The New Airport for Berlin – Has Willy-Brandt (BBI) Airport enough Capacity for the Future?

A Simulation Approch

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German Aviation Research Society Workshop (G.A.R.S.) at ILA 2010
Berlin, June 10th 2010

Personal Background

- Graduate in Business Administration and Engineering from Berlin School of Economics and Law (BSEL) and University of Applied Sciences Berlin
- Diploma Thesis (2009): “Benchmarking Airport Productivity and the Role of Capacity Utilization”
- 4th year in German Airport Performance Research Project at Berlin School of Economics and Law
- Conducted Benchmarking studies of European Airports and Airlines (75 Airports, 50 Airlines)
- Consultation in MIME Project, funded by EU Commission, studying Noise mitigation around airports, by market-based instruments
- Looking for new opportunities in Air Transportation Research & Development and PhD position

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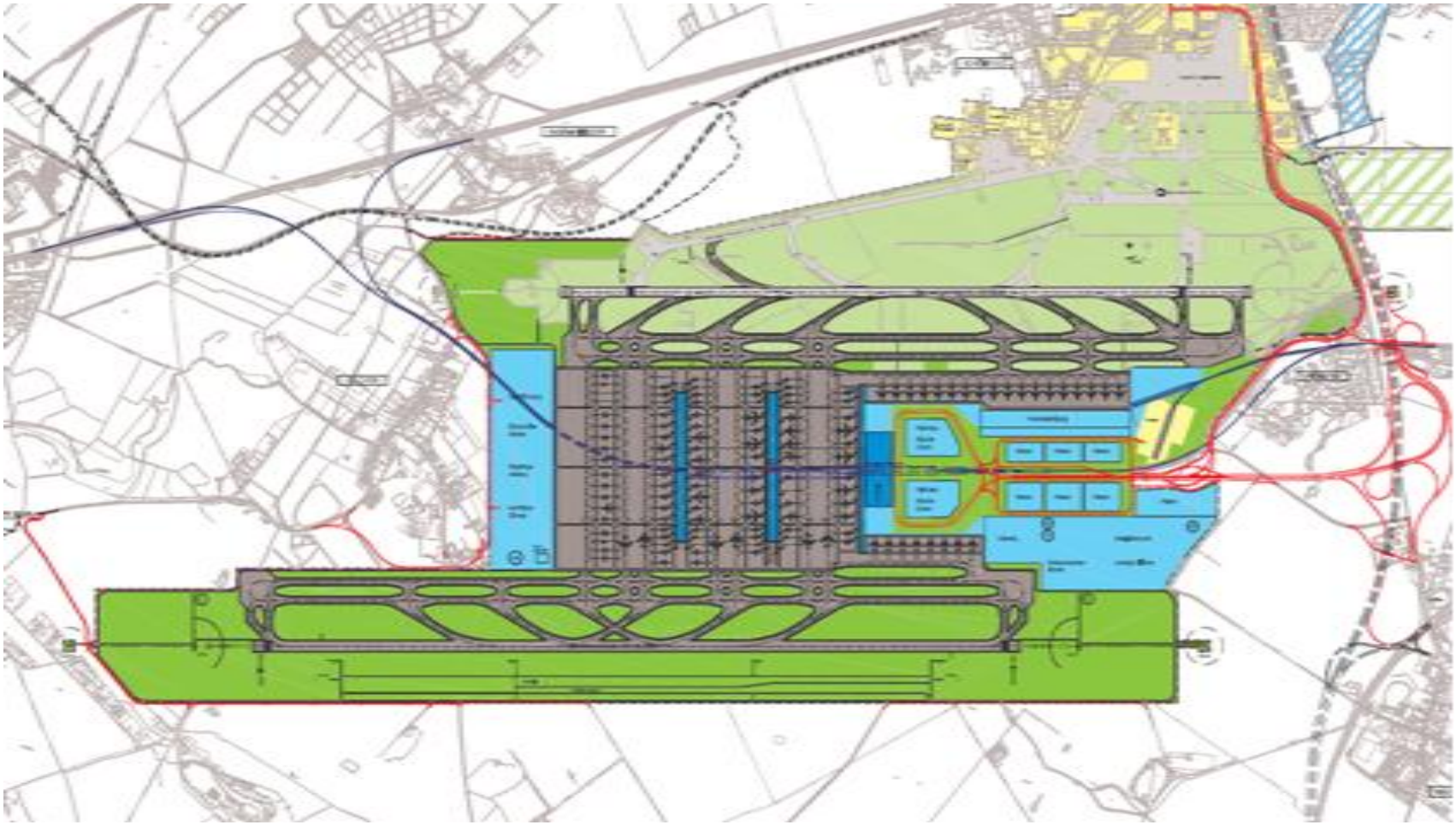
Plan of Berlin-Brandenburg International Airport



Why is Airport Runway Capacity so important

Economical Perspective:

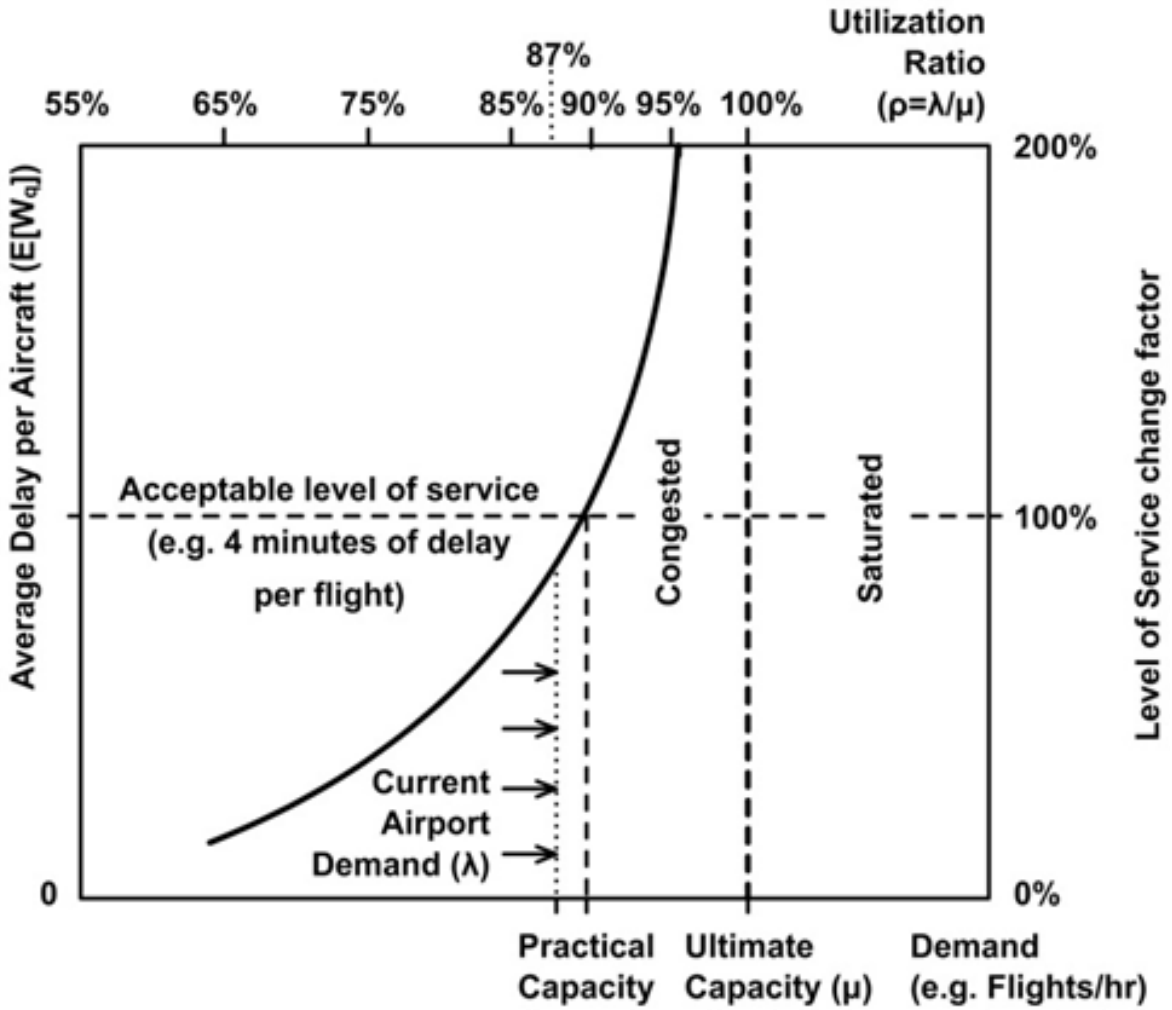
- **Global Competition** of Regions which makes air interface vital
- **Attracting Airlines and Business**, Tourists and Transit Passengers
- **Reducing Costs** for Flying, by providing enough slots for demand and increasing future demand

