
Hub Airport Capacity

International Competition

Final Report

16 December 2013



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Scope

As part of PwC's support on analysis and strategy to the Airports Commission, we were asked to provide a review of available international evidence of air transport movements (ATMs) and passenger terminal capacity at Paris Charles de Gaulle (CDG), Frankfurt Airport (FRA), Amsterdam Airport Schiphol (AMS) and Dubai Airport (DXB) both now and in the future; and to identify relevant approaches to assessing likely growth in non-transfer traffic at these airports as well as any external assessments of when/if capacity limits are expected to be reached. The assessment incorporates all relevant airport level and national restrictions due to technical site constraints, planning permission, noise limits, operating hours and emissions.

This report provides a summary of this review¹.

¹ The report was prepared between July to October 2013 and all sources were referenced and up-to-date at that time.

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Introduction

Background

The scope of this paper is to review available international evidence of air transport movements (ATMs) and passenger terminal capacity at London Heathrow Airport (LHR), Paris Charles de Gaulle (CDG), Frankfurt Airport (FRA), Amsterdam Airport Schiphol (AMS) and Dubai Airport (DXB) both now and in the future; identify relevant approaches to assessing likely growth in non-transfer traffic at these airports; and identify any external assessments of when/if capacity limits are expected to be reached. This assessment considers airport level and national restrictions due to technical site constraints, planning permission, noise limits, operating hours and emissions.

Comparison of the Five Airport Hubs

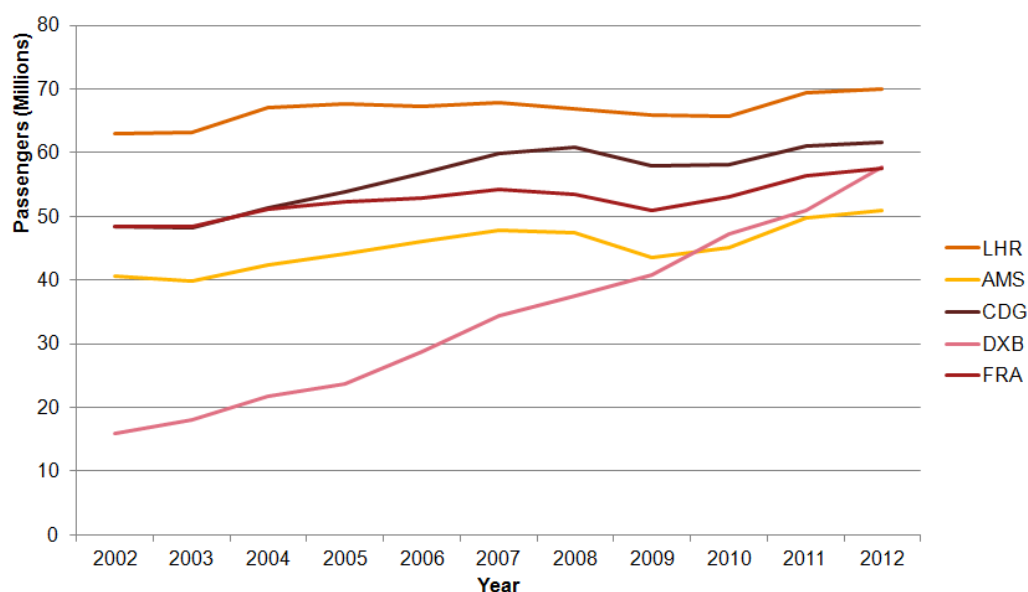
Figure 1: Key features

	LHR	AMS	CDG	DXB	FRA
Opened	1946	1920	1974	1960	1936
Runways	2	6	4	2	4
Terminals	4 (5 by 2014)	1	3	3	2
PAX (2012)	70m	51m	62m	58m	58m
Transfer %	37.0%	41.0%	31.4%	48.4%	51.0%
ATMs (2012)	471k	423k	491k	344k	482k
Land area	1,227ha	2,787ha	3,257ha	3,500ha	2,000ha
World rank by total PAX	3	16	7	10	11
PAX annual growth (2002-2012)	1.1%	2.3%	2.4%	13.7%	1.7%
ATM annual growth (2002-2012)	0.2%	0.5%	-0.2%	8.8%	0.5%
Future PAX capacity in 2020	86m ⁱ	85m ⁱⁱ	80m ⁱⁱⁱ	98.5m ^{iv}	88m ^v
Future ATM capacity in 2020	480k ^{vi}	510k ^{vii}	690k ^{viii}	560k ^{ix}	700k ^x

Source: Airport websites, master plans, annual reports, CAA, Flightglobal Pro. Note additional sources are provided in the appendix.

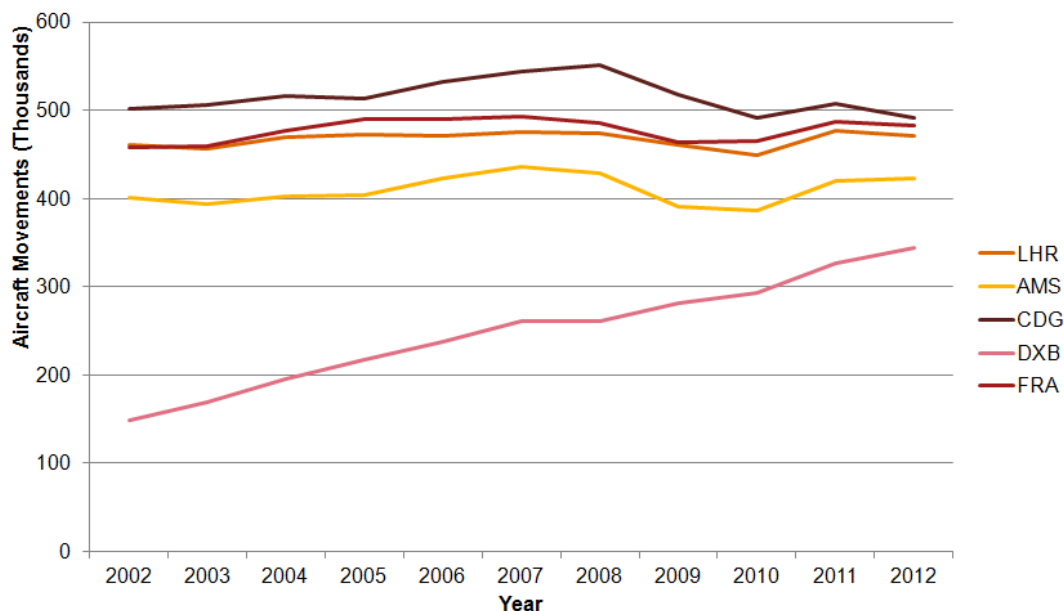
Although LHR is the third busiest airport in the world in terms of total passenger traffic, with its runways currently operating at 99% capacity the airport has seen limited annual growth of 1.1% in **total passenger movements** over the last ten years, from 63.0 million passengers in 2002 to 70.0 million in 2012. This is lower than the annual growth rates of the other main European hubs of AMS, CDG and FRA, which have seen passenger numbers increase annually by 2.3%, 2.4% and 1.7% respectively (note that FRA was constrained until the fourth runway went into operation in October 2011). Consequently, LHR's position as Europe's busiest airport has weakened in the last ten years with, for example, CDG's total passenger movements representing 88% of LHR's movements in 2012 versus only 77% in 2002.

