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Airport Capacity and Demand Calculations by Simulation - The Case of Berlin-Brandenburg International

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… the initial situation

Ramsauer warnt BBI vor Provisorien

BERLIN - Bundesverkehrsminister Peter Ramsauer (CSU) hat davor gewarnt, mögliche Verzögerungen beim Bau des Großflughafens Berlin Brandenburg International (BBI) mit Provisorien wettzumachen. Die Prüfung des Zeitplans, der schon bisher „außerordentlich ambitioniert" gewesen sei, laufe noch, sagte er dem Tagesspiegel. „Wir können uns keinen Pannenflughafen leisten." Ramsauer übte grundsätzliche Kritik an der Flughafenpolitik Berlins. Zwar werde der BBI ein Tor zur Welt für die Region. „Wenn aber die Zahl der Landebahnen insgesamt von vier bei den bisherigen Flughäfen auf zwei reduziert wird, sind Engpässe vorprogrammiert." Ramsauer zeigte sich skeptisch, dass sich BBI als großes Drehkreuz in Zentraleuropa etablieren könne. Senatssprecher Richard Meng wies dies zurück. Es sei „keine besonders verantwortliche Haltung", wenn der Bund als Miteigentümer des BBI schon vor der Eröffnung schlechte Stimmung mache. *mod*

Tagesspiegel,
07.06.2010 (Page 1)

… if the number of runways will be reduced from four on the previous airports to two, bottlenecks are inevitable. …. (!!)

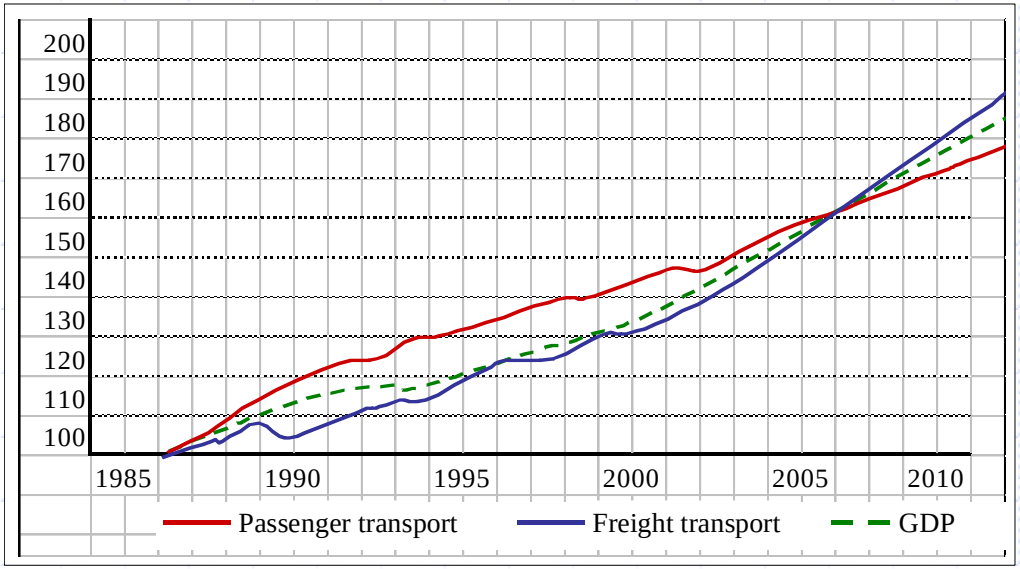
…. Is he right or not ???

Content:

- Introduction
- Basic conditions
- Test design
- Simulation results
- Conclusion and outlook

Introduction / Importance of aviation (1)

- **The *mobility* of *people* and *goods*, as the **** context between development in the transport sector and of the GDP indicates, is an indispensable basis for a *sustainable development* of a social system and a long-term stable *economic growth.***



Introduction / Importance of aviation (2)

- **The air transport has *considerable importance* concerning the management of mobility, especially in *trans-* and *inter-continental transport*.**

  This does not only affect *industry*, *retail trade* and *tourism*, but also to a great extend, the *scientific community*.