Technical Perspective:

- **Operating at Practical/Sustainable Capacity** is important for Airport System Stability, Reliability (Scheduling!) and Service Quality (level-of-service (LOS) of e.g. 4 minutes of mean delay/flight)
- **Operating at Maximum capacity leaves no margin-of-safety** for unscheduled random events, e.g. weather (snow!), unscheduled flights (Business jets, Charter, General Aviation (GA)), emergency landing etc.)
- **Delays increase exponentially at high utilization rates**
- **Knock-on delay effects make operating at airport costly for airlines**

Relationship between Demand, Capacity and Delay

- As airport demand increases towards its (ultimate) capacity, the airport system becomes congested and average delays per flight increase exponentially.



Modified from Horonjeff 2010, p.488

Berlin Airports today and tomorrow

- **From 3 (Tegel (TXL), Schoenefeld (SXF), Tempelhof (THF) airports) make 1 (Willy-Brandt Airport (BBI))**
- **Existing airports (SXF and TXL) will be replaced fully by BBI on October 2011**
- **Political Dimension and Relevance** for a study of BBI capacity and future development:

"When the **Number of Runways** at the existing Airports **will be reduced from 4 to 2**, Bottlenecks are bound to occur."

(German Federal Transport Minister Peter Ramsauer, Tagesspiegel, June 7th, 2010)

European Comparisons

- **Peer group of independent, far parallel-runway airports** (Separation of at least 1500 meters and alternate-mode operations)
- **Best Practices** with similar runway layout and highest productivity (2008) in comparison to BBI (SXF + TXL): **London-Heathrow and Munich**
- **BBI has the potential to rank third-biggest European airport** (before Palma-de-Mallorca (PMI) and Oslo (OSL)) **in peer group by 2012**

Airport	Annual PAX (million)	Annual Flights (thousand)	PAX per Flight	Peak Hour Throughput
London-Heathrow	67.2	473	142	103
Munich	34.5	409	84	93
BBI (TXL+SXF 2008)	21.2	212	100	48
BBI Planned Final 2023 (Planning Permission 2004)	30	301-329	100-91	90
BBI Sustainable Final at 2024 (60% growth from 2008 at 3%; SIMMOD study 2010)	28.1	303	93	76

BBI Study Background

- Study prepared for International Conference on Operations Research "Mastering Complexity“ Munich 2010 with Prof. Joachim Daduna (BSEL)
- Full study available in September 2010
- Software: GUI: Visual SIMMOD
  Engine: FAA SIMMOD Engine
- Flight schedule data: Flightstats.com
- Basic Information: Official Planning Permission Documents for BBI

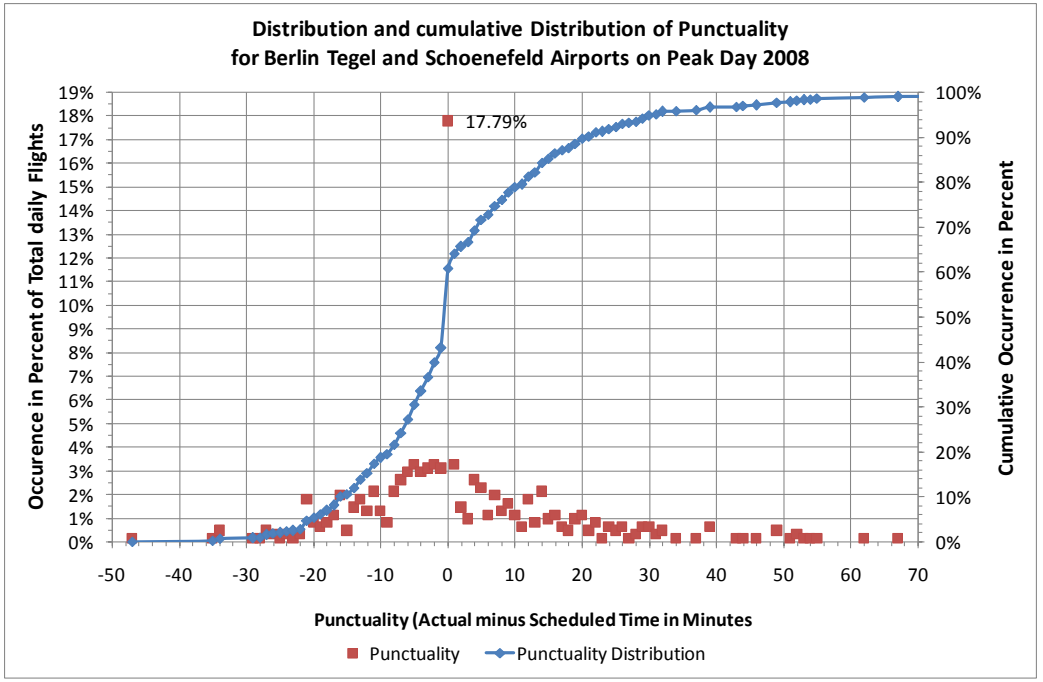
- Sensitivity Analysis towards 6 Scenarios with different traffic mixes (shares of aircraft wake turbulence classes: Small (<7 tons MTOW), Large (7-136 tons MTOW) and Heavy (>136 tons MTOW))
- 11 growth scenarios (-20%,0%,20%,40%,…,200%) at 10 iterations each
- Based on predefined Design Peak Day 2008 (June 26th 2008)

