarking

Software-Tool Overview:



A New Approach to Terminal Benchmarking

- Inputs:

- **Peak hour total passengers**
- **Peak hour number of originating passengers**
- **Peak hour number of departing passengers**
- **Peak hour number of terminating passengers**
- **Share of Direct Transit passengers (checked airside)**
- **Direct Transit passengers (checked airside)**
- **Proportion of transfer passengers not checked airside during peak hour**
- **Peak hour number of transfer passengers not checked airside**
- **Peak hour number of terminating and international/domestic transfer passengers (arriving passengers)**
- **Proportion of long-haul departing passengers during peak hour**
- **Proportion of short-haul departing passengers during peak hour**
- **Proportion of terminating passengers arriving by wide-body aircraft during peak hour**
- **Proportion of terminating passengers arriving by narrow-body aircraft during peak hour**
- **Time of arrival of first passenger at gate hold rooms (minutes before standard time of departure of largest aircraft handled at the gate)**
- **Time last passenger should board (minutes before standard time of departure)**
- **Number of visitors per originating passengers**
- **Number of visitors per terminating passengers**
- **Number of passengers per wide-body aircraft at 80% load factor**
- **Number of passengers per narrow-body aircraft at 80% load factor**
- **Maximum Number of Seats on largest aircraft handled at gate**
- **Maximum Number of Seats on largest aircraft handled at airport**
- **Average occupancy time of departure lounge per departing long-haul passenger**
- **Average occupancy time of departure lounge per departing short-haul passenger**
- **Proportion of Passengers to be customs checked**
- **Average processing time per passenger at check-in desk**
- **Average processing time per passenger at Passport Control - Departure**
- **Average processing time per passenger at Passport Control - Arrival**
- **Average processing time per passenger at Customs - Arrival**

A New Approach to Terminal Benchmarking

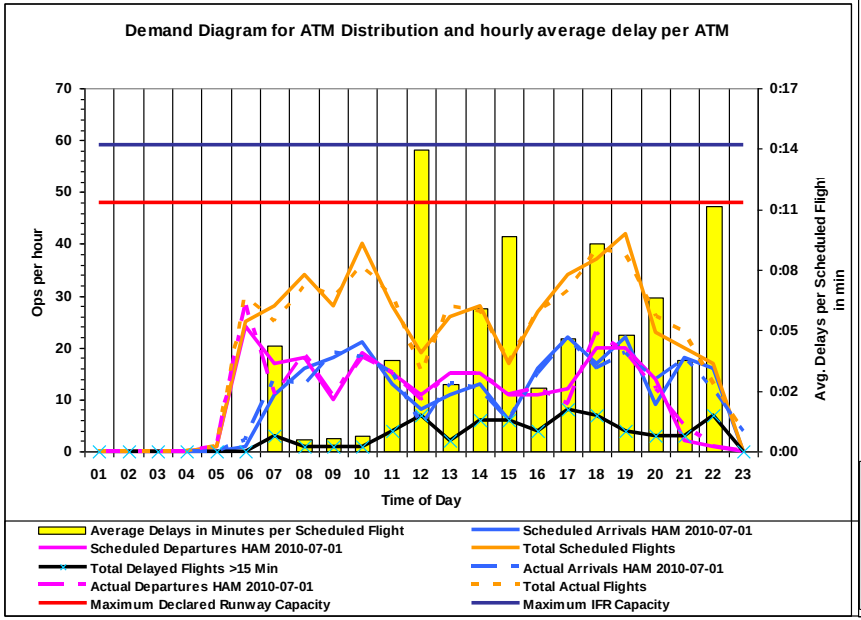
- Outputs:

