Scenarios of European Airport Capacity And the Implications for Aircraft Technology in the Year 2020

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Abstract
The air traffic market is on average growing steadily with high annual rates. However, infrastructure capacity in the air transport system is hardly keeping pace, resulting in unacceptable delay situations.

The joint scenario process “Airport Capacity Europe 2020” under lead of the Institute of Aeronautical Engineering, TU München in cooperation with Airbus, DaimlerChrysler, and Technology Research Group investigates potential developments of the European air traffic and its impact on capacity at regional, major, and hub airports of Western, and Central Europe.

As a non-constrained air traffic environment is vital to the total aviation industry, it is an interest of aircraft manufacturers to estimate which technical means on the side of the aircraft can induce a better use or even enhancement of existing, and future resources.

Based on three key scenarios the question is addressed, which aircraft technologies and concepts would have to be implemented into commercial aircraft of a size bigger than 100 passengers to relieve capacity constraints at airports, and generate airline value.

Dealing with the different procedural aircraft flight phases in the airport vicinity, the operational bottle necks in each of the scenarios were revealed. Taking these pieces of information together with other scenario results, conclusions could be drawn about the airport capacity situations at the three types of airports in 2020.

Introduction
Air traffic is since decades characterized by a steadily growing market. However, in recent years more factors have come into the game which limit infrastructure resources, resulting in capacity not keeping up with the pace of air travel demand. Delay analyses show that the number of delays before the last downturn in air traffic in 2001 reached a considerable peak in absolute numbers.

The main cause of delay was assigned to the en-route phase. The reaction on this had already been prepared and took place with the introduction of reduced vertical separation minima, and an enhanced flight management. It resulted in a drastic capacity gain of available air space. With this change, a different capacity limitation, i.e. those at airports, became much more obvious in the figures.

In contrast to airspace, the surroundings for airports to grow are much more complicated than commonly supposed. Limited areas, long project approval procedures, severe discussions with the community around the airport, ongoing privatization, and missing political backing are some of the factors which contribute to the airports’ slow reaction potential to growing demand.

Their endeavour to comply with demand to leave as least flights unaccommodated as possible is on the long term only realizable with high investments in airside and landside infrastructure. Runway and terminal extensions as well as installation of modern guiding systems are the most effective measures to be taken.

Additionally, other factors like higher security and safety levels as well as measures to secure sustainability for noise, emissions, and other environmental compatibility are demanded from politics and community nowadays much more than in the past. This pressure is passed on from airports to airlines by imposing noise abatements, operating quotas, curfews, and other measures that impact considerably on capacity.

Taking these developments into account, it is not necessarily a logic consequence that air traffic continues the growth from the past decades. It therefore is an important interest to all stakeholders to develop solutions that enlarge airport capacities. The aircraft manufacturer has identified his duty to contribute.

Different technologies, like for example wing vortex distortion devices, and low noise high lift devices aim at the creation of higher productivity, noise compliance or emissions compatibility to enhance throughput and minimize operational cost.

For the manufacturer, differentiation through these technologies could lead to a competitive advantage with a new set of key buying factors for airlines at highly congested airports.

Approach and Aim

In contrast to prognoses evolving from past principles and evolution, scenarios are used as a qualitative method to derive different, non-linear but consistent future environments to build operational performance implications, technical requirements and specific recommendations upon. The actual strength of the method thereby is, to conclude the silver bullet for all futures, if that is within reach. The aim is to answer the question which aircraft technology would be required to address future capacity situations at European airports. The scope of the research has been focused to: until the year 2020, Central and West Europe, aircraft over 100 passengers, and mission phase from initial approach to departure (first fix).

Firstly, the current capacity situation is examined by categorizing airports, fleet mixes at these categories, and passenger segments contributing to the air traffic. The following common airport categories have been defined according to their number of total commercial passengers per year: 1) hub airports (over 25 mln passengers), 2) major airports, and 3) regional airports (less than 10 mln passengers).

Secondly, the current European aircraft fleet is divided into three major segments: 1) twin aisle aircraft (e.g. Boeing 747 and 777), 2) single aisle aircraft (e.g. Airbus 320 family), and 3) regional aircraft (less than 90 passengers, Bombardier and Embraer).
Analyses revealed the aircraft type composition as well as movements of types at the airport categories. The left three columns in the following picture show the rough fleet distribution in Europe as of 2002:

Similarly, passengers are divided into four segments to characterize different markets and customers with their specific behaviours: Passengers travelling 1) full service, business and first, 2) full service, economy, 3) low cost and 4) charter.

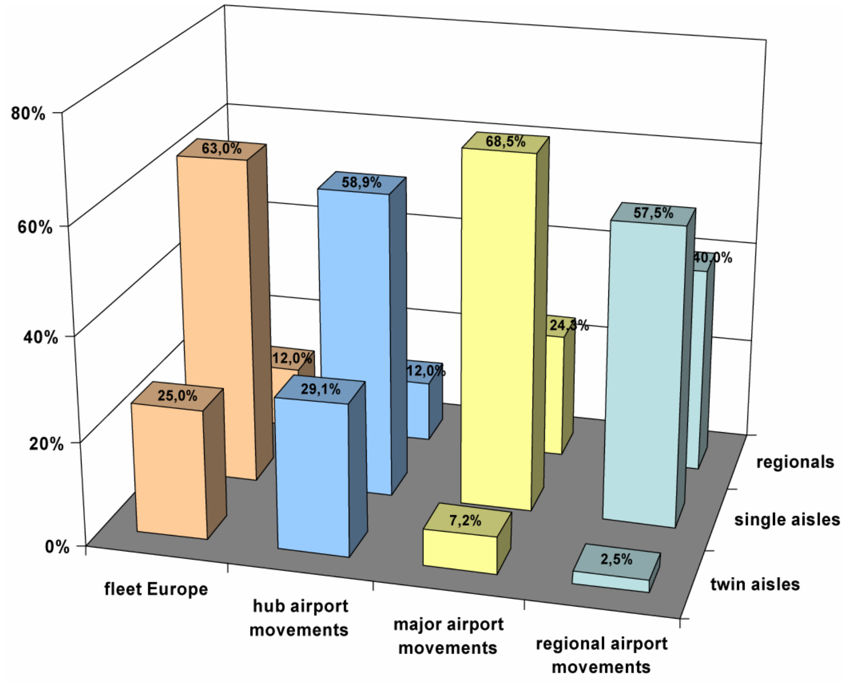

Figure 1 Fleet mix and movement proportions at European airports

It is assumed that passengers of segment 1 is the classic network carrier customers relying on network quality, punctuality, service, and convenience, whereas segment 2 relies on comparable qualities but with higher price consciousness. Segment 3 is largely price motivated and segment 4 marks mainly leisure travel to tourist destinations.

Based on a funded insight of today's traffic distribution, scenarios are generated under consideration of factors with major impact on the focusing questions. Together with specific environmental, regulatory, infrastructure, and other conditions in the scenario, future capacity situations could be addressed and evaluated for their compliance with the respective demands.

Developed scenarios

Three different scenarios cover a relevant range of potential evolutions of European air traffic and infrastructure. The following assumptions accompany all scenarios as premises: 1) until 2020 established airport expansion plans will be realized, 2) availability of new airport areas is low, and 3) to focus exclusively on airside capacity (landside capacity posing no restrictions). Only the key developments are described which result in traffic growth and specific capacity constraints.

Scenario: "One Sky, Two Segments"

The scenario describes a division of the air travel market into two dominating segments; the higher quality business, and the low price customer. Further cornerstones of this scenario are:

- The recovery after the economic depression in the beginning of the years 2000, which has affected the business traveller segment considerably, generates an average moderate economic development of 2.3%.
- Low cost carriers keep growing steadily especially at private trips, which are shifting for a great part from the economy segment, caused by a spreading low cost network with higher connectivity.
- The high revenues business segment demands for quick and on-time performance. Serving airlines build up a significant higher number of point-to-point connections to comply with this.
- The more stringent requirements towards air traffic coming from the business segment result in: a) fundamental redesign of airspace, b) privatization of airports, and c) a more customer oriented provision of service.
- Growing ecological awareness leads to restrictions and favours alternative transport.
- Increasing congestion due to a heterogeneous fleet mix, notably

putting pressure on almost all operational phases.

Due to the quick growth of low cost carriers, regional airports are overburdened and often lacks of modern ground equipment for effective flight control. Airport traffic management especially has problems to cope with the traffic at bad weather. Also terminal capacity reaches it space limits with missing extension plans.

The most relevant performance improvements (e.g. best solution for the airline, airport, and manufacturer) to be adopted by the aircraft are: 1) ground control independent landing system, 2) fully or partly automated taxi guidance systems, and 3) redundant position measurement systems. This in order to improve: landing efficiency, safety and capacity with bad weather, ground operation, and optimization of airport space utilization, furthermore to decrease runway occupancy- and taxi-times.

Scenario: "Ready to stop"

The cornerstones of this scenario are the following:

- The new integrated Europe has problems to find a way back to steady and sustainable economic growth. Ongoing high oil prices hinder recovery, which also has extensive impacts on the aviation industry.
- Low cost carriers keep growing strongly, but severe changes put this segment under pressure. European legislation prohibits attraction of airlines by price dumping and looks closely if airlines are subsidized. Additionally, consumer protection backs passenger rights and consolidation is encouraged.
- The high pressure on ticket prices and productivity forces airlines to dramatically reduce costs in all respects to survive the consolidation process. Full service carriers focus on their advantage of offering networks to their customers and concentrate traffic flows to their hubs.
- Stabilized ticket prices and no mentionable increase in environmental restrictions, as politics has recognized the precarious situation economy and air travel is in and neither opposes new taxes nor gives signs to airports to further impose obstacles.
- The critical situation at hub airports is regulated by high airport fees for small and slow turboprop aircraft.

Most capacity conflicts occur at hub and large major airports. Initial approach and landings are constrained because of differences in aircraft size (vortex problematic, slow aircraft et cetera). Long turn-around-times, and congestion at gates result in traffic jams because of little availability of apron and manoeuvre areas at the terminal.

The most relevant performance improvements (e.g. best solution for the airline, airport, and manufacturer) to be adopted by the aircraft are: 1) Higher fuel delivery rates, and easily cleanable cabins, 2) higher deceleration potential, and brake-management systems, and 3) reduction of wing vortex; this in order to improve turn-around times, runway throughput, and approach efficiency.

Scenario: "Never Change a Running System!?!"

The cornerstones of this scenario are the following:

- A stabile political status accompanies economic growth; air traffic is fostered and generates a strong growth of 4.2%. Especially the low cost segment maintains high annual gains in traffic volumes.
- International flights have considerably more point-to-point connections from medium sized airports to destinations particularly in North America and the Middle East. Feeding of these volumes has been largely taken over by low cost airlines, collecting passengers with thin but price sensitive routes.
- Lower margins in the aviation industry (partly due to the success of low cost carriers) lead to a smaller attractiveness to invest in this business. As a consequence, technical standards on the airside are almost untouched resulting in stagnating technological progress and air traffic guiding systems are not implemented.
- Public awareness for environmental issues entails severe restrictions from airport side, cutting capacity and favouring environmentally friendly aircraft. Despite demand for such technology, the speed of system development and certification is still unchanged imposing long lead times.
- Air traffic control has to deal with much more aircraft. Dynamic control of airspace around the airport (both civil and military) enhances capacity by avoiding canalized and complicated traffic flows. As a consequence retention times of aircraft in the air are decreased and aircraft are more frequently approaching.
- Available infrastructure at large major and hub airports is operated at capacity limits, with peak hours now covering the major part of the opening time of the airport. However, the system collapses when unexpected events, like weather, safety or security issues, reduce capacity tremendously.

The highly congested scenario describes capacity shortfalls at every airport category and almost every mission phase. Infrastructure could not be developed, noise and emission regulations cut airport operating times. The lack of adequate guiding systems at regional airports causes especially approach and landing problems. The frequent operation of thin routes by low cost carriers with small narrowbodies congests hub airports at taxiways. Finally, capacity is limited as optimizing traffic management systems are not implemented, because airports cannot agree on standardization.

The most relevant performance improvements (e.g. best solution for the airline, airport, and manufacturer) to be adopted by the aircraft are: 1) Improved cabin design focus on higher productivity (simple, efficient configuration, easy cleanable etc.), 2) aircraft flight energy managed approach (reachable with aerodynamics, flight mechanics and more direct approach trajectories), and 3) reduction of noise, and emissions (Auxiliary Power Unit, alternative power generation, and higher BPR for engines); this in order to improve turn-around times, approach, and landing performance, and environmental compatibility.

Scenario fit and robust technology recommendations

Having composed different performance requirements and derived technology summaries, the overall look and reasonable selection of technology portfolios is vital. Influenced by necessary invests for research, developments, production, implementation, and product support, the identified, most relevant, and scenario specific recommendations, and solutions are cross checked in all three respective scenarios. The result is qualitatively illustrated in the diagram: The three columns indicate the fit of the technologic recommendations with regard to the benefit for airside airport capacity on the ordinate compared to the investment for aircraft manufacturers on the abscissa:

Only five concepts seem to be of major importance to future feasible capacity measures from the side of the aircraft in all scenarios:

- Ground-independent landing systems,
- Minimization of wing vortex generation,
- Time optimized fuelling processes,
- Intelligent taxi guiding systems, and
- Technologies regarding airport approach.

Interestingly, specific focus on research of low noise technologies fell out as a robust recommendation, since in two scenarios no severe restrictions were challenged. However, noise compliance is a fundamental requirement and with growing traffic, aircraft manufacturers are advised to maintain research activities in this field.

Conclusions

The development of air traffic in Europe has considerable impact on airport capacity situations. Growth as one of the main drivers is based on demand, but the question still will be if airports can extend their resources in the same range of magnitude to provide sufficient capacity.

According to the scenario specific conditions, growth figures in passengers segments and distributions of traffic flows over airport categories, airport capacity was limited in every scenario. Addressing the particular bottle necks, required aircraft performance improvements at the aircraft mission phases around and on the airport were determined which appointed dedicated technologies assuring the technological fulfilment.

Targets must be aligned over time by updates of this scenario process. However, eventual changes from the current trend are already now better foreseeable and assessable, because potential consequences have been elaborated today in differentiated scenario views of the future.

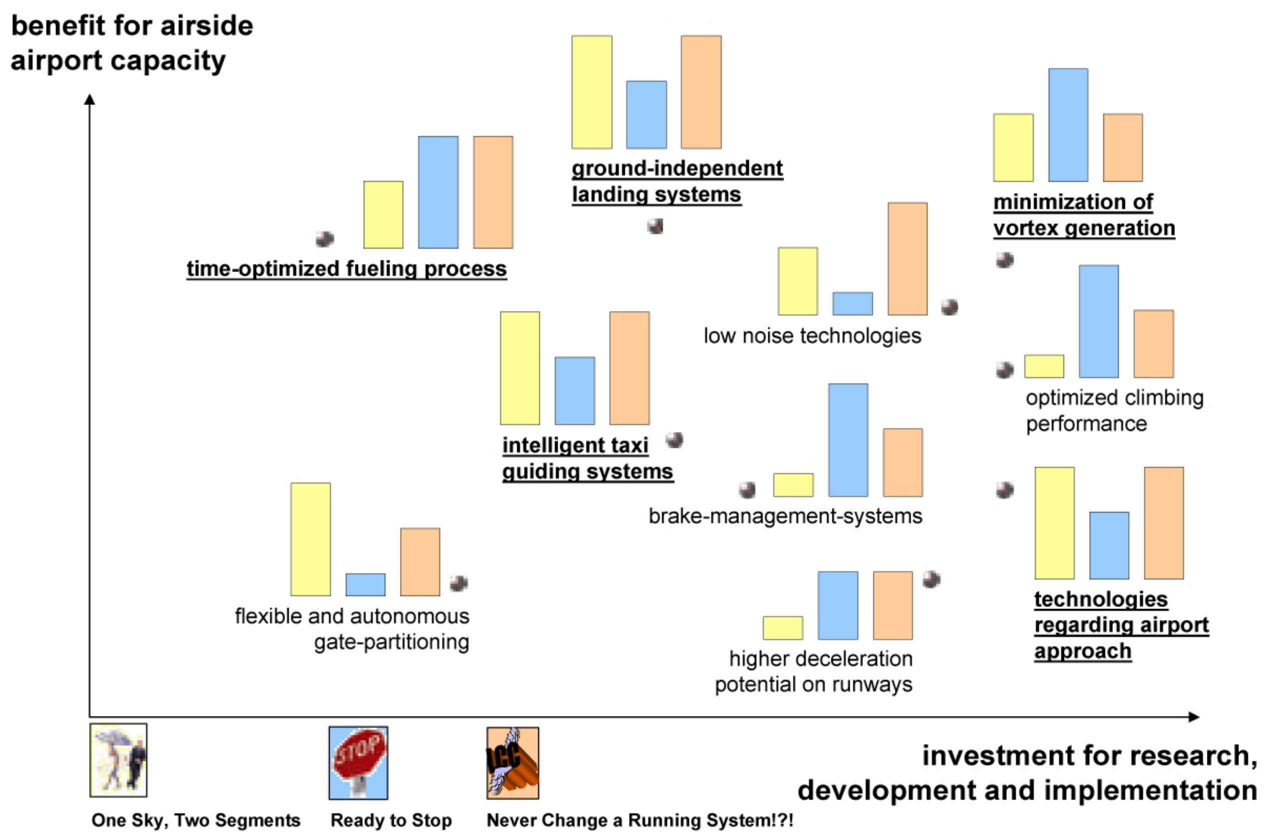

Figure 2: Cross-evaluation of technological recommendations