Simulated Scenarios and Traffic Mixes

					Scenario 0		Scenario I		Scenario II		Scenario III	
Airport	SXF		TXL		BBI		BBI		BBI		BBI	
Turbulence Class	Share	Flights	Share	Flights	Share	Flights	Share	Flights	Share	Flights	Share	Flights
HEAVY	0%		3%	12	2%	12	5%	32	15%	95	5%	32
LARGE	100%	155	95%	454	96%	609	95%	603	80%	508	84%	533
SMALL	0%		3%	14	2%	14	0%	0	5%	32	11%	70
Sum	100%	155	100%	480	100%	635	100%	635	100%	635	100%	635
Mix Index (MI)	100%		102%		102%		110%		125%		99%	
MI = 3 x (% HEAVY) + (% LARGE)												

BBI SIMMOD Study Assumptions

- Realistic assumptions resulting from combined actual traffic data of Berlin Tegel (TXL) and Schoenefeld (SXF) airports and Planning Permission documents:

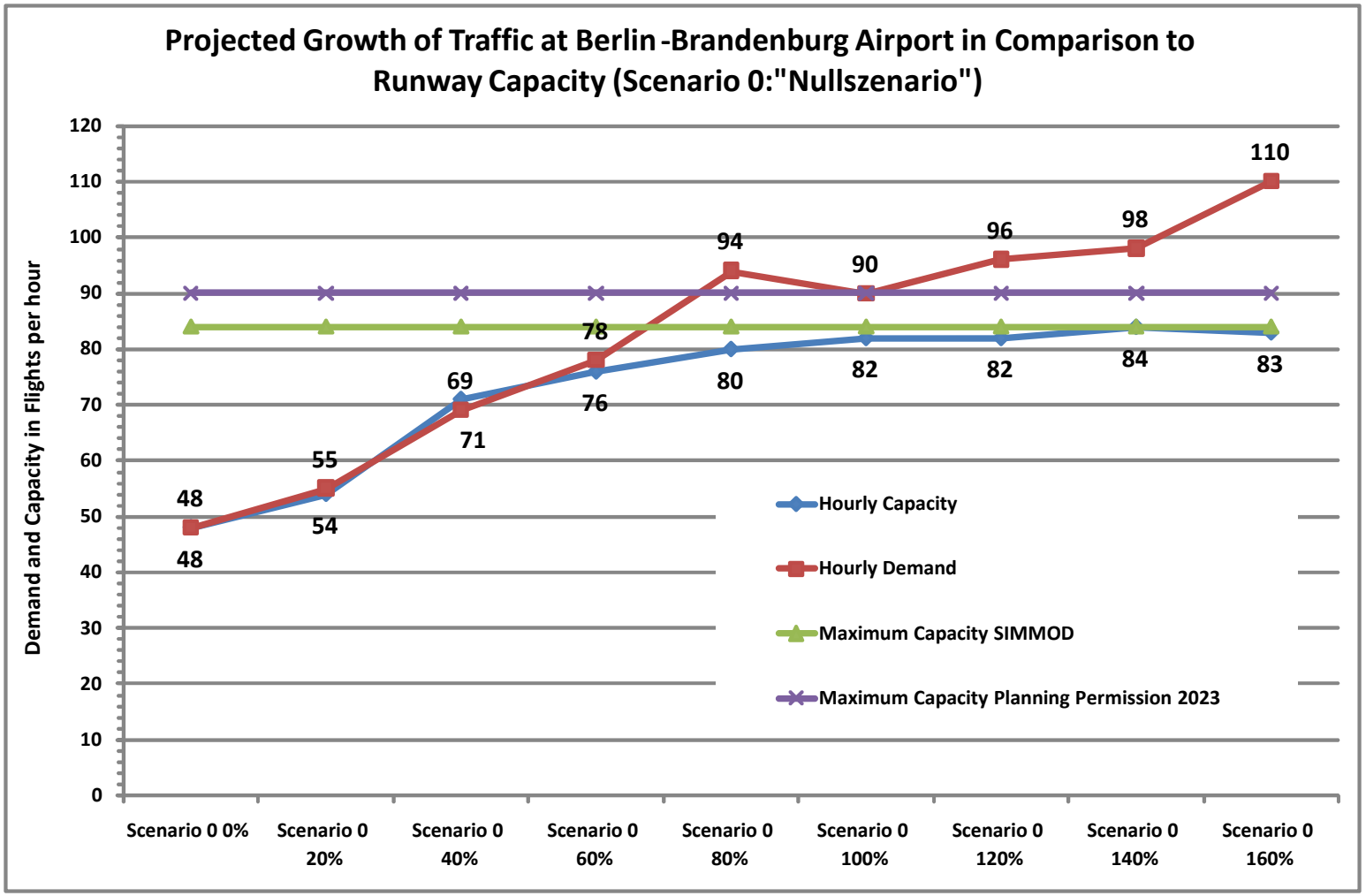


- Delay per Flight will be Key Performance Indicator
- Schedule
- Traffic Mix
- Runway Layout
- Parking Stands
- Punctuality & other Random Distributions
- 20 Additional Business Jet or GA Flights in morning & evening Peaks (7-12 & 15-20; Scenario 0a)

Presenting Interim Results

- **Scenario 0** (baseline, 2 independent parallel runways, current SXF+TXL=BBI traffic mix):
- **Simulated throughput Capacity of 82-84 Flights per hour at 120-140%!** Further increase of traffic resulted in grid locking queues and therefore flight cancellations.
- **Sustainable long-term throughput/capacity of 76 Flights per hour!** (1 operation every 47 seconds) The animation proves this.
- **Demand higher than Capacity at 60% Growth**, based on 2008 busy day schedule and Level-of-Service of 5-6 minutes of Avg. Delay per flight.
- **Delays will increase exponentially beyond 60%** growth.
- Upper and lower boundaries of historic growth rates at TXL and SXF underline the assumption that **demand=capacity reached between 2016-2024** (at 3-6% annual growth).
- **Each 20% growth increment** results in **doubling of daily delays**