Introduction / Structures of air traffic

- **Basis for air transport are (*global*) *linked structures* with the aid of which *different locations* can be *interconnected* with a relatively *small expenditure of time*.**
- **Within these *air transport networks* the airports are the *central facilities*, which allow access to (as well as exiting from) this mode of transport.**
- **Thus, the airports have a *central function* in the overall system, by what available capacities determine the *maximum capability* of air transport to a large extend.**

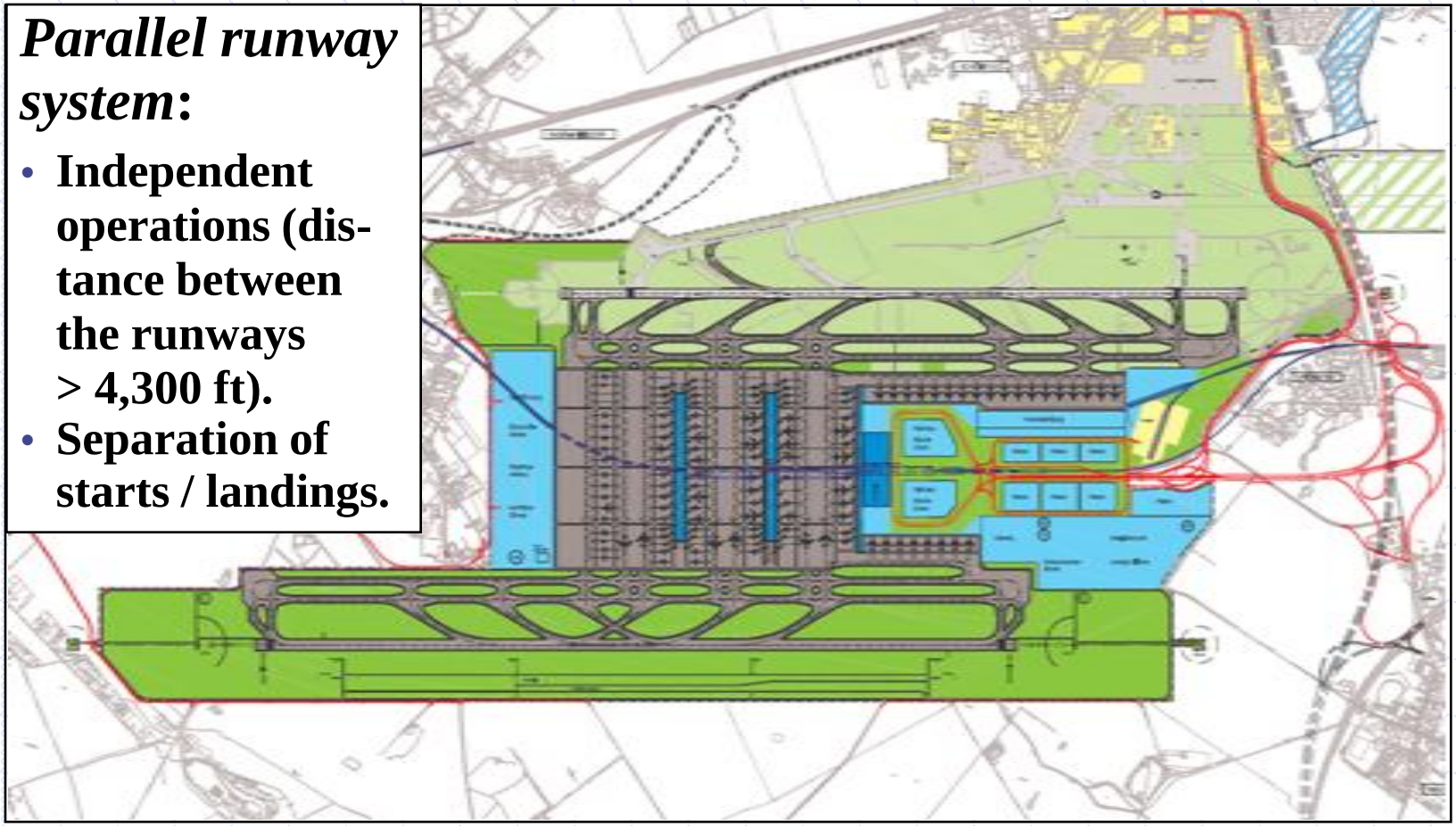
Basic conditions / Problem description

- **Analyzing the *performance* of the airport *Berlin-Brandenburg International* (BBI) (currently being under construction) with a view to the expected (*capacitive*) *requirements* of the coming years.**
- **Starting point are the (partly also political justified) decisions taken in the context of the *plan approval procedure* and the resulting *construction* and *design requirements*.**
- **Objective of the study is to answer the question whether the long-termed *sustainability* of the *investment decision* taken is guaranteed.**