In contrast to the limited growth seen across the four European hubs, DXB has seen very strong growth of 13.7% per annum in **total passenger movements** (up from 16.0 million passengers in 2002 to 57.7 million in 2012). This growth has been driven by the large-scale expansion of the airport (terminal capacity having more than doubled from 23 million passengers in 2002 to 75 million in 2012) and the rapid growth of Emirates Airline, which has also helped insulate DXB from the general downturn in the aviation industry during 2008 and 2009.

Figure 2: Total passenger movements (2002 to 2012)

Source: CAA, Schiphol, Fraport, Dubai Airports and Aeroports de Paris

Growth in ATMs has lagged behind passenger growth across all airports due to fleet up-gauging. At LHR, due to runways operating at 99% capacity, there has been very limited annual growth of 0.2% in **commercial aircraft movements** over the last ten years, from 460 thousand ATMs in 2002 to 471 thousand in 2012. This is lower than the annual growth rates of AMS and FRA (both 0.5%), but higher than the negative annual growth of 0.2% at CDG (which experienced significant fleet up-gauging). In contrast to the limited growth at each of the four European hubs, DXB has seen very strong growth of 8.8% per annum in **commercial aircraft movements** (up from 148 thousand ATMs in 2002 to 344 thousand in 2012).

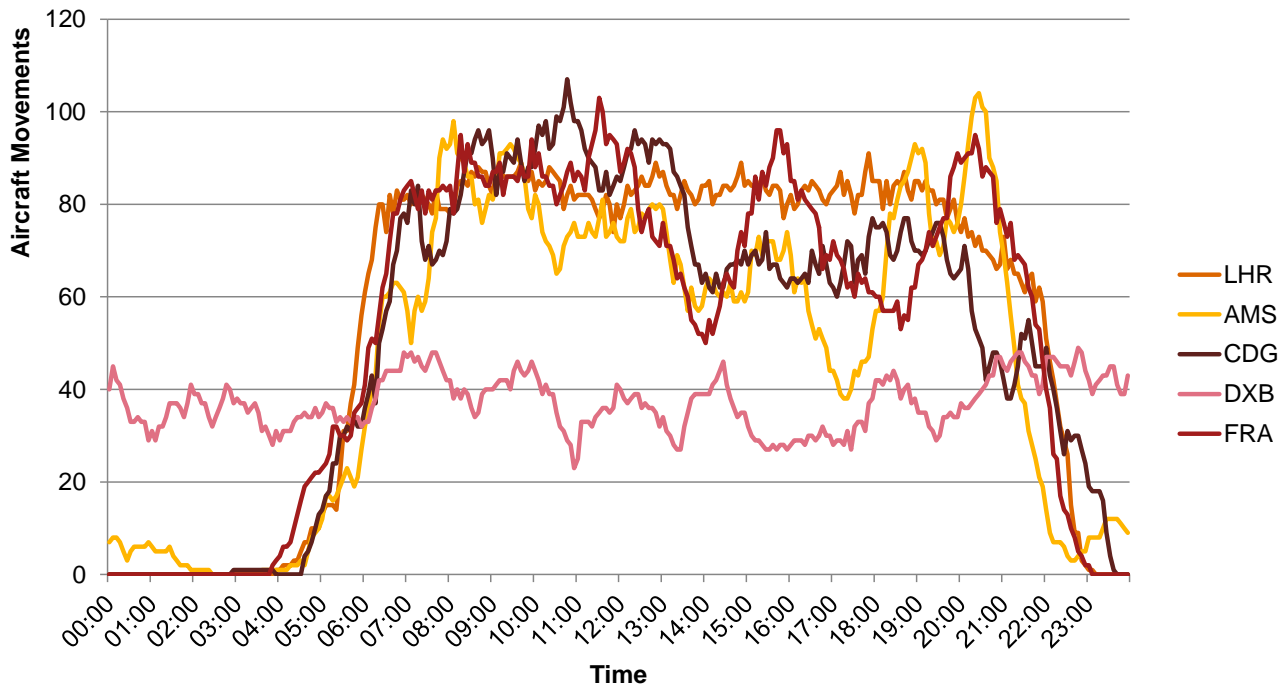
Figure 3: Commercial aircraft movements (2002 to 2012)

Source: CAA, Schiphol, Fraport, Dubai Airports and Aeroports de Paris

Restrictions on operating hours at European hubs lead to most aircraft movements at LHR, AMS, CDG and FRA occurring between 6am and 11pm, with a limit to operations outside these hours. In contrast, DXB is the sole airport in this group to remain fully operational twenty-four hours a day, with aircraft movements remaining consistent throughout the day/night at around 40 ATMs per hour.

At LHR, aircraft movements quickly peak at approximately 90 ATMs per hour after 6am and remain at this level until 11pm when limits on night movements commence (reflecting that LHR's runways are currently operating at 99% capacity). The other airports, including DXB, experience a lot more variation in demand throughout the day, indicating room for peak spreading and therefore increased practical capacity.

Figure 4: Rolling hourly scheduled movements (all hubs)



Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2013, assumed to be typical of a busy day)

Sources of information

To estimate when planned capacity is likely to be reached at the five airport hubs, we have drawn on a range of sources to:

- 1) Forecast future passenger and ATM growth at each airport
- 2) Forecast terminal and runway capacity at each airport

The sources include:

- Official government forecasts (e.g. DfT for LHR)
- Master Plan Forecasts (AMS and DXB)
- Direct discussions with executives at AMS and DXB

Forecast traffic

Where official forecasts are not available through desk-top research (e.g. CDG and FRA), we have conducted a high level trend analysis to extrapolate 2012 passengers to 2050. We have also taken into consideration the IATA airline industry forecast (2012-2016), Boeing and Airbus forecasts (to 2030) and econometric analysis. We have then overlaid assumptions on number of passengers per movement based on an extrapolation of historical trends. The following table summarises the sources for each forecast applied for each airport.