Results Scenario 0: Simulated Peak Throughput at BBI



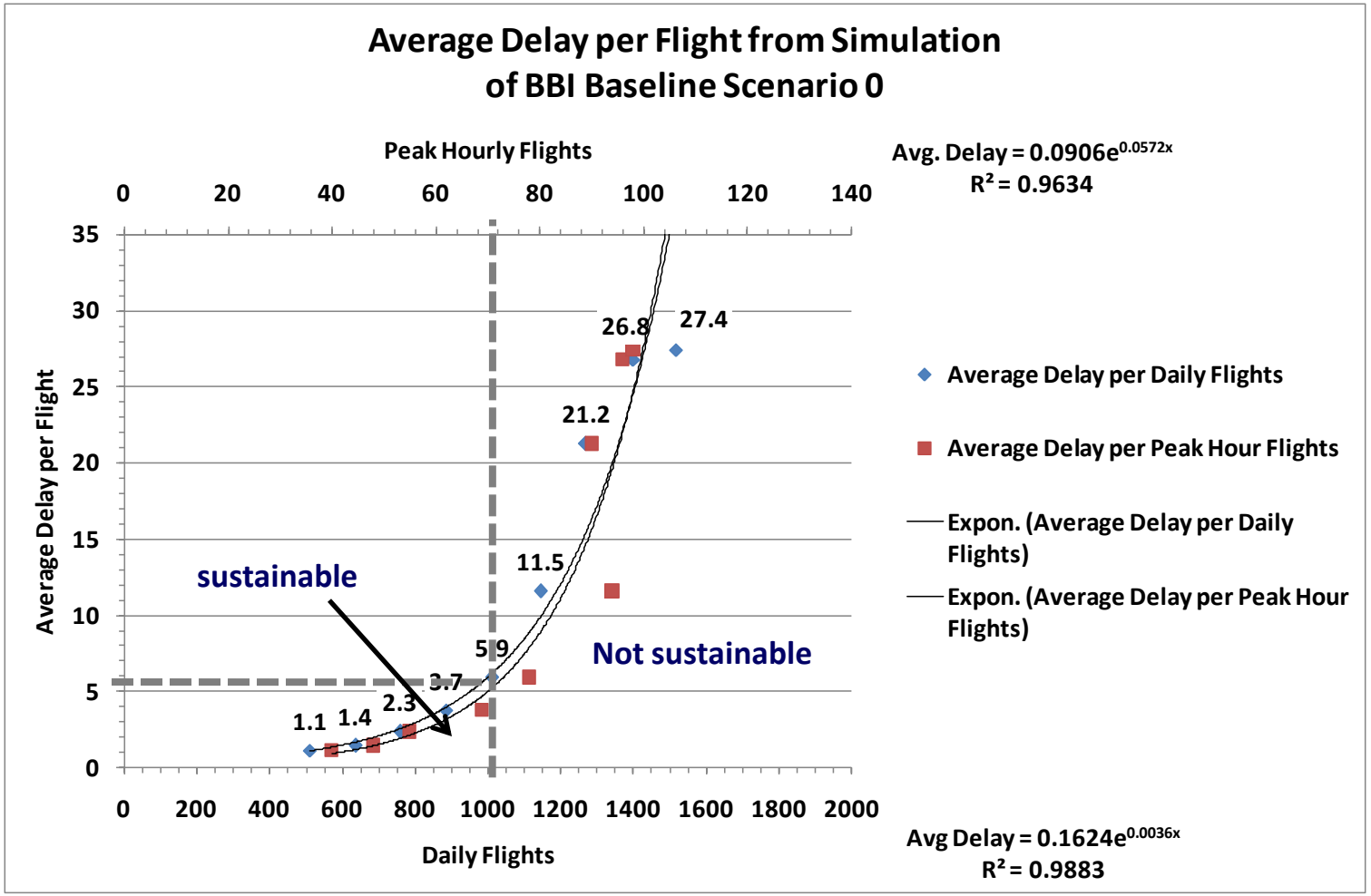
Results: Simulated Delays at BBI:

- Scenario 0

(*Note: 42€ cost per minute of delay (Eurocontrol 2009: “Standard Inputs for CBA Analyses”)

Growth from Baseline	Daily Flights	Peak Hour Demand	Hourly Capacity	Mean Delay per Flight	Daily Delay Minutes	Daily Delay Costs at 42€ * (without cancellation costs)	Cancellations
-20%	511	40	40	1.1	543	EUR 22,806	0
0%	635	48	48	1.4	887	EUR 37,254	0
20%	758	55	54	2.3	1760	EUR 73,920	0
40%	886	69	71	3.7	3287	EUR 138,054	0
60%	1012	78	76	5.9	5955	EUR 250,110	0
80%	1145	94	80	11.5	13223	EUR 555,366	0
100%	1270	90	82	21.2	26968	EUR 1,132,656	1
120%	1400	96	82	26.8	37501	EUR 1,575,042	134
140%	1517	98	84	27.4	41538	EUR 1,744,596	440
160%	1639	110	83	58.2	95364	EUR 4,005,288	807