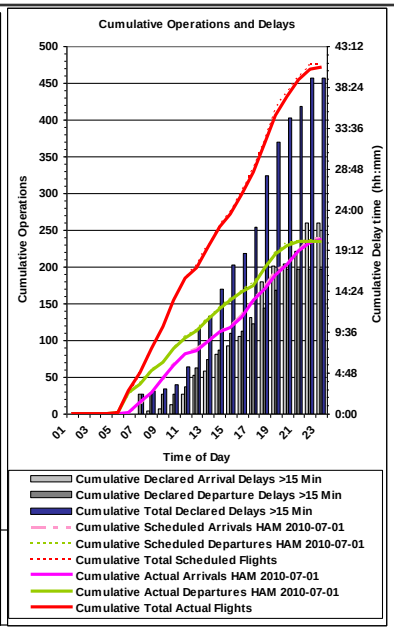
Formula	Process	Variable
1.6.5.1	DEPARTURES CURB	Curb length required
1.6.5.2	DEPARTURES CONCOURSE	Area required
1.6.5.3	QUEUING AREA - CHECK-IN	Area required
1.6.5.4	CHECK-IN DESKS (Centralized, Common Check-In)	Number of required check-in desks
1.6.5.5	PASSPORT CONTROL - DEPARTURE	Number of required passport positions
1.6.5.6	SECURITY CHECK - CENTRALIZED	X-ray Units required
1.6.5.7	DEPARTURE LOUNGE (excluding Concessions except BAR/SNACK FACILITIES)	Area required
1.6.5.8	SECURITY CHECK - GATE HOLD ROOM	X-Ray Units Required
1.6.5.9	GATE HOLD ROOMS	Area required
1.6.5.10	ARRIVALS HEALTH CHECK (where required)	Control Positions Required
1.6.5.11	QUEUING AREA - PASSPORT CONTROL - ARRIVAL	Area required
1.6.5.12	PASSPORT CONTROL - ARRIVAL	Control Positions Required
1.6.5.13	BAGGAGE CLAIM AREA (excluding claim devices)	Area required
1.6.5.14	NUMBER OF BAGGAGE CLAIM DEVICES	Claim devices required for Wide-body aircraft Claim devices required for Narrow-body aircraft Required Claim Length Wide-body Required Claim Length Narrow-body
1.6.5.15	QUEUING AREA - ARRIVALS CUSTOMS	Area required
1.6.5.16	ARRIVALS CUSTOMS	Number of Customs positions required
1.6.5.17	ARRIVALS CONCOURSE WAITING AREA (excluding Concessions)	Area required
1.6.5.18	ARRIVALS CURB	Curb length required
1.6.5.19	RESTAURANT SEATING CAPACITY TO MEET IRREGULARITIES	Seats required