Figure 5: Source of forecast traffic by Airport

Airport	Sources	Discussion
LHR	DfT Aviation Forecast	82m passengers by 2030 and maximum of 480,000 movements throughout the forecast period
AMS	Schiphol Airport Preliminary Master Plan (2013)	25% growth in passengers over the ten years (implies 63mppa by 2022)
CDG	Historical trend analysis	72 mppa by 2020
DXB	Dubai Airports Strategic Plan (2012)	98.5 mppa by 2020
FRA	Historical trend analysis	65 mppa by 2020

Terminal and runway capacity

We have used data sourced through desk-top research (including review of Master Plans and airport websites) and/or direct communication with relevant executives, to estimate the planned terminal and runway capacity at each airport at specific future dates based on current airport plans. We have then extrapolated the capacity forecasts out to 2050. The following table summarises the sources for each capacity forecast applied for each airport.

Figure 6: Source of capacity forecast by Airport

Airport	Sources	Max terminal capacity	Max runway capacity
LHR	London Heathrow Airport	86m passengers throughout the forecast period	480k ATMs throughout the forecast period
AMS	Schiphol Airport Preliminary Master Plan (2013) Direct communication with Head of Strategy at Schiphol Group	85m passengers by 2020	630k ATMs by 2030, extrapolated to 750k ATMs by 2040
CDG	Aéroports de Paris, press articles	80m passengers throughout the forecast period	690k ATMs by 2015
DXB	Dubai Airports Strategic Plan (2012) Direct communication with Head of Operational Research Strategy and Development Group at Dubai Airports	98.5m passengers at DXB by 2020; 160m passengers at DWC by 2035	560k ATMs at DXB by 2016; 1,200k ATMs at DWC by 2035
FRA	Fraport, press articles	88m passengers by 2020	700k ATMs throughout the forecast period

Airport Overviews

The following section looks at each airport individually.

London Heathrow Airport (LHR)

LHR is the busiest airport in the United Kingdom and the third busiest airport in the world in terms of total passenger traffic, handling more international passengers than any other airport. However, LHR's runways are currently operating at around 99% capacity given planning constraints for annual air traffic movements of 480,000, limiting PAX movements below total terminal capacity of 86 million passengers.

PAX 2012: 70 million

ATMs 2012: 471 thousand

Hub for: British Airways, Virgin Atlantic

Terminals: T1, T3, T4 and T5 (new T2 to open in 2014)

Runways: 3,902m & 3,658m

Airport Overview

Infrastructure description

LHR lies 14 miles (22 km) west of Central London, and has two parallel east-west runways along with four operational terminals on a site that covers 1,227 hectares. The biggest constraints on the number of flights are runway space and aircraft parking bays.

Brief history of how infrastructure has evolved

Figure 7: Key milestones

Year	Milestone
1944	Construction of London Airport's runways begins.
1946	London Airport officially opens.
1955	Her Majesty The Queen opens the Central Terminal Area and Control Tower.
1969	Terminal 1 is opened and existing buildings renamed Terminals 2 and 3.
1977	The London Underground link is opened.
1986	His Royal Highness Prince Charles and Princess Diana inaugurate Terminal 4.
1997	The Terminal 5 public planning inquiry ends – the longest in UK history.
1998	The Heathrow Express rail service is launched.
2007	A new air traffic control tower is operational – the tallest in the UK.
2008	Terminal 5 is officially opened by Her Majesty The Queen in March. The first commercial A380 flight arrives at Heathrow.
2009	Terminal 4 underwent a major refurbishment to improve facilities.
2010	Demolition work started on Terminal 2 to make way for its £1 billion replacement.

Runways, terminal, airfield

Heathrow operates two parallel runways running east-west, which are extended versions of the two east-west runways from the original hexagram.

Figure 8: Runway information

Runway	Location	Length (metres)	Width (metres)
Northern	09L/27R	3,902	45
Southern	09R/27L	3,658	45

There are a total of 174 aircraft stands at LHR.

Figure 9: Aircraft stands

Type	Stands
Connected	125
Disconnected	49
Total	174

The airport has four passenger terminals (Terminals 1, 3, 4 and 5) and a cargo terminal. Terminals 3 and 4 underwent major refurbishments between 2007 and 2009. Terminal 5 was opened to passengers in March 2008. Construction of a new Terminal 2 complex to replace the old terminal building and adjacent Queen's Building began in 2009 with the first phase expected to open in 2014.

Figure 10: Terminal information

Terminal	Opened	Area (sq meters)	PAX 2012 (millions)
1	1968	74,601	13.6
2	2014*	-	-
3	1961	98,962	18.6
4	1986	105,481	9.8
5	2008	353,020	28.1
Total		632,064	70.0