Results: Simulated Delays at BBI

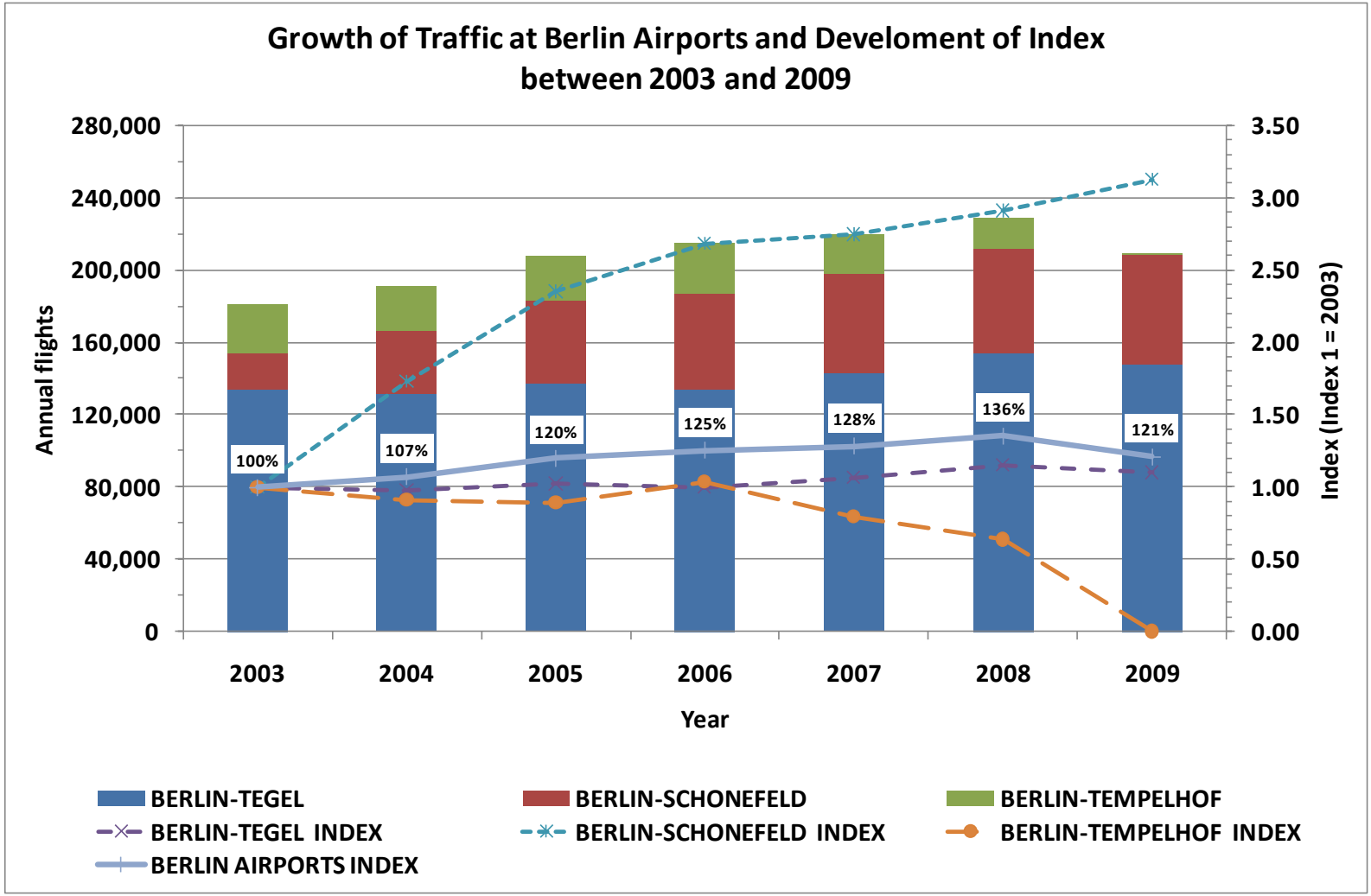


Capacity limits reached at BBI

- The Sustainable Capacity of 76 Flights per Hour and 60% growth can be reached after:
- 16 years at 3% average growth of traffic (2008-2024) $(1+r)^n - 1 = (1+0.03)^{16} - 1 = 60\%$
- 12 years at 4% average growth of traffic (2008-2020) $(1+r)^n - 1 = (1+0.04)^{12} - 1 = 60\%$
- 10 years at 5% average growth of traffic (2008-2018) $(1+r)^n - 1 = (1+0.05)^{10} - 1 = 63\%$
- 8 years at 6% average growth of traffic (2008-2016) $(1+r)^n - 1 = (1+0.06)^{8} - 1 = 59\%$

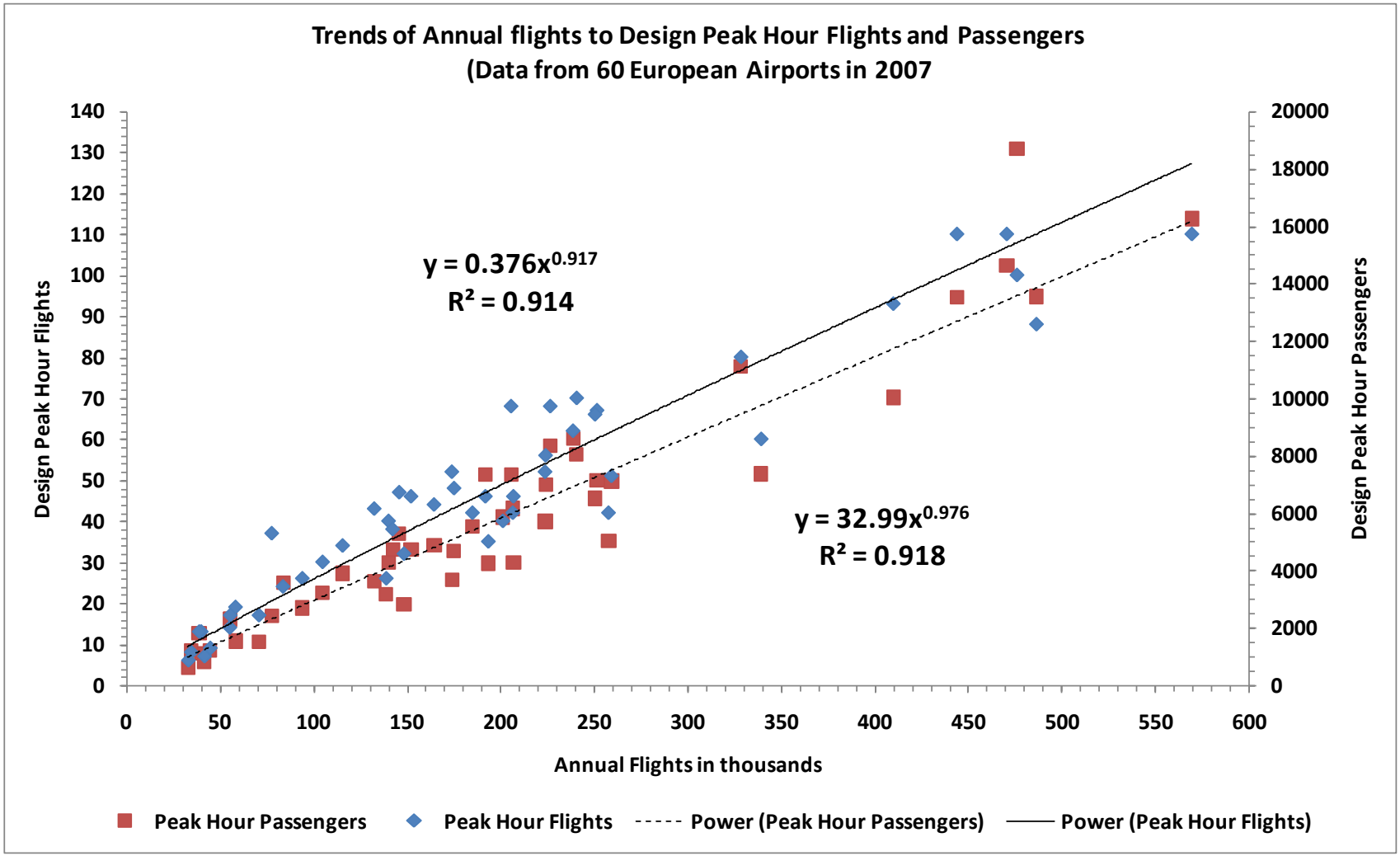
- The planning timeline for a third runway at BBI depends on the economic developments in the region in the next months and years.
- We must start discussing a 3rd runway at BBI in 2014 the latest, as a result from Scenario 0 (3% growth), if 10 years until realisation are considered.
- Legal, political and environmental approval time will increase further in the future, so do the opportunity costs from building a runway too late.