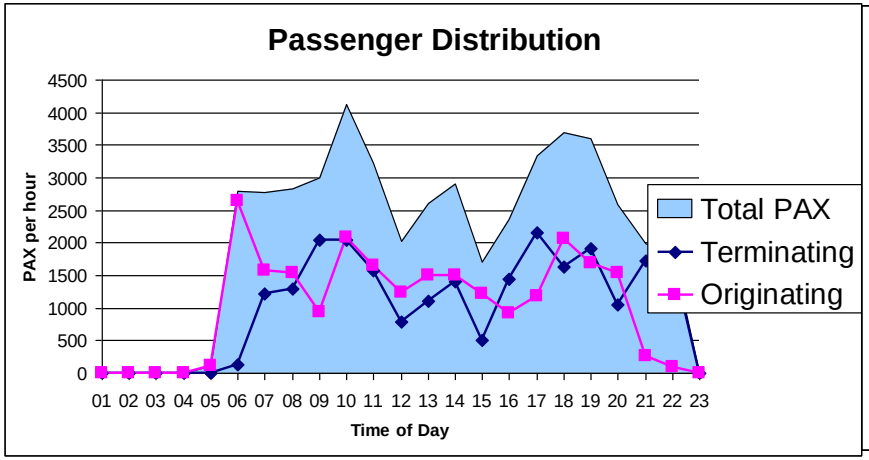
Preliminary Results from the Formulae

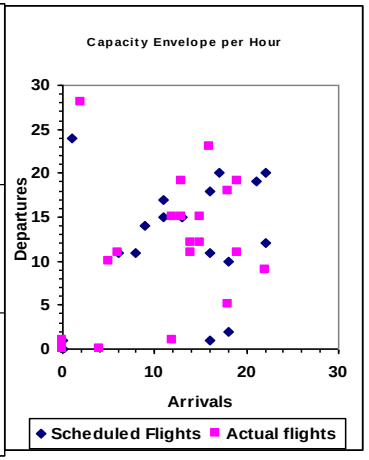
Flightschedule Date		Units Capacity available Capacity reached	CAP ACDP 2003	DEM 2010-07-01		CAP ACDP 2003	DEM 2010-07-01		CAP ACDP 2003	DEM 2010-07-01		CAP ACDP 2003	DEM 2010-07-01		CAP ACDP 2003	DEM 2010-07-01		CAP ACDP 2003	DEM 2010-07-01	
Airport			LCY	LCY		LGW	LGW		FRA	FRA		VIE	VIE		DUS	DUS		HAM	HAM	
Terminal Size		m2	7000	5140			21092		745000	42406		54800	24613		231000	19660		16000	13876	
Peak hour Departing PAX			1000	876		5400	3872		10500	6935		3000	4100			3094		3500	2653	
Peak hour Arriving PAX			2400	872		5500	2664		9000	6682		3100	4092			3912		3500	2158	
Peak hour Transfer PAX			0	0			387			2081		1200	820			391			432	
Total Peak hour PAX			3400	1739		12000	6082		14000	11921		4400	5638			5820			4126	
Peak Hour				18			06			14			10			06			06	
DEPARTURES CURB		meters		64			256			357			241			199			163	
DEPARTURES CONCOURSE		m2		1807			7506			11729			7441			5885			4925	
QUEUING AREA - CHECK-IN		m2		241			1065			1907			1127			849			728	
CHECK-IN DESKS (Centralized, Common Check-In)		Desks	26	32		327	142		378	254		84	150		162	113		43	97	
PASSPORT CONTROL - DEPARTURE		Positions		5		N.A.	21		58	38		15	23		38	17		5	15	
SECURITY CHECK - CENTRALIZED		Units	2	3		15	13		80	23		32	14		26	10		9	9	
DEPARTURE LOUNGE (excluding Concessions except BAR/SNACK FACILITIES)		m2		1007			5962			11905			5917			3989			3271	
SECURITY CHECK - GATE HOLD ROOM		units		1			1			2			2			1			1	
GATE HOLD ROOMS		m2		115			291			435			353			333			333	
ARRIVALS HEALTH CHECK (where required)		positions		3			3			3			3			3			3	
QUEUING AREA - PASSPORT CONTROL - ARRIVAL		m2		216			754			2161			1214			967			533	
PASSPORT CONTROL - ARRIVAL		positions	6	8		27	28		80	80		20	45		28	36		7	20	
BAGGAGE CLAIM AREA (excluding claim devices)		m2		863			2637			6615			4051			3873			2136	
NUMBER OF BAGGAGE CLAIM DEVICES	WB	devices		0		5	3		12	6		1	1		8	3		4	0	
	NB	devices	3	4		7	4		22	9		6	10		12	7		6	6	
QUEUING AREA - ARRIVALS CUSTOMS		m2		27			84			209			128			123			68	
ARRIVALS CUSTOMS		positions	6	5		6	15		9	37		3	23		Not available	22		2	12	
ARRIVALS CONCOURSE WAITING AREA (excluding Concessions)		m2		863			2793			7444			4381			3641			1882	
ARRIVALS CURB		meters		55			168			420			258			222			109	
RESTAURANT SEATING CAPACITY TO MEET IRREGULARITIES		seats		127			478			478			388			366			366	

Preliminary Graphical Results from the Software









Maximum Technical Hourly Capacity (IFR/VFR)	59
Maximum Declared Capacity/Slots	48

Daily Scheduled Arrivals	238	100.00%
Daily Scheduled Departures	236	100.00%
Total Daily Scheduled Flights	474	100.00%
Daily Actual Arrivals	237	99.58%
Daily Actual Departures	235	99.58%
Total Daily Actual Flights	472	99.58%
Cancellations	2	0.42%
Delayed Arrivals	41	17.23%
Delayed Departures	26	11.02%
Delayed Total Flights	67	14.14%
Daily Arrival Delays (hh:mm:ss)	22:26:00	56.79%
Daily Departure Delay (hh:mm:ss)	17:04:00	43.21%
Daily Total Delay (hh:mm:ss)	39:30:00	100.00%
Average Delay per Delayed Arrival	0:32:50	in min
Average Delay per Delayed Departure	0:39:23	in min
Average Delay per Delayed Flight	0:35:22	in min
Average Delay per Scheduled Arrival	0:05:39	in min
Average Delay per Scheduled Departure	0:04:20	in min
Average Delay per Scheduled Flight	0:05:00	in min
Peak Hour Flights	23	Ops/hr
Peak Hour to Daily Scheduled Flights Ratio	4.85%	
Peak Hour Seats per Aircraft	133	
Peak Hour PAX (SLF 85%)	2607	
% Light Class Aircraft	0%	
% Medium Class Aircraft	100%	
% Heavy Class Aircraft	0%	
Mix Index	100%	

Outlook and further Refinement

- Obtaining detailed floor plans
- Passenger flow simulation for locating terminal “bottlenecks” (e.g. wrong arrangement of facilities & servers)
- Runs regarding sensitivity to varying seat load factor
- Runs regarding sensitivity to different schedules
- Runs regarding sensitivity to different levels-of-service
- Runs regarding sensitivity to different transfer rates

Thank you for your attention! Questions?

Suggestions and Comments are welcome.

branko.bubalo@googlemail.com
www.gap-projekt.de