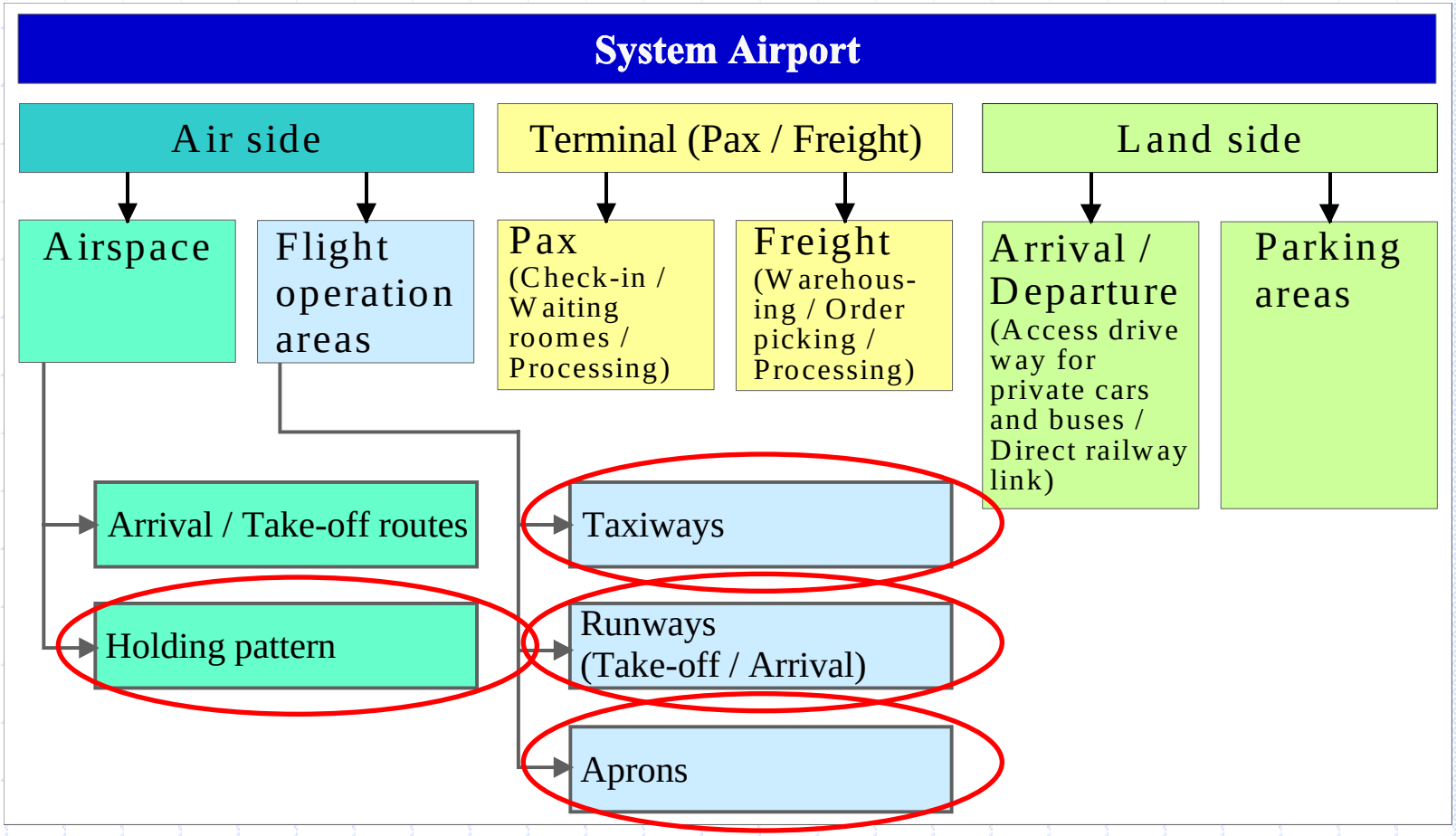
Basic conditions / Layout BBI airport

***Parallel runway system*:**

- **Independent operations (distance between the runways > 4,300 ft).**
- **Separation of starts / landings.**