Growth of Berlin Airports

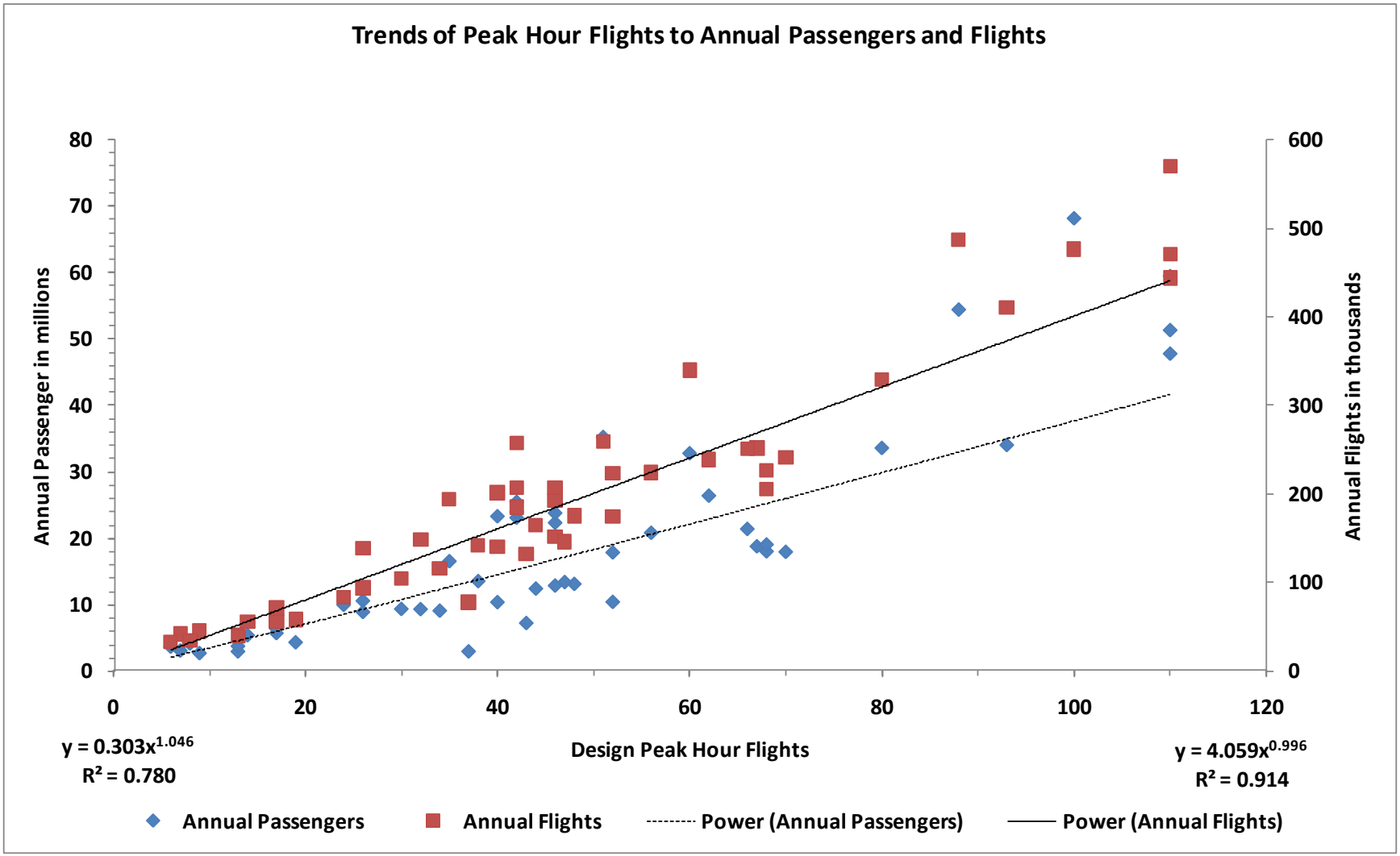


Source: Eurostat

Trends of Annual and Peak Hour Flights in Europe



Trends of Peak Hour and Annual Flights in Europe



Approximation Functions established from 60 EU airports

If Annual Flights are known from forecasts:

1. Peak Hour Flights = 0.376*Annual Flights (in thousand)^0.917
2. Peak Hour Passengers = 32.99*Annual Flights (in thousand)^0.976

If Peak Hour Flights are known from forecasts or simulations:

3. Annual Flights in thousand = 4.059*Peak Hour Flights^0.996
4. Annual Passengers in million = 0.303*Peak Hour Flights^1.046

Source: Bubalo 2010

Testing Assumptions Using Approximation Equations

- BBI Planning Permission Forecast 2023 (2004):
  - **355.000 Flights per year and 90 Movements per hour**.

  With 1. & 2.: 355.000 annual flights -> 82 Peak Hour Flights and 10173 Peak Hour Passengers

  With 3. & 4.: 90 Peak Hour Flights -> 359.000 Annual Flights and 33.5 million Passengers

- BBI SIMMOD Study (2010):
  - **Sustainable Capacity at 76 Flights per hour after 60% growth**

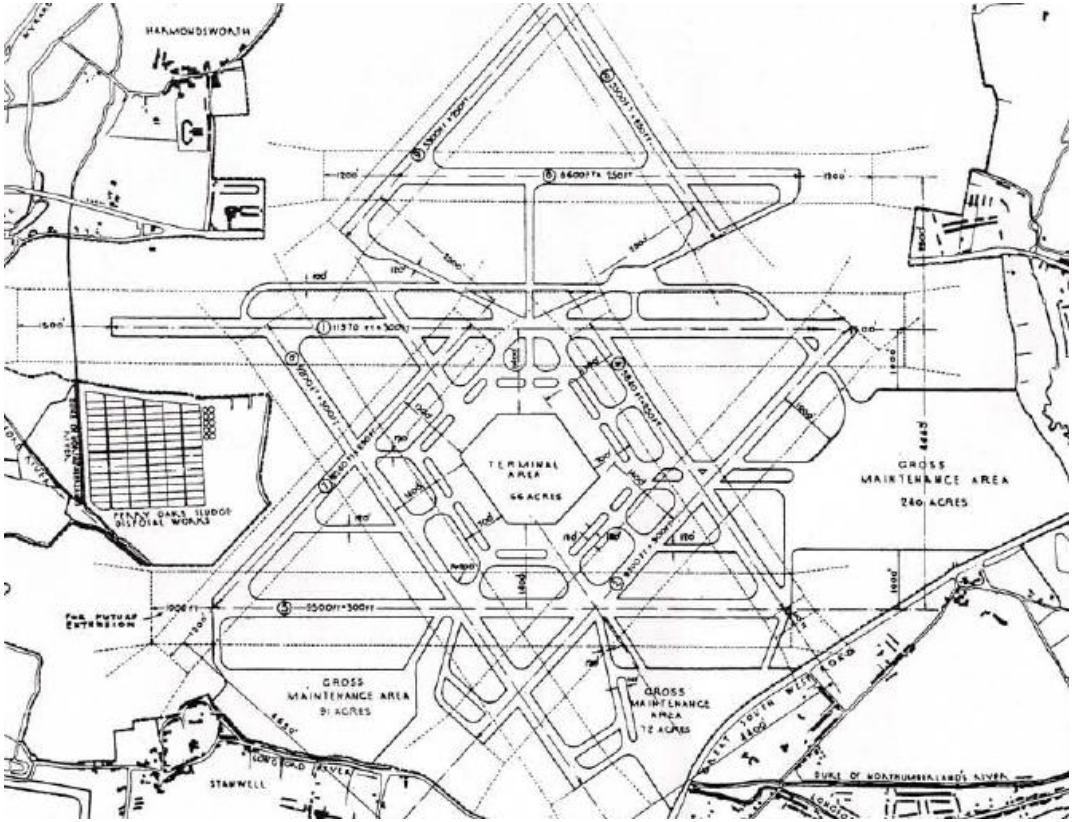
  With 3. & 4.:76 Peak hour flights->303.000 flights and 28.1 million PAX
  - **Capped Capacity at 82-84 Flights per hour after 100%**

