



AIRPORT CAPACITY FORECAST

SHORT-TERM FORECASTING OF RUNWAY CAPACITY

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Why capacity forecast – airline flight cancellation

Early flight cancellation with expected capacity drops of the airport (e.g. because of adverse weather conditions)

Airline

Advance information allows earlier flight adjustments

Departure flight cancellations preferable 24 hours in advance
(NOT 1 hour)

Early coordination for inbound flights

Allows airport wide coordination between airlines



08:50	Larnaca	AA6621	Cancelled
08:50	Berlin	BA662	Cancelled
08:50	Glasgow	AA6594	Cancelled
08:50	Palma Mallorca	GF5222	Cancelled
08:55	Prague	LH6639	Go to Gate
08:55	Moscow	CX7121	Cancelled
8:55	Nice	BA872	Cancelled
8:55	Manchester	BD193	Go to Depart
9:05	Dublin	GF5280	Cancelled

ACF objectives (SESAR WP E)

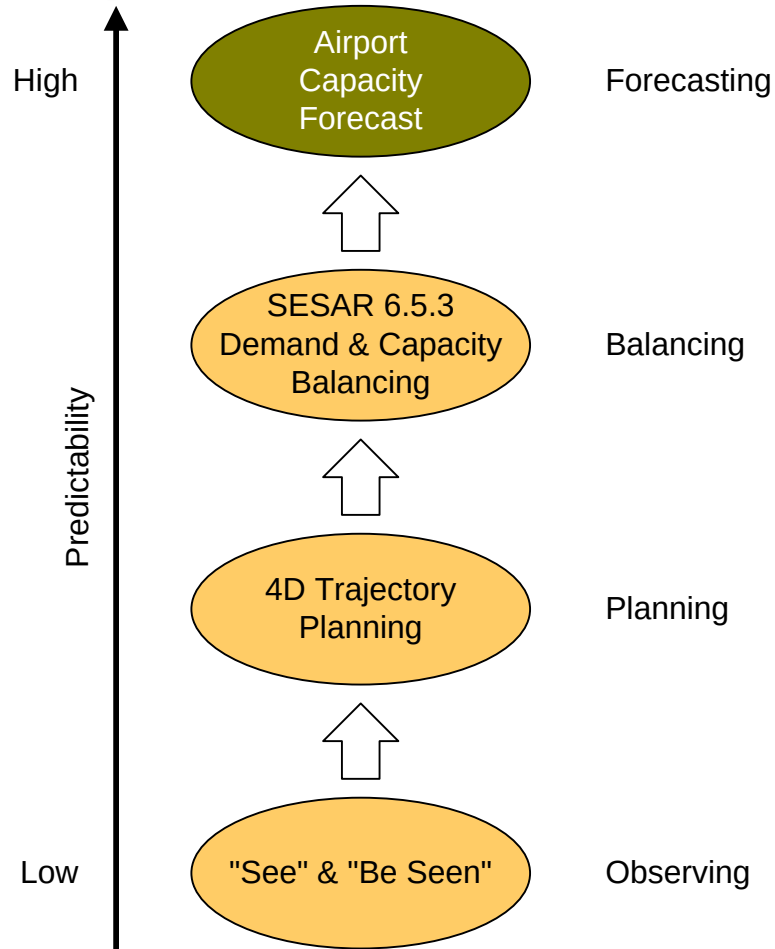
Airport Capacity Forecast (ACF) investigates the use of forecast information concerning airport capacity, which will allow airport stakeholders to optimise use of their resources

The main research question in the project is:

Using a probabilistic capacity forecast, will stakeholders be able to respond better to changes in airport capacity (landside and airside)?

This presentation will focus on runway management

Scope



Research & Prototyping of several use cases

- Modelling (uncertainty)
- HMI development (dashboard)

Evaluation of the models

Characteristics of capacity forecasting for ACF

Probabilistic, uncertainty

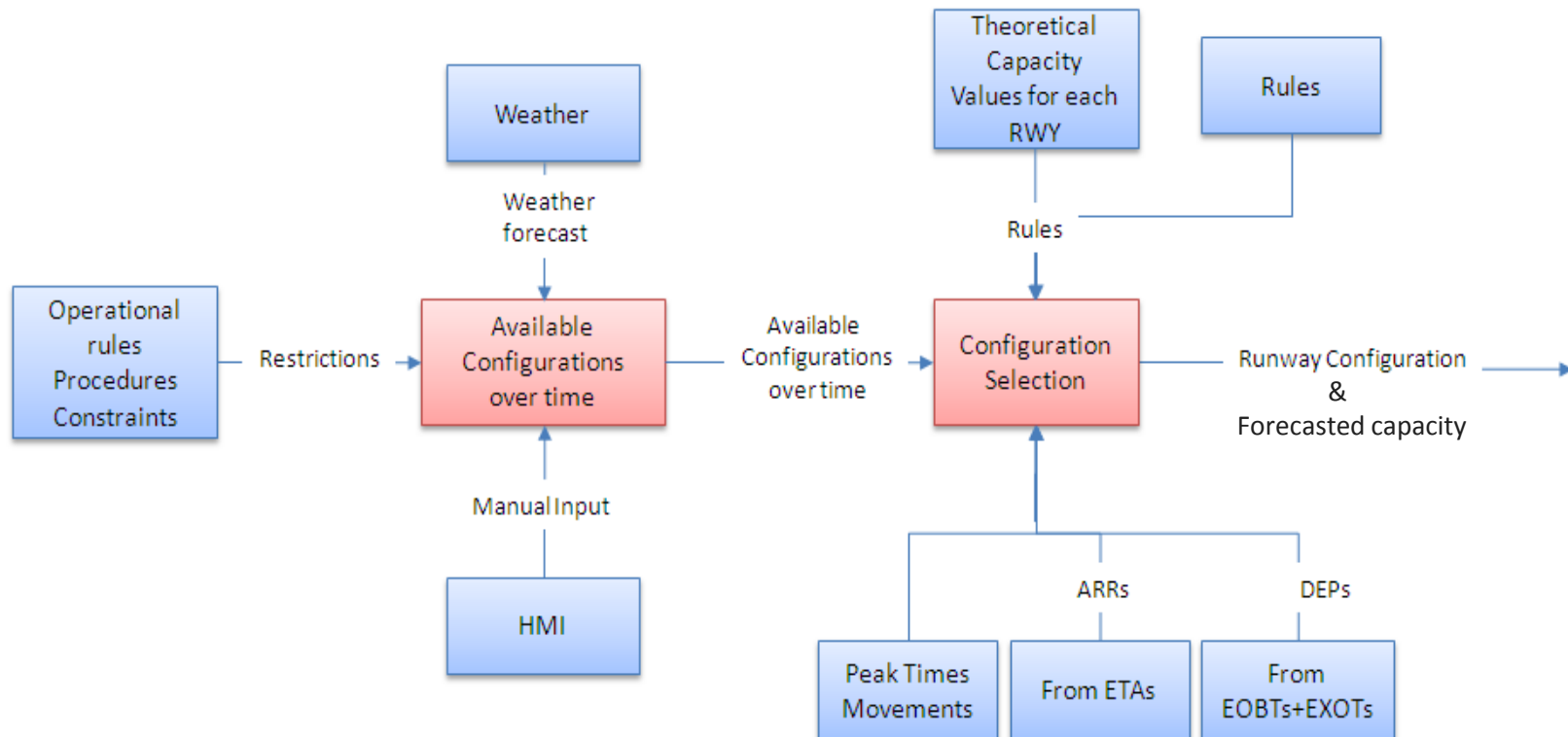
1 hour to 48 hours

Estimation of consequences of events

=> High predictability of near term capacity



Runway management (source: SESAR)



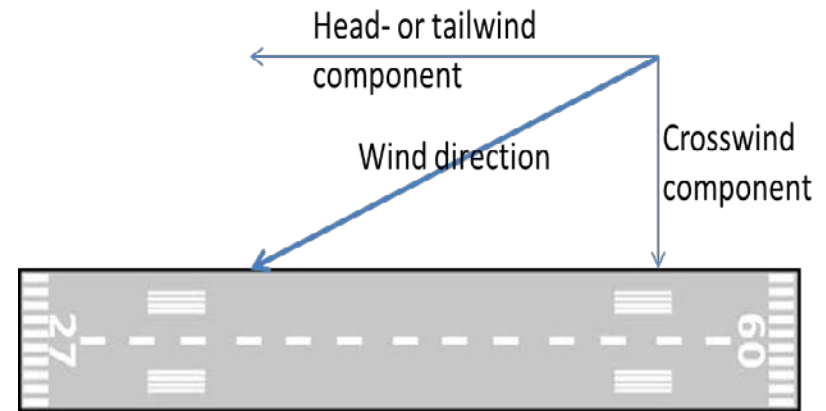
Weather forecast

	08	09	10	11	12	13	14	15	18	21	00	03	06	09	12
Visibility < 5 km and/or ceiling < 1000 ft (%)	85	80	75	75	70	65	65	70	50	70	70	75	75	70	60
RVR < 1500 m and/or ceiling < 300 ft (%)	0	5	5	5	5	5	5	5	10	15	20	40	50	40	20
RVR < 550 m and/or ceiling < 200 ft (%)	0	0	0	0	0	0	0	0	5	5	10	25	25	25	10
RVR < 350 m (%)	0	0	0	0	0	0	0	0	0	0	0	5	10	0	0
Winddirection (deg)	↗ 200	↗ 210	↗ 210	↗ 210	↗ 210	↗ 220	↗ 230	↘ 240	↘ 240	↗ 220	↗ 220	↗ 220	↗ 200	↗ 200	↗ 210
Windspeed (kt)	10	11	12	13	13	13	12	12	8	7	7	6	8	10	14
Gusts (kt)							17								19
Standarddeviation winddirection (deg)	15	10	10	10	10	15	15	15	25	30	30	30	25	15	10
Standarddeviation windspeed (kt)	2	2	2	2	2	2	3	2	2	3	2	2	2	2	2
CB (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
Thunderstorm (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	08	09	10	11	12	13	14	15	18	21	00	03	06	09	12

Windvector

Wind vector is

(230 degrees, 12 knots),
standard deviation (15, 3)

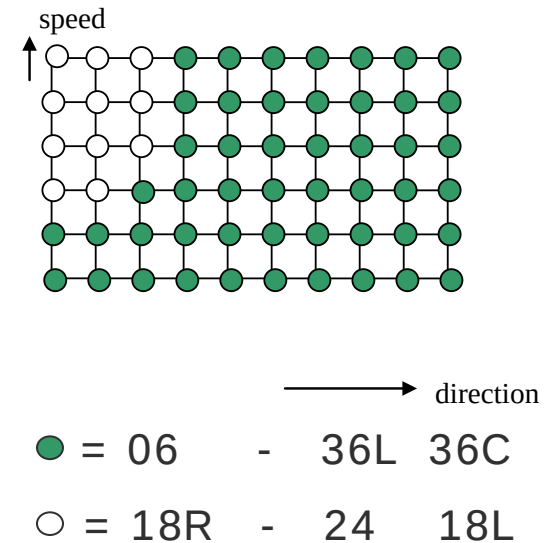
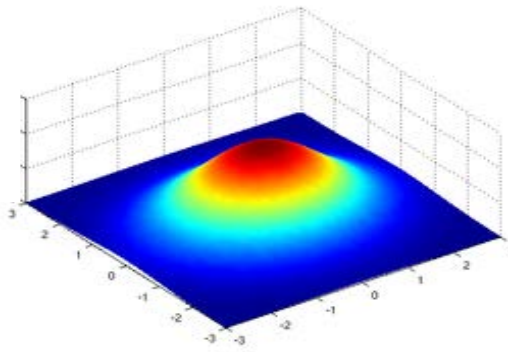
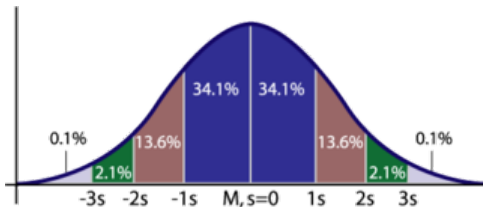


Runways are used in combinations of take-off and landing
runways

Most airports operate a preferential runway system, based on
noise and capacity constraints

Runway combination forecasting

Meteo forecast is a probability forecast
=> runway forecast is probabilistic



Runway use can therefore also not be determined in absolute values. Other parameters are playing a role in the allocation of runways

- preference tables (noise preference)
- runway and taxiway availability
- ILS
- local meteorological conditions (e.g. local showers)
- non-local meteorological conditions in the FIR

Runway selection

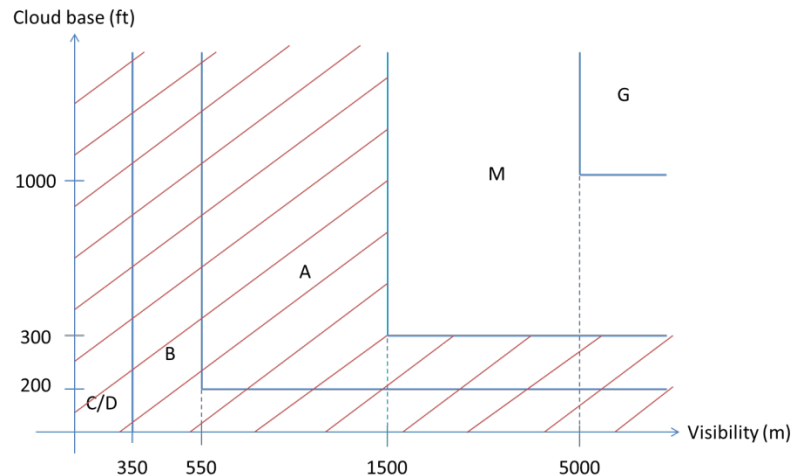
Last update: Short term: 10652 UTC Long term: 10510 UTC

OUTBOUND PEAK				8	9	10	11	12	13	14	15	18	21	0	3	6	9	12
06	-	36L	36C	2	1	0	0	0	0	0	0	22	17			10	3	0
18R	-	24	18L	99	99	99	99	99	99	94	99	94	94			74	74	89
36R	-	36L	36C	2	2	1	0	0	4	4	17	42	23			13	4	0
18R	-	18L	18C	15	20	25	25	30	35	34	30	50	30			25	30	40
06	-	36L	09	2	1	0	0	0	0	0	0	28	39			23	4	0
27	-	36L	24	4	2	1	0	0	5	5	39	78	63			34	6	0
27	-	24	18L	99	94	94	94	94	94	92	94	89	84			50	60	69
27	-	24	27	99	99	99	99	99	99	97	99	99	99			99	99	86

We have set up a method for runway combination selection

Runway capacity

Capacity is based on
Runway combination
UDP
visibility conditions



Visibility

LVP = categories A to D, based on visual observation possibility

LVP = based on horizontal visibility and cloud base

LVP = ILS category (on ground and aircraft equipment)

Marginal = for parallel operations at Schiphol

Capacity

(not) UDP

Visibility categories

Date	Hour	Landing						Total
		GV-UDP	GV-NUDP	MV	AV	BV	CV	
10/01/2012	5:00	0	16,8	3,6	3,6	0	0	24
10/01/2012	6:00	0	43,6	10,1	8,4	2,2	0	64,2
10/01/2012	7:00	0	43,6	20,1	2,8	0	0	66,5
10/01/2012	8:00	0	43,6	20,1	2,8	0	0	66,5
10/01/2012	10:00	51	0	13,4	2,8	0	0	67,2
10/01/2012	11:00	38	0	0	0	0	0	38
10/01/2012	12:00	68	0	0	0	0	0	68
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
				1,6	0	0	0	32
				1,9	0	0	0	38
				11,4	0	0	0	38
				7,2	0	0	0	24
				7,2	0	0	0	24
				6,8	7,2	0	0	24
				4,4	9,6	0	0	24
				⋮	⋮	⋮	⋮	⋮
				0	0	0	0	68
				0	0	0	0	38
				0	0	0	0	68
				0	0	0	0	38
30/06/2013	10:00	68	0	0	0	0	0	68
30/06/2013	11:00	68	0	0	0	0	0	68
30/06/2013	12:00	38	0	0	0	0	0	38
30/06/2013	13:00	68	0	0	0	0	0	68

$C_{rwy}(X, Y)$

$$\begin{aligned}
 &= P(G) \times C_G(X, Y) + P(M) \\
 &\times C_M(X, Y) + P(A) \times C_A(X, Y) \\
 &+ P(B) \times C_B(X, Y) + P(C) \\
 &\times C_C(X, Y)
 \end{aligned}$$

X = configuration of runways

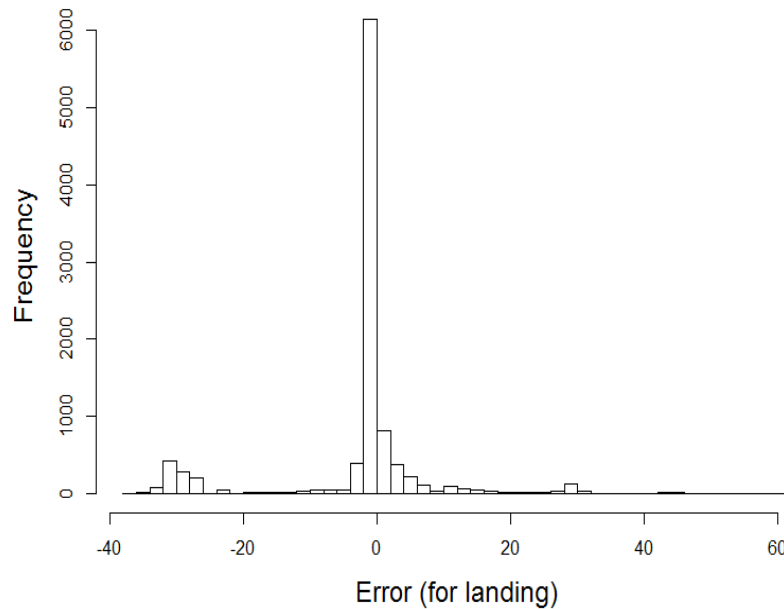
Y = peak period

Runway capacity forecast - result

Evaluation from one and a half year (January 2011 until June 2012) of meteo and runway recordings

Date	Hour	Landing			Taking off	
		Forecasted capacity	Actual capacity		Forecasted capacity	Actual capacity
10/01/2012	5:00	24	24		24,3	25
10/01/2012	6:00	64,2	38		30,5	40
10/01/2012	7:00	66,5	68		31,6	37
⋮	⋮					
18/07/2012	18:00	32	38		71,8	40
18/07/2012	19:00	38	38		73,8	74
18/07/2012	20:00	38	38		38,5	40
⋮	⋮					
30/06/2013	11:00	68	68		37	37
30/06/2013	12:00	38	38		74	40
30/06/2013	13:00	68	68		37	37

Result: prediction of capacity



Winddirection	ARR DEP OFF NIGHT			
	% Hits	% Hits	% Hits	% Hits
10	69%	45%	56%	83%
20	75%	50%	68%	94%
30	36%	56%	64%	96%
40	76%	37%	83%	97%
50	82%	38%	81%	88%
60	69%	41%	76%	98%
70	65%	35%	85%	91%
80	60%	54%	65%	83%
90	45%	36%	34%	78%
100	23%	28%	14%	53%
110	16%	34%	47%	74%
120	33%	35%	41%	64%
130	55%	53%	33%	71%
140	50%	53%	71%	75%
150	73%	67%	49%	85%
160	61%	66%	73%	93%
170	44%	51%	71%	79%
180	56%	70%	72%	92%
190	58%	77%	76%	89%
200	68%	86%	75%	85%
210	64%	78%	80%	93%
220	67%	79%	70%	92%
230	63%	62%	60%	88%
240	68%	57%	68%	80%
250	54%	48%	59%	87%
260	65%	52%	60%	69%
270	61%	42%	63%	75%
280	29%	29%	61%	57%
290	22%	17%	37%	45%
300	22%	20%	32%	77%
310	23%	24%	38%	56%
320	44%	34%	53%	78%
330	57%	30%	68%	77%
340	65%	69%	71%	92%
350	53%	35%	65%	82%
360	80%	36%	74%	96%

Evaluation (qualitative)

More effort necessary for “difficult” wind directions

Capacity is easier to predict than runway configuration
overlap between runways within configurations
different configurations have a similar capacity

(interesting as the capacity is derived from the
configuration)

Is the choice for operating one instead of two runways a
problem?

Conclusion (so far)

Automated airport capacity forecast has been proven for runway management

- The most important factor in “airport capacity”
- Three steps:
 - Forecast strategy
 - Forecast runway configuration
 - Forecast capacity

Still open

- How to present the figures (recognisable)
- Further evaluations
- Give an airport overall capacity forecast through a dashboard
- Will stakeholders be able to better respond?