Basic conditions / Process structure "System Airport"



Test design / Basic data (1)

Flight movements at a (typical) peak day (Thursday, 26.06.2008) (= Scenario 0)

- **Traffic load curve (24 hours).**
- **Differentiated by *weight* or *wake vortex turbulence classes*.**

Hour of day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Sum
Heavy								1	1	2		1	1	1	1	1			1	1			1		12
Medium	2	1		1	1	2	24	26	46	43	34	39	25	31	32	32	37	41	42	44	46	35	21	4	609
Light								2	1		2	1		1		2		1	2	1	1				14
Sum	2	1	0	1	1	2	24	29	48	45	36	41	26	33	33	35	37	42	45	46	47	35	22	4	635

(Heavy (H) > 136 t *Maximum Take off Weight* (MTOW) / Medium (M) 136 - 7 t MTOW / Light (L) < 7 t MTOW)

Test design / Basic data (2/1)

***Minimal* safety distance to be observed (Standard):**

- **At landings: *Nautical mile* (NM)**
- **At starts: *Seconds***

Sequence	Arrival - Arrival			Departure - Departure		
Leading \ Trailing	H	M	L	H	M	L
Heavy	4	5	6	120	120	120
Medium	3	3	4	60	60	60
Light	3	3	3	60	60	60

Test design / Basic data (2/2)

Effect of weight and wake vortex turbulence classes in *sequencing* (for landings) on the achievable capability.

Example: Combination of aircraft types H and L:

- **Sequence 1: H → L → H → L → H → L = 24 NM**
- **Sequence2: H → H → H → L → L → L = 20 NM**

Test design / Definition of scenarios

Starting basis *scenario* 0.

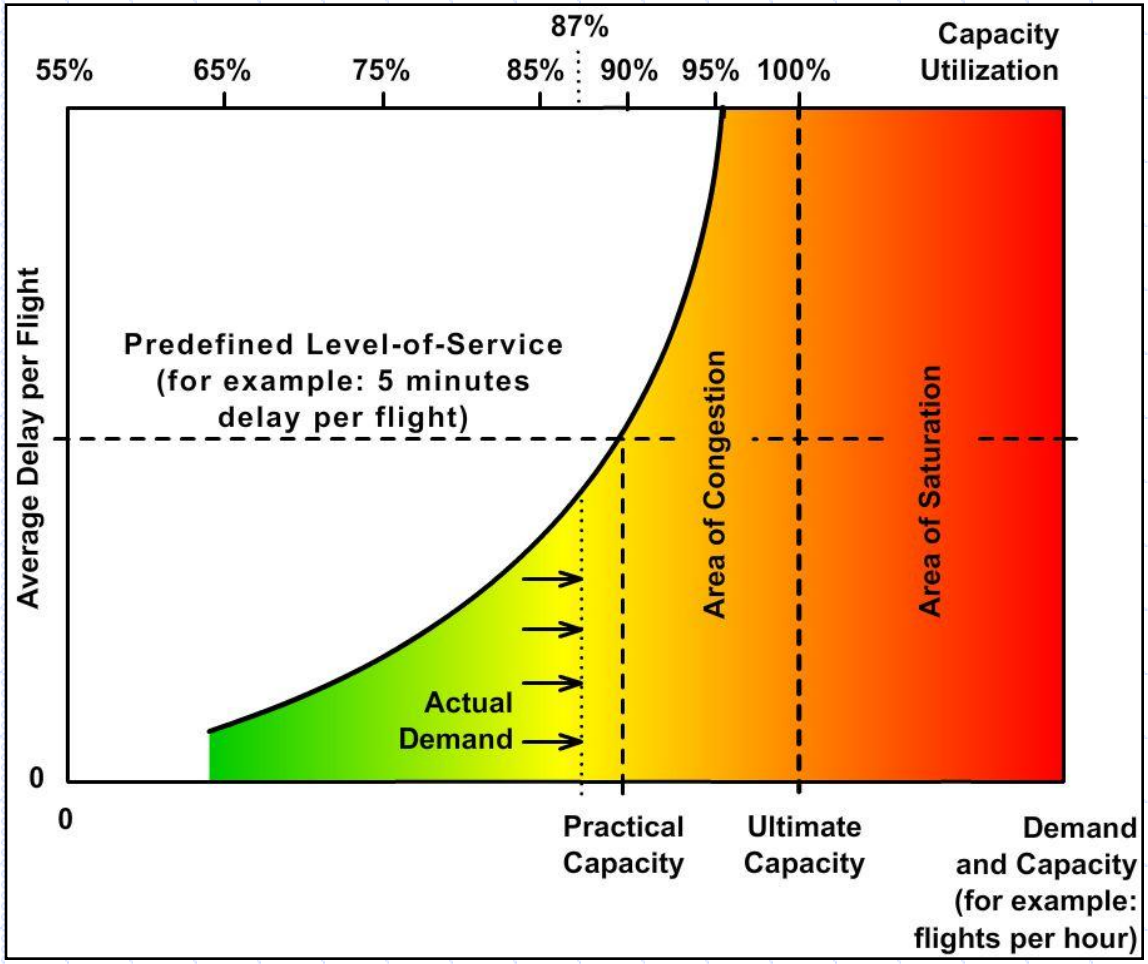
Variation of type mix (H / M / L).