  With 3. & 4.:82 Peak Hour flights -> 327.000 Annual Flights and 30.4 million annual Passengers

Resulting BBI Forecasts based on 2008 traffic schedule

Airport	Annual PAX (million)	Annual Flights (thousand)	PAX per Flight	Peak Hour Flights	Capacity
BBI 2008 (TXL+SXF 2008)	21.2	212	100	48	48
BBI Planned Capacity 2023 (Planning Permission 2004, at 3%)	30	301-355	100-85	90	90
BBI Sustainable Capacity 2024 (60% growth from 2008 at 3%; this study)	28.1	303	93	76	82
BBI Sustainable Capacity 2018 (60% growth from 2008 at 5%, this study)	28.1	303	93	76	82
BBI Maximum Capacity (100%)	33.5	359	93	90	82

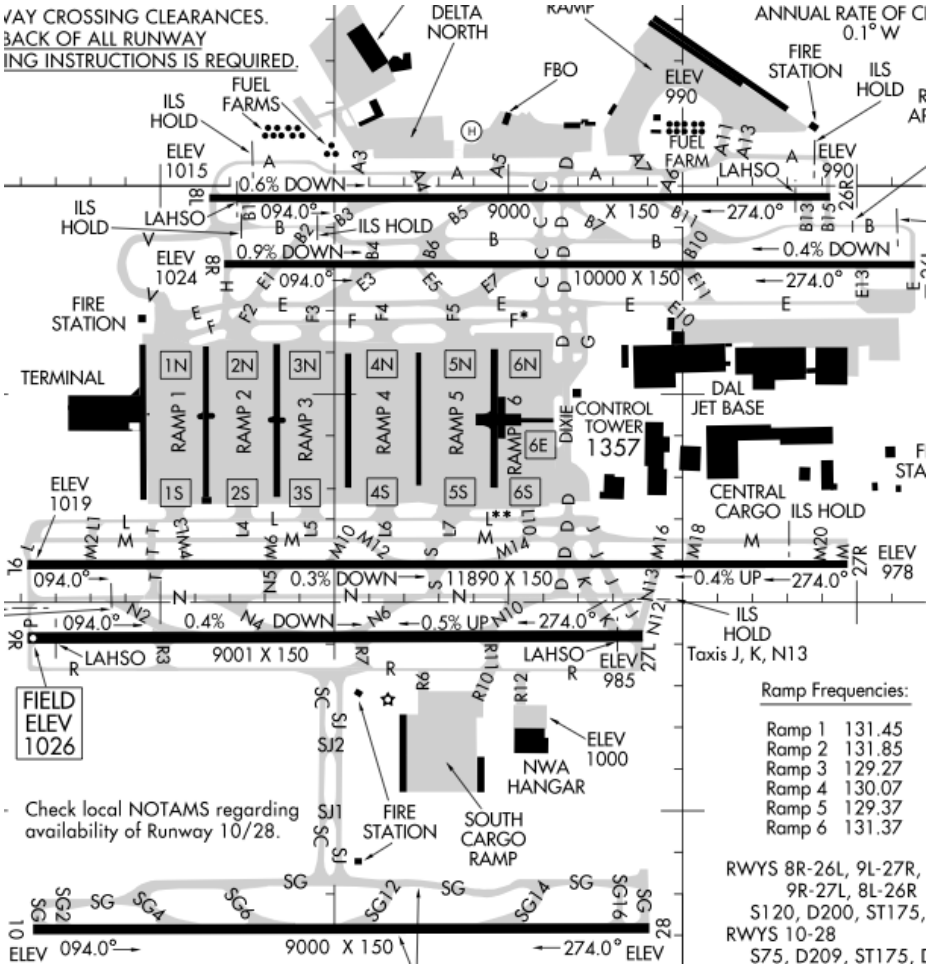
How far should we think for the future of BBI?



- Should we develop a vision for an ultimate stage of development for BBI, despite of political concerns?
- Runway configuration Master plan of London-Heathrow after 1945