*Currently under development

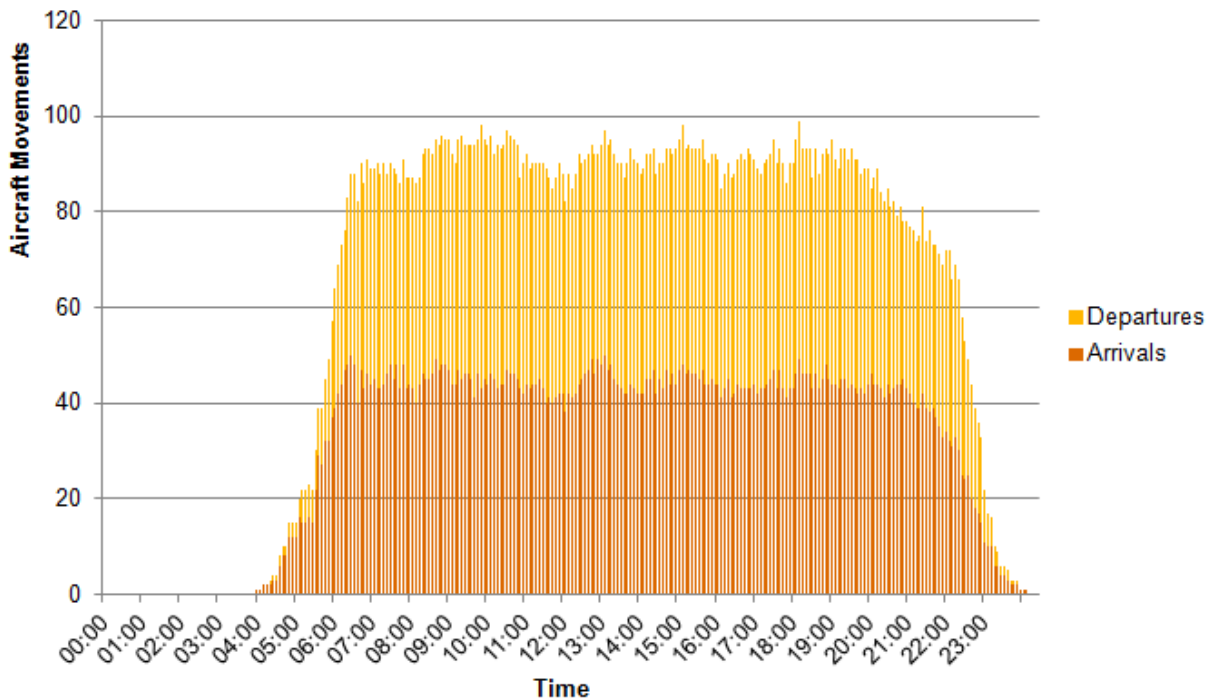
Site size / constraints

Having two runways puts Heathrow at a distinct disadvantage compared to its international hub competitors which have between four and six runways. Furthermore, for noise limitation reasons, LHR operates one runway for take-offs and one for landings, rather than a mix of take-offs and landings on each runway (the latter “mixed mode” would allow higher runway utilisation²) the number of aircraft that can land and depart remains constrained (LHR currently operates at 99% capacity). But the size of the site at 1,227ha – smaller than both the other European “big four” and DXB – means there are constraints for developing another runway within the airport's boundaries.

Peak profile

As LHR is largely closed to traffic from 11pm to 6am, there are minimal aircraft movements between these times. Once the airport fully opens to traffic at 6am, aircraft movements quickly peak at approximately 90 ATMs per hour and remain at this level while the airport is open to traffic (reflecting that LHR's runways are currently operating at 99% capacity).

² Note that LHR is currently operating a mixed mode trial

Figure 11: Rolling hourly scheduled arrivals and departures – LHR

Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2013)

Regulations and Restrictions

LHR makes up some of the UK's most critical transport infrastructure. As a result, the airport must adhere to a range of regulations and restrictions. Various regulatory bodies in the UK influence Heathrow's operations including:

- The Department for Transport (DfT) – responsible for UK aviation policy.
- The Civil Aviation Authority (CAA), the UK's independent aviation sector regulator – responsible for safety regulation, price regulation of Heathrow, Gatwick and Stansted airports and more general consumer regulation of UK airports.

Operating hours

Heathrow is a 24 hour operation airport and there is not, and never has been, a night ban. However, in order to try to balance the interests of the local communities and those of the airports users, there are restrictions and rules regarding night flights.

The Department for Transport is responsible for making the restrictions on the types of aircraft that can be scheduled to fly at night.

A quota is set for total allowable night movements for both winter and summer seasons. Additional discussion on noise restrictions is included in the Appendix.

Planning permission

Generally, any development at Heathrow involving the extension of a runway or terminal, the provision of a new terminal, or a non-operational building (i.e. not connected to the operation or function of the airport) will require planning permission with an application made to the local planning authority.

Any development requiring planning permission, and likely to cause a significant environmental impact, could also be subject to the EIA process, whereby the planning application would need to be accompanied by an Environmental Statement (ES) setting out all likely significant environmental impacts arising.

Noise limits

Heathrow Airport operates the noise and track-keeping (NTK) system which takes radar data from air traffic control radars and combines it with flight information such as call-sign, tail number, type and destination. It captures data from both fixed and mobile noise monitors around the airport, to be matched to operational data. This data is used to provide information to the public, support their work with airlines and other stakeholders, and inform their noise strategy. Measures currently in place mean that aircraft flying in and out of Heathrow are on average 15% quieter than fleets of the same airlines which land at other world airports

Emissions

Located to the west of London, LHR is within an area of high emissions; with significant contributions from London itself, two nearby motorways (M25 and M4), major roads, local industry and local housing, as well as the airport. The main pollutants of concern in the Heathrow area are nitrogen dioxide (NO₂) and particles (measured as PM₁₀ and PM_{2.5}). The EU has specified concentration limits for these pollutants due to their impact on human health. Only NO₂ exceeds the EU limit value in some local areas which requires LHR to reduce emissions of its precursor – oxides of nitrogen (NO_x).

Where airport operations significantly add to these emissions, LHR aims to play its role in achieving compliance with the EU limit values at sites around the airport. This is achieved by tackling the airport's own emissions (those it controls), and working in partnership with airlines and other companies that use the airport to address the emissions they create (those LHR guides and influences).

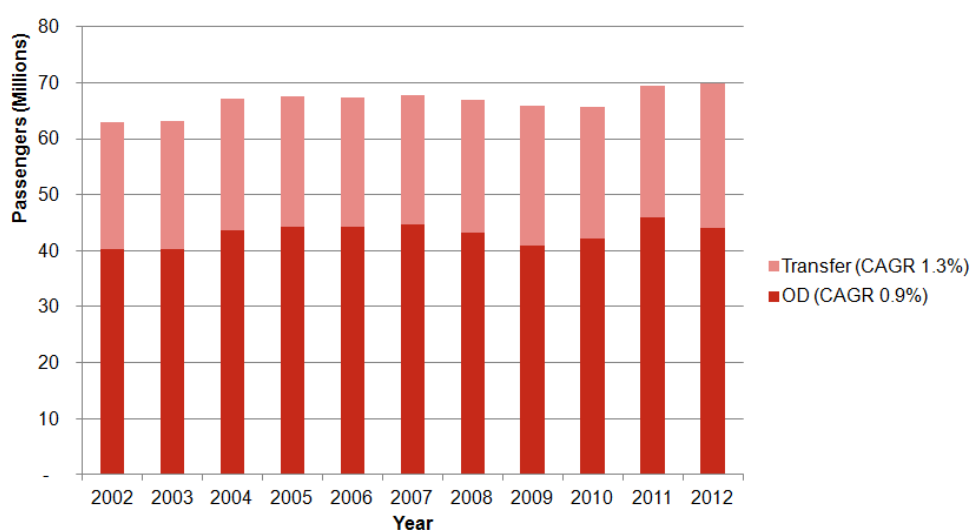
LHR encourage the cleanest possible aircraft fleet to use the airport by levying a NO_x-based landing charge, minimising the use of auxiliary power units by enforcing mandatory time limits, and encouraging the efficient movement of aircraft whilst taxiing. Over the next 10 years, the development of low and zero emission vehicle fuels and technologies is likely to provide a range of choices to reduce NO_x (and CO₂) from airside vehicles.³

Traffic Trends

Historical growth

LHR has seen limited growth over the last decade (CAGR of 0.9%), due to capacity constraints. Transfer passengers have remained at around 35% over the last ten years based on CAA survey data.

Figure 12: Historical passenger movements at LHR (2002 to 2012)



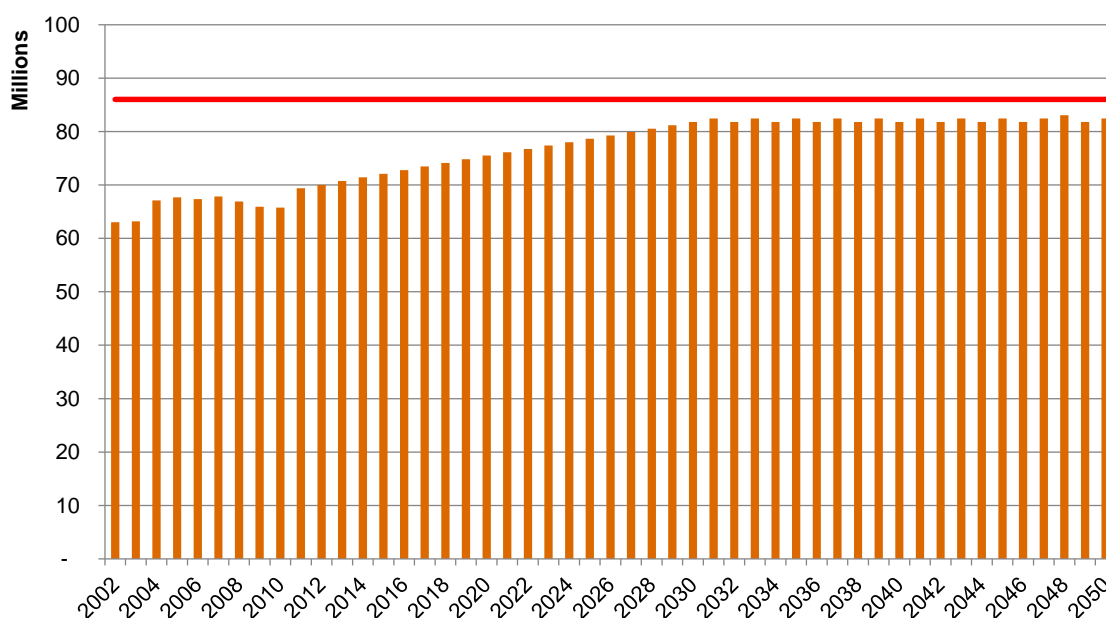
Source: CAA Airport statistics (total terminal passengers) and CAA surveys (transfer %s)

³ Heathrow Airport website

Future growth outlook

The DfT forecasts limited growth in PAX at LHR based on a constrained case. Runway capacity is limited to 480 thousand ATMs per annum throughout the forecast and thus PAX increases can only be achieved through aircraft up-gauging and increasing load factors.

Figure 13: Forecasted passenger movements at LHR

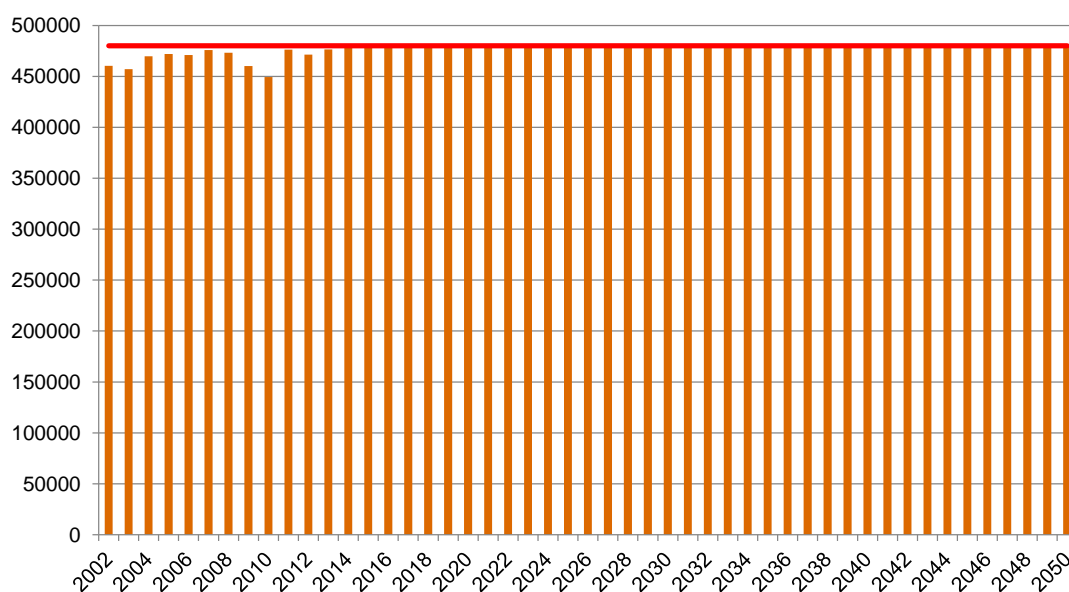


Note: The red line indicates stated capacity

Source: CAA airport statistics, DfT UK Aviation Forecasts (2013) (Constrained central case)

Annual ATMs have been around maximum capacity of 480 thousand and are assumed to remain at this level with runways operating at close to 100%.

Figure 14: Forecasted aircraft movements at LHR



Note: The red line indicates stated capacity

Source: CAA airport statistics, DfT UK Aviation Forecasts (2013) (Constrained central case)

Amsterdam Airport Schiphol (AMS)

AMS is Europe's fourth busiest airport by total passenger traffic and the world's fifth busiest by international passenger traffic. The airport has six runways, with plans for a seventh (post 2030), and operates one terminal (single terminal concept) split into three large departure halls, which converge again once airside. With AMS approaching the limits of the capacity of the terminal, piers and aircraft stands on peak days, there are plans for further terminal expansion including the construction of a separate new terminal that would end the single terminal concept.

PAX 2012: 51 million

ATMs 2012: 423 thousand

Hub for: KLM

Terminal: One-terminal concept with three sections/halls

Runways: 3,800m 3,500m, 3,453m, 3,400m, 3,300m & 2,014m

Airport Overview

Infrastructure description

AMS lies 6 miles (9 km) southwest of Amsterdam, and has six runways along with one large terminal, split into three large departure halls, on a site that covers 2,787 hectares.

Brief history of how infrastructure has evolved

Figure 15: Key milestones

Year	Milestone
1916	Amsterdam Airport Schiphol starts as a military airfield.
1920	First KLM flight Amsterdam Airport – Schiphol becomes a civil aviation airport.
1938	Schiphol becomes Europe's second airport to gain a tarmac runway system.
1956	The City of Amsterdam approves the plan to build a new airport.
1967	New terminal at Schiphol Centre opens.
1975	Extension of the terminal by 120% is completed.
1978	Opening of the Schiphol rail link.
1991	The new air traffic control tower is completed.
1993	The west wing of the terminal opens.
2003	Runway 18R-36L, the new (fifth) main runway, taken into use.
2009	Extension of Departure Lounge 1, Departure Hall 3 and Arrival Hall 4 completed.
2012	"Backbone 70 Million Bags" baggage system becomes fully operational.

Runways, terminal, airfield

AMS operates six runways⁴, one of which is used mainly by general aviation aircraft.

Figure 16: Runway information

Runway	Location	Length (meters)	Width (meters)
1 - Polder	18R/36L	3,800	60
2 - Zwanenburg	18C/36C	3,300	45
3 - Kaag	06/24	3,500	45

⁴ Note that noise sharing regulations mean that not all 6 runways can be operational at one time

4 - Aalsmeer	18L/36R	3,400	45
5 - Buitenveldert	09/27	3,453	45
6 - Schiphol East	04/22	2,014	45

There are a total of 198 aircraft stands at AMS.

Figure 17: Aircraft stands

Type	Stands
Connected	93
Disconnected	105
Total	198

AMS operates one large terminal (single terminal concept), where all facilities are located under a single roof radiating from the central “plaza”. The terminal though is divided into three large sections/departure halls, designated 1, 2 and 3, which converge again once airside. To all of these halls, piers or concourses are connected. However, it is possible, on both sides of security or border inspection, to walk from one pier to another, even those connected to different halls.

Site size / constraints

The total size of the AMS site is 2,787 hectares. The physical site and runways are not expected to pose any significant constraints on activity at the airport.

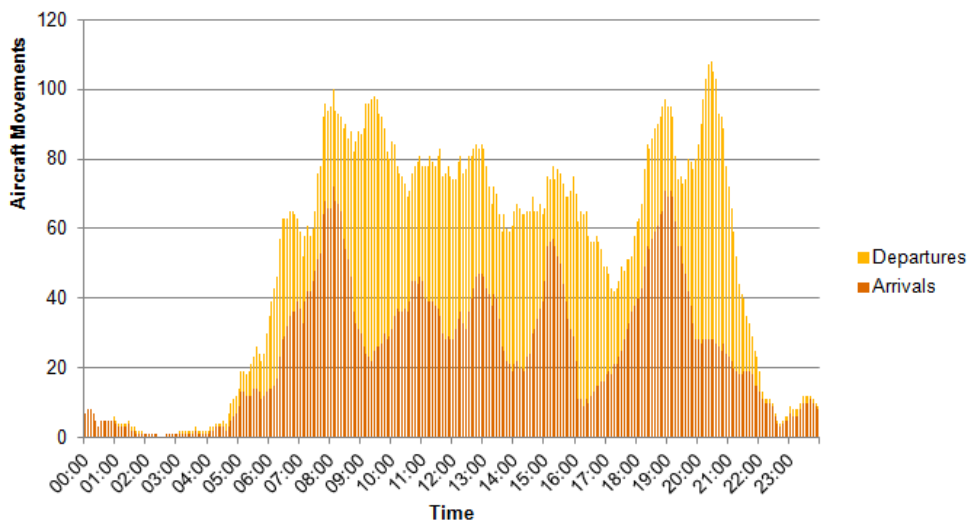
Expansion plans

A number of projects that address the expected increase in passenger demand at AMS have been started. One major reform already initiated is the central security concept in the non-Schengen area of the terminal. Security checks of passengers and hand luggage will take place at central security filters instead of at the gates. To create room for this process change, an additional floor will be constructed on a number of piers (E, F and G) and an existing floor will be redesigned to accommodate security control.

Central security ultimately results in a far more efficient process, better use of the boarding lounge and gate capacity, more comfort for passengers and better future preparedness of business operations in light of new legislation and regulations in the area of security. This extensive project is expected to be completed in 2015, with the investment programme related to this project amounting to approximately €350 million.

Peak profile

The hourly profile demonstrates the core operating hours at AMS of 0600 – 2300. Night movements (between 2300 and 0600) are restricted to 30,000 per annum. There are some peaks and troughs throughout the day indicating capacity to expand during off peak times (i.e. peak spreading).

Figure 18: Rolling hourly scheduled arrivals and departures – AMS

Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2013)

Regulations and Restrictions

The Aviation Act lays down the terms of the operating license of AMS. In addition, the Act regulates the manner in which the Schiphol Group (owners of AMS) may determine the aviation charges, as well as the level of these charges. The Aviation Act applies to aircraft, passenger and security charges. The Act also contains provisions limiting the return generated. This must not exceed the weighted average cost of capital.

The Netherlands Competition Authority (NMa) regulates the charges levied. If there is disagreement on these charges, the NMa will examine whether any complaints from the airlines are justified. If such complaints are upheld, AMS is obliged to set new charges.

Noise limits

AMS aims to make the Schiphol region an attractive region to live and work in. One way to achieve this is through the airport's active participation in the Alders platform – this is a round table, at which partners and local residents are consulted to ensure that the growth of air traffic at AMS and the quality of life in the surrounding area are in balance.

The local Community Contact Centre Schiphol supplies homeowners in the vicinity of the airport with information on aircraft noise and air traffic. Noise reduction is achieved by reducing ground noise and stimulating quieter aircraft – the latter is partially achieved by charging higher landing fees depending on the noise category of the aircraft (determined on the basis of its noise certification).

Figure 19: Noise categories and landing fees

Noise category	Certified noise level (EPNdB)	Landing fee
Category MCC3 (marginally compliant)	0 to -5	base charge +60%
Category A (high noise)	-5 to -9	base charge +40%
Category B (average noise)	-9 to -18	base charge
Category C (low noise)	< - 18	base charge -20%

If the noise certification values of an aircraft are not available, the noise category will be based on the conservative classification of aircraft types.

Future expansion of the airport is potentially constrained by the Covenant on Disturbance Reduction, which lays down agreements to restrict, as much as possible, noise disturbance from air traffic to and from airports in the Netherlands. Most significantly, this includes measures concerning:

- the maximum ceiling of 580,000 aircraft movements in 2020 (of which 70,000 must be non-mainport flights from regional airports); and
- limited use only of a 'fourth runway', intended to restrict disturbance in the inner area.

This means that air transport movements at AMS cannot exceed 510,000 until 2020. From 2020, the limitation on movements will be driven by noise levels. For example, if noise levels decrease by 10%, the maximum number of movements can increase by 5%. This is to ensure that absolute noise levels do not increase. Schiphol Group expect that given the increased use of quieter aircraft, the number of annual movements that can be accommodated at AMS can increase by nearly 50% by 2040 to around 750,000.

Emissions

AMS has set a goal to generate 20% of its own energy needs in a sustainable way by 2020. The biggest contributors to CO₂ emissions at Schiphol are energy consumption; heating, air conditioning, lighting and mobility (motor pool and commuters). Schiphol actively works at reducing greenhouse gases by cutting down on its energy consumption and through greater efficiency and sustainable energy practices. The airport has reduced its energy consumption by smart on and off switches for its lighting and air conditioning and has also chosen energy efficient LED lighting. AMS also has 8 locations with heat/cold storage, and has a field with 3,000 m² solar panels.

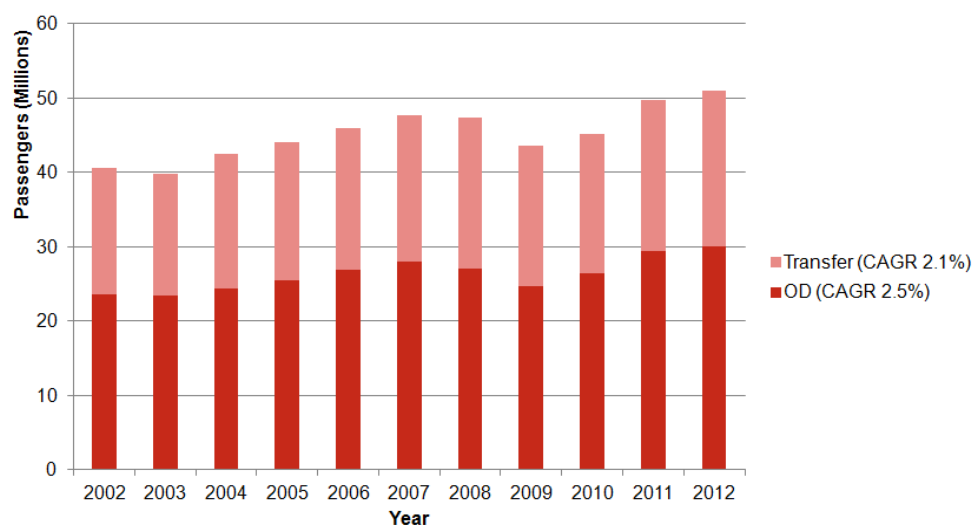
Schiphol plays a part in the Airport Carbon Accreditation benchmark set by the Airports Council International. In March 2012, the CO₂ reduction effort at Schiphol was awarded with the Airport Carbon accreditation level 3 (the second highest level). This was obtained not only because of the reduction of CO₂ output at the airport, but also because the airport was successful in motivating its partners (airlines, ground handlers) to reduce their CO₂ output.

Schiphol also strives to make mobility more sustainable by making road traffic to/from/at the airport cleaner and with less volume. AMS encourages passengers and employees to use public transportation to reach Schiphol and discourages the dropping off and picking up of passengers by car. The airport recently opened the first battery switching station for electric taxis. The electric taxi is driven onto a belt and the empty battery is switched for a charged one; within 5 minutes the taxi is ready to go with a fully charged battery. In addition, from 2014 AMS will switch to electric buses for passenger transport to the airplanes.

Traffic Trends

Historical growth

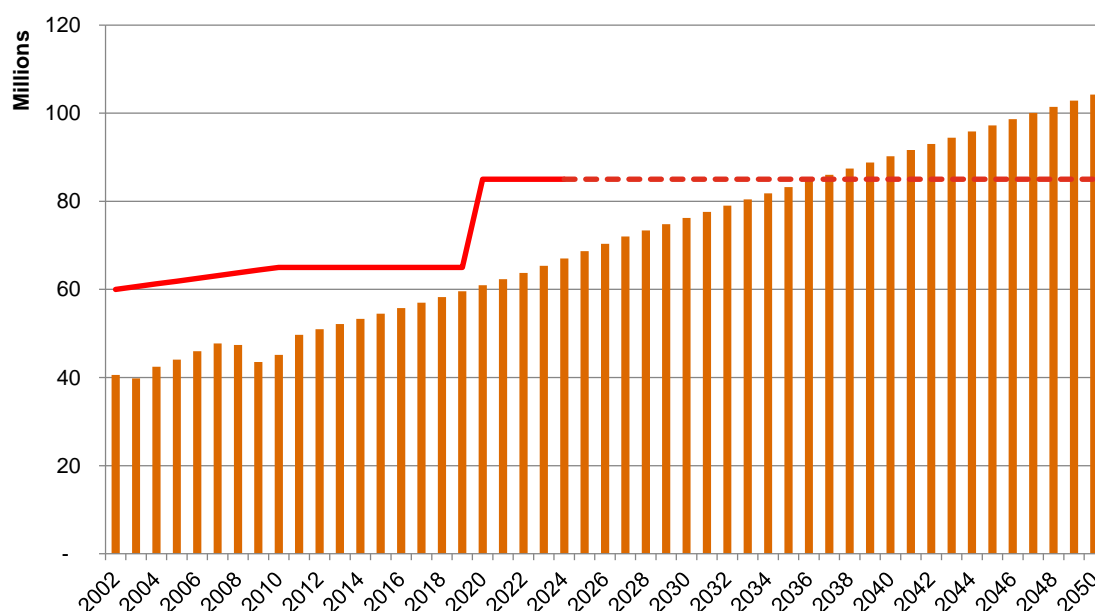
AMS has seen steady growth over the last decade at a compound annual growth rate of 2.3% with similar growth experienced across OD and transfer passengers.

Figure 20: Historical passenger movements at AMS (2002 to 2012)

Source: Schiphol Group

Future growth outlook

Amsterdam Schiphol's master plan contains a forecast estimating that airport passengers will grow to 62 million by 2020 and 72 million by 2025, however, these forecasts have been revised down recently and it is expected that these figures will be reached 1-2 years later. This trend has been extrapolated to 2050. The forecast growth estimates that the current terminal capacity of 65 million will be reached in around 2023. The current master plan (2020) allows for expansion of the terminal to cater for 85 million passengers. If growth continues, it would be expected that terminal capacity is reached between 2035 and 2040, however, this is beyond the master planning period and it would be assumed that there would be incremental terminal expansion to enable further growth.

Figure 21: Forecasted passenger movements at AMS

Note: The red line indicates expected capacity

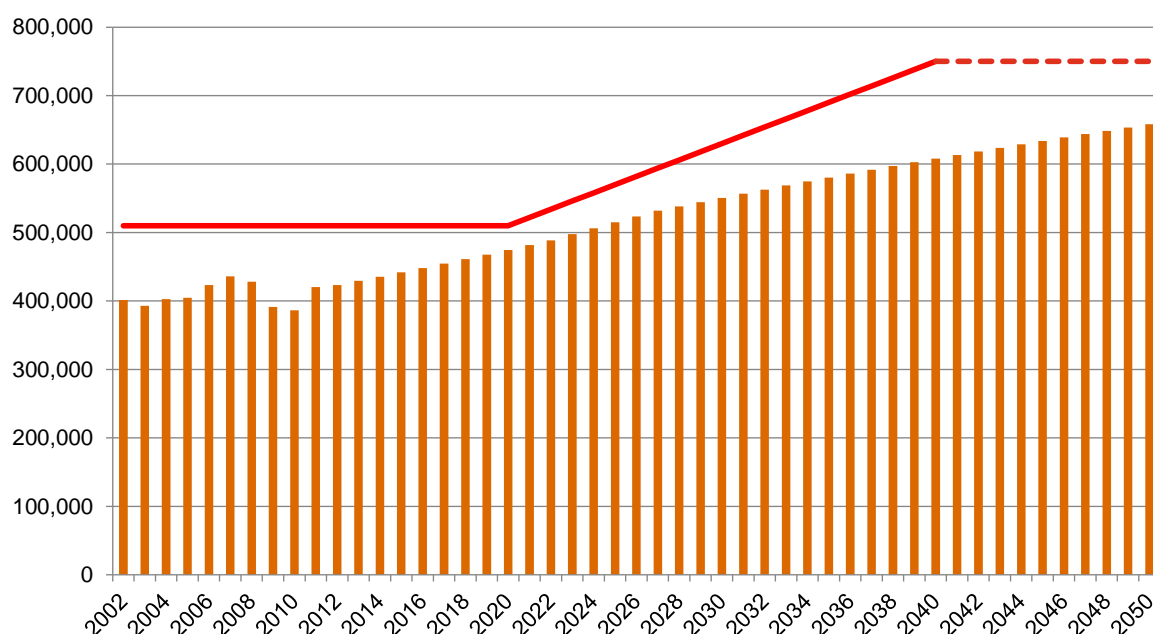
Source: Schiphol Group traffic statistics and Preliminary Master Plan (2013), PwC analysis

Forecast ATMs have been estimated based on passenger growth and aircraft up-gauging assumptions. It is assumed that the average seat capacity of aircraft will continue to increase in the short-term, however, once KLM's fleet renewal plan is completed, it is assumed that this levels off. This is based on the assumption that

AMS remains a hub and requires frequent short-haul flights to feed the hub. Due to noise restrictions within the Alders Platform, air transport movements at AMS cannot exceed 510,000 until 2020 (the maximum number of air transport movements for the Schiphol Group is set at 580,000 in 2020, 70,000 of which must take place at Eindhoven Airport and Lelystad Airport).

From 2020, the limitation on movements will be driven by noise levels. For example, if noise levels decrease by 10%, the maximum number of movements can increase by 5%. This is to ensure that absolute noise levels do not increase. Assuming that new aircraft technology reduces noise emissions, Schiphol airport expects the maximum cap on air transport movements to increase by around 50% from 2020 to 2040 to 750,000 ATMs (although all six runways at AMS can't be used simultaneously, there is still sufficient capacity in the existing runway system to cater for forecast growth to 2050). It is not expected that air transport movements will exceed this cap over the forecast horizon.

Figure 22: Forecasted aircraft movements at AMS



Note: The red line indicates expected capacity

Source: Schiphol Group traffic statistics and Preliminary Master Plan (2013), PwC analysis

Paris Charles de Gaulle Airport (CDG)

CDG is Europe's second busiest airport (after LHR) in passengers served and Europe's busiest airport in aircraft movements, with 491 thousand ATMs in 2012. The new satellite, S4, to Terminal 2E was completed in July 2012 – dedicated to long-haul flights, it has the ability to handle 16 aircraft simultaneously and will significantly reduce connecting times for transfer passengers. With an expected capacity of 7.8 million passengers annually, the opening of satellite 4 has increased terminal capacity at CDG to 80 million.

PAX 2012: 62 million

ATMs 2012: 491 thousand

Hub for: Air France

Terminals: T1, T2 & T3

Runways: 4,215m, 4,200m, 2,700m & 2,700m

Airport Overview

Infrastructure description

CDG lies 16 miles (25 km) north of Paris, and has four parallel east-west runways along with three operational terminals with a capacity of 80 million on a site that covers 3,257 hectares.

Brief history of how infrastructure has evolved

Figure 23: Key milestones

Year	Milestone
1966	Start of construction of Terminal 1.
1974	Inauguration and commissioning of CDG, revolutionary with its terminal composed of a central cylindrical body and seven satellites.
1976	Inauguration of the RER station.
1981	Inauguration of Terminal 2B.
1982	Inauguration of Terminal 2A.
1989	Opening of Terminal 2D.
1991	Opening of Terminal T9 for charter flights.
1993	The opening of Terminal 2C, entirely reserved for international traffic with computerised baggage sorting.
1998	Opening of runway 4, with a length of 2,700 metres. It forms a southern doublet with runway 2.
2002	T3 terminal (formerly T9) doubles its area to hold departing passengers, and triples the area of its commercial space.
2003	The sixth terminal is commissioned; the "E" is used by Air France and SkyTeam alliance and is reserved for international traffic. It enables the docking of 18 aircraft.
2007	Commissioning of CDGVal, the automated metro which connects the CDG1 and CDG2 terminals.
2008	Commissioning of the new departure lounge at