Scenario	0		I		II		III		IV		VI	
%-Share / #	%	#	%	#	%	#	%	#	%	#	%	#
Heavy	2	12	5	32	15	95	5	32	20	127	2	13
Medium	96	609	95	603	80	508	84	533	65	413	84	533
Light	2	14	0	0	5	32	11	70	17	95	14	89
Sum	100	635	100	635	100	635	100	635	100	635	100	635
Mix index	102		110		125		99		125		90	

Test design / Simulation procedure (1/1)

- **Analyzed demand developments:**
  - ***Decrease* of -20%**
  - ***Zero growth***
  - ***Growth rate* of 20% (stepwise up to 200%)**
- **Examination of *peak load times* (****** Stundenraster).**
- ***Target values*:**
  - ***Demand* (Number of flights)**
  - **Accruing *delays* (Minutes / costs)**
  - **Occurring *flight cancellations* (Number / costs)**

Test design / Simulation procedure (1/2)



Connection between the factors *demand*, (available) *capacity* and *delays*.

Test design / Simulation procedure (2)

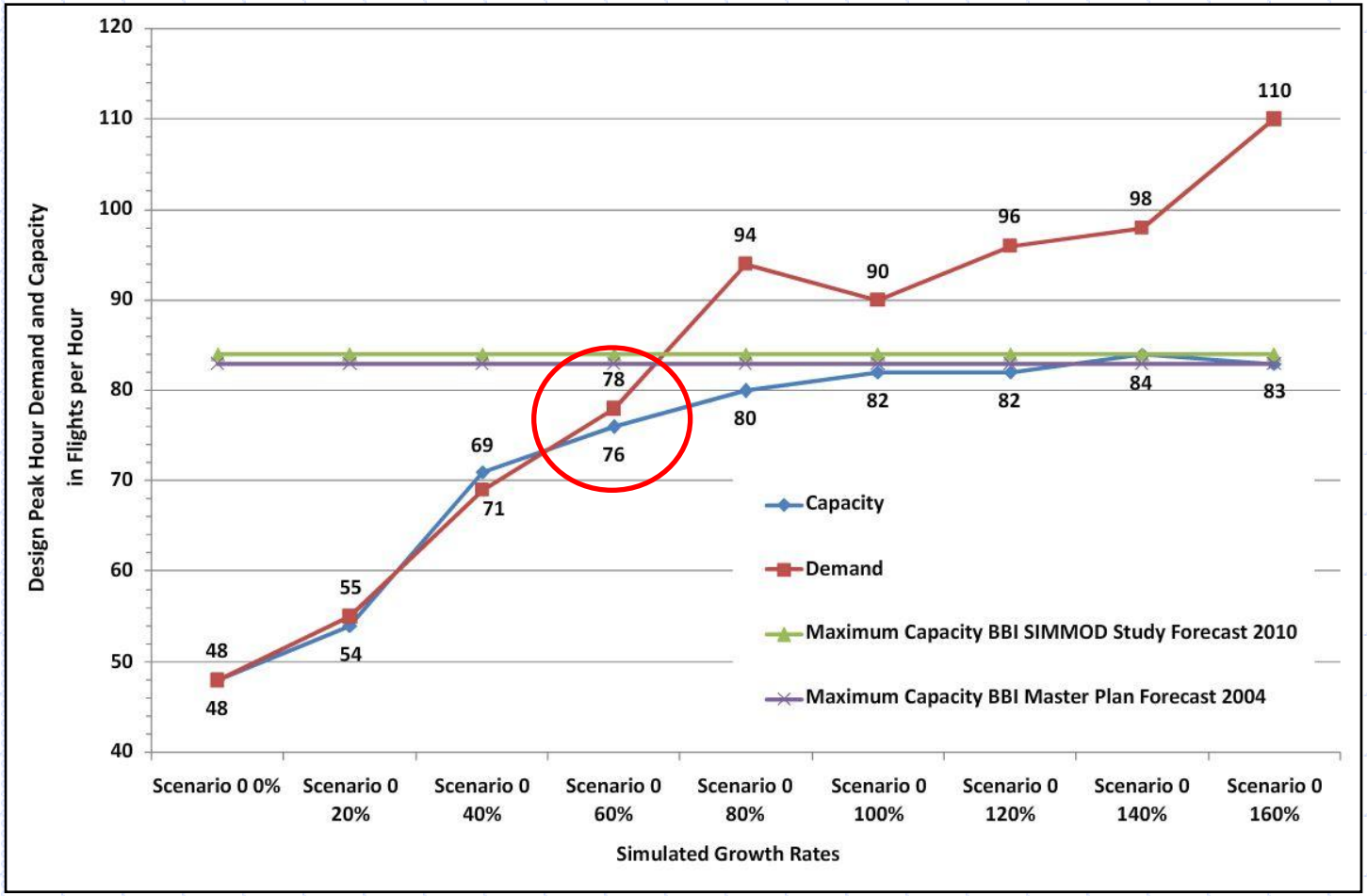
- **Consideration of *capacity restrictions*:**
  - **Number of *parking positions*.**
  - ***Possibility to access* to the (both) runways (for independent take-off and landing operations).**
  - **Capacity of *aprons*.**
- **Constraint to *lower air space* (Radius of about 20 NM).**
- ***Simulation tool*:**
  - **Visual SIMMOD Version 1.9.1**
  - **Tools of the *Federal Aviation Administration* (FAA)**

Simulation results / Calculations for scenario 0 (1)

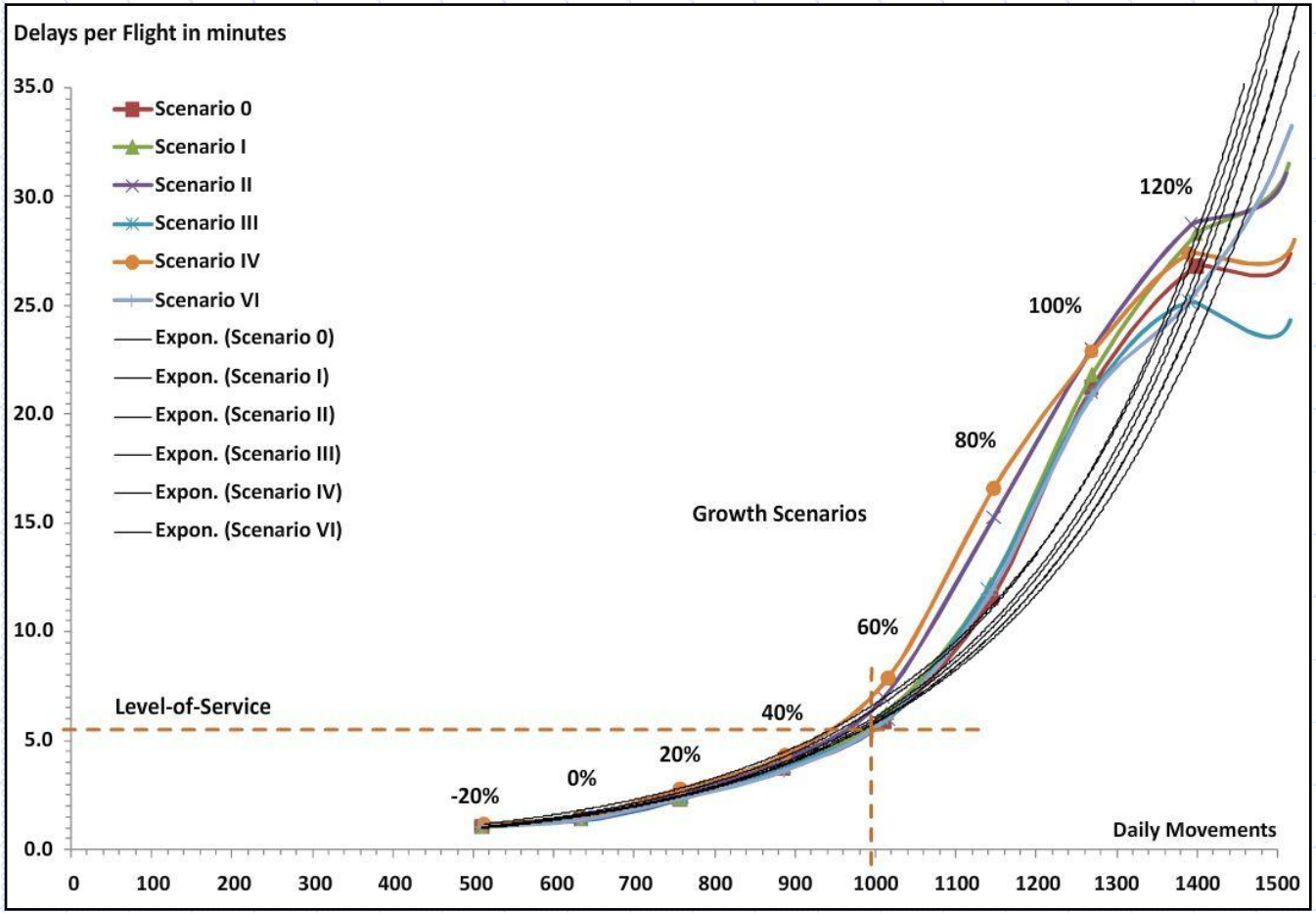
Rate of growth (%)	Number of flights / Day	Demand / Peak load (Hour)	Throughput capacity (Hour)	Average delay / Per flight (Min)	Sum of delays (Min)	Delay costs (€)[1]	Cancellations
- 20	511	40	40	1.1	543	22.806	0
0	635	48	48	1.4	887	37.254	0
20	758	55	54	2.3	1.760	73.920	0
40	886	69	71	3.7	3.287	138.054	0
60	1012	78	76	5.9	5.955	250.110	0
80	1145	94	80	11.5	13.223	555.366	0
100	1270	90	82	21.2	26.968	1.132.656	1
120	1400	96	82	26.8	37.501	1.575.042	134
140	1517	98	84	27.4	41.538	1.744.596	440
160	1639	110	83	58.2	95.364	4.005.288	807

[1] Delay cost factor (per minute): € 42,00 according to EUROCONTROL (Standard Inputs for CBA Analysis)

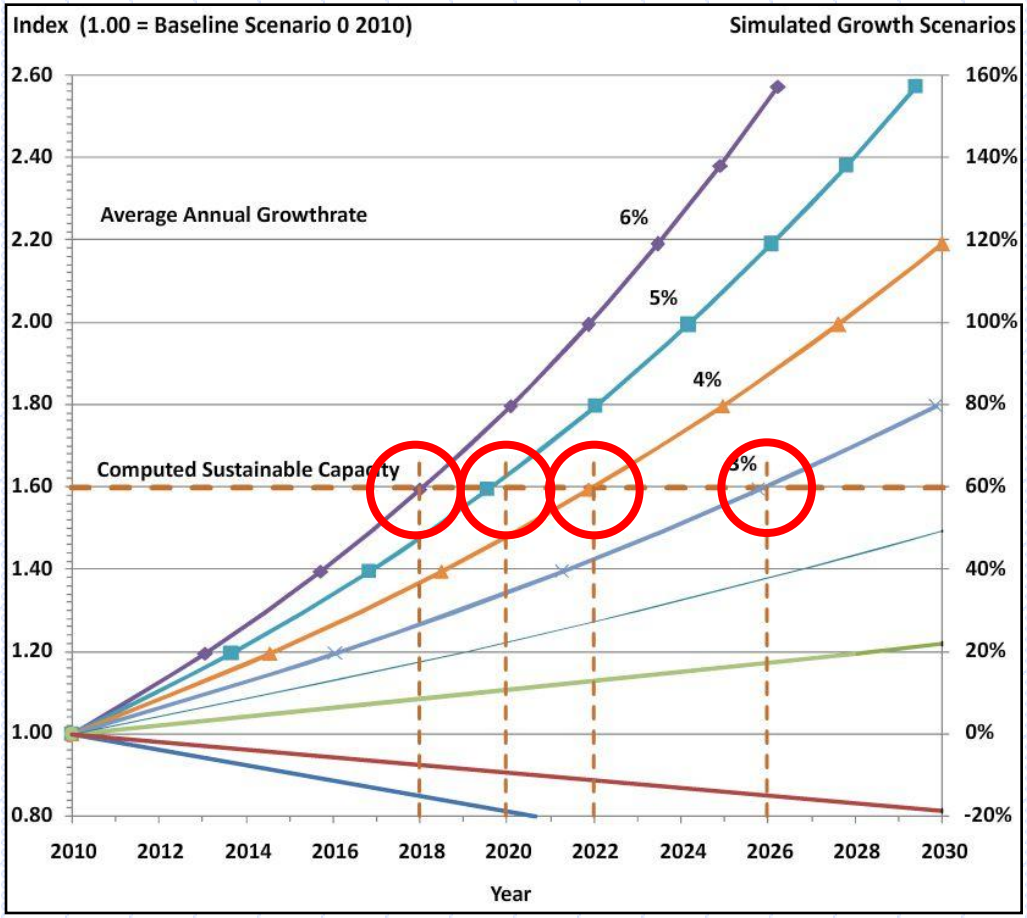
Simulation results / Calculations for scenario 0 (2)



Simulation results / Comparison of scenarios (1)



Simulation results / Comparison of scenarios (2)



Annual growth rate 3%:

→ **Capacity limit attained 2026**

Annual growth rate 4%:

→ **Capacity limit attained 2022**

Annual growth rate 5%:

→ **Capacity limit attained 2020**

Annual growth rate 6%:

→ **Capacity limit attained 2018**

Conclusion and outlook (1)

- **Simulating a hypothetical beginning of operation in *2010, Six years* after the actual *start of operations* of the airport BBI (scheduled for June 03, 2012), at peak hours (at an annual growth of 6%) runway *capacity bottlenecks* are expected in the field of s*tarts* and *landings*.**

- **If there are additional effects *inducing increasing demand* (e.g. hub function for the *Scandinavian* and *Eastern European* area / hub function for different airlines), or if there is greater *increase* of *demand* (as well as of the offered flight numbers), capacity limits can be reached even before the year 2018.**

Conclusion and outlook (2)

- **Proceeding from the results presented, a defined planning for a *first stage of expansion* should have been already started *two years ago (2008)*, as well as the initiation of the necessary *plan approval procedure*.**
- **From this the question of the *root* of this (possibly serious) misjudgement arises:**
  - **(*Political motivated*) *miscalculation* of demand trends under the specific conditions in the Berlin Brandenburg area.**
  - **(*Knowingly*) *undersizing the project* because of *cost considerations* to achieve a (*political* and *parliamentary*) *enforcement* of the intended *investments*.**

Conclusion and outlook (3)

- **Experiences at Munich airport *Franz Josef Strauß* (MUC):**
  - **Starting up 1992 with a capacity of 13 Mio Pax (total passenger volume: 8,1 Mio).**
  - **Total passenger volume 2008: 34,5 Mio.**
  - **Implementing of a *third* runway is intended for 2020. Start of planning has been in March 2007 (Regional planning procedure).**