The World Busiest Airport

- Atlanta Int. (2008):
  88 million passengers
  970,235 flights

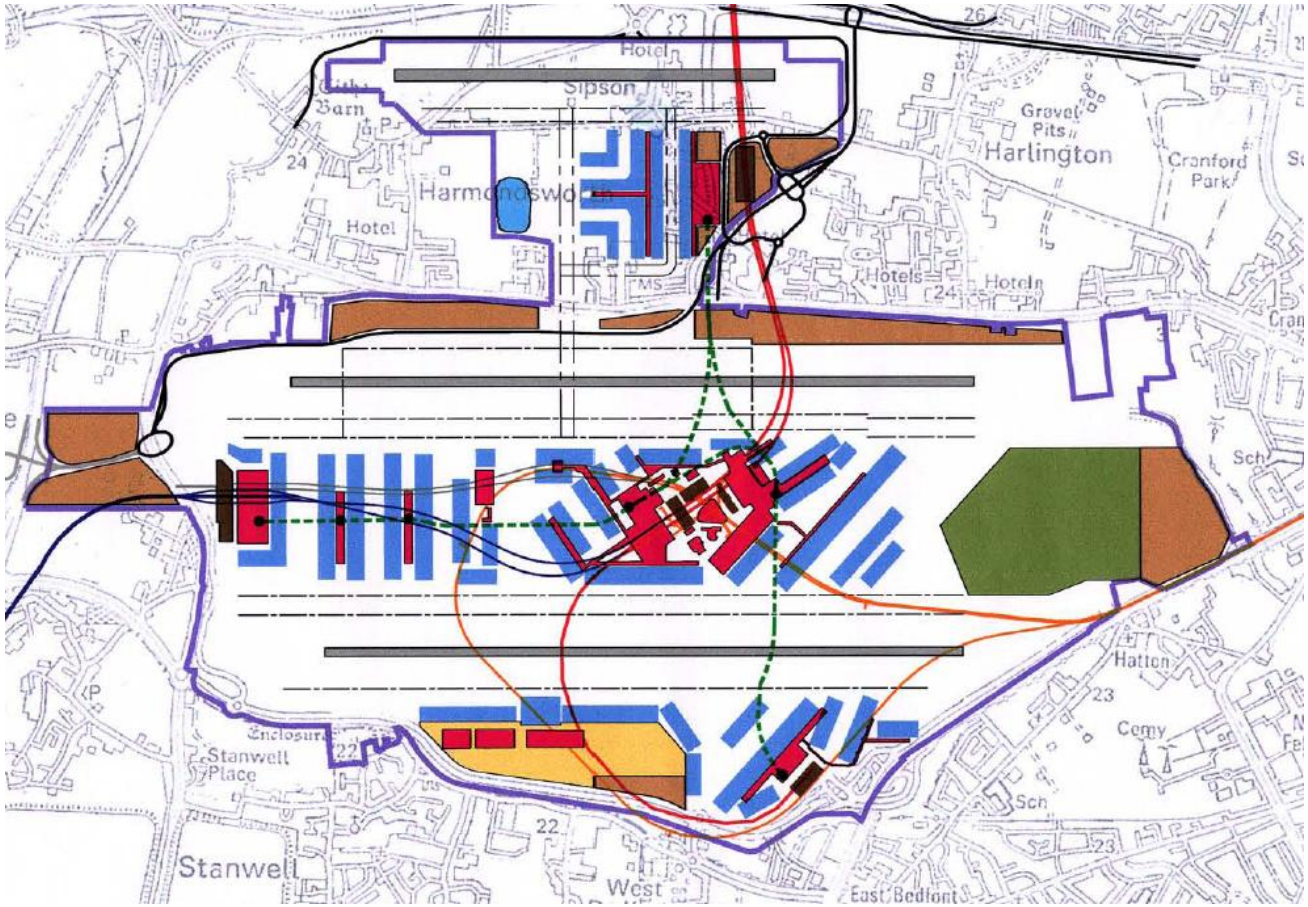


- How far is too far?

How far should we think for the future of BBI?

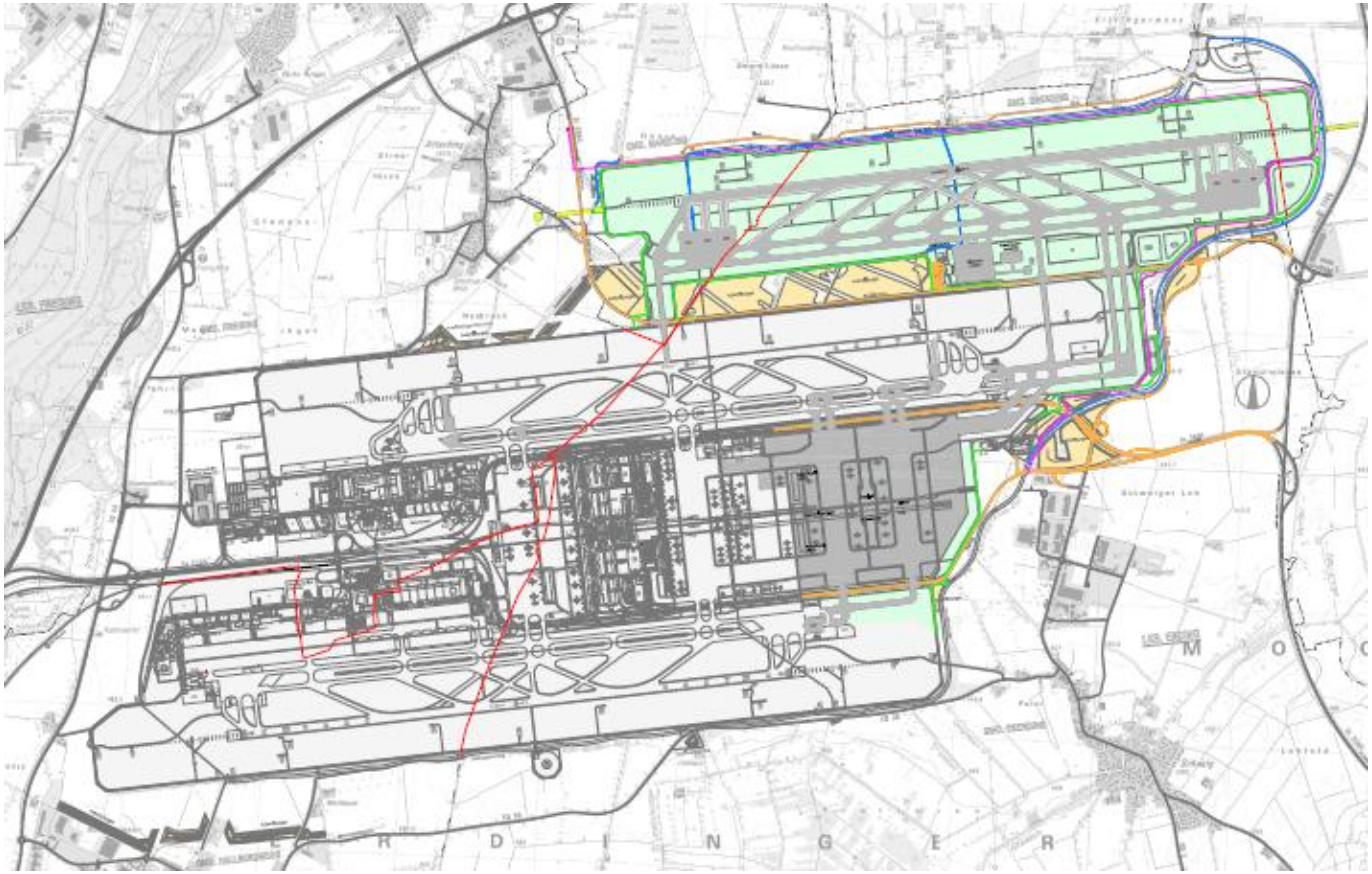
- Regional and airport planners must be creative and realistic in their forecasts and long term views.
- Runways take 10 years of planning, approval and construction time (economical life 40-100 years)
- Noise and local air quality increasingly important, but very difficult to quantify & monetize for compensations
- The future is uncertain, but market outlooks predict further growth of air transportation
- We can learn from other airports already:
  - London Heathrow in 2010: saturated most of the day
  - Munich in 2010: congested during daily peak hours
- Possible near Future for BBI? ->

Current Plan London Heathrow (2020?)



- Strong public opposition against 3rd runway
- Environmental and Legal battle will be endless

Current Plans for Munich (2020?)



- Munich 2 had been under restrictions from 1993 on.
- 3rd runway is strongly opposed, but will be built

Vision

- Commitment and Continuing Discussion towards aviation needs (including General and Business Aviation).
- Neighbours of airports should be kept well informed about future developments, even if 20 years or more in advance.
- Master plans must present long-term views with high and low growth forecasts.
- Runways are long-term investments, which are depreciated over 50 to 100 years, so long-sided visions needed.
- Apart from looking at runway capacity, environmental capacity could become more critical in the future.
- Simulation is the tool to make airport capacity planning and (noise) impact forecasts, realistic, transparent, safe and fair.

Thank you for your attention! Questions?

Suggestions and Comments are welcome.

Full study available after:

International Conference

OPERATIONS RESEARCH

MUNICH 2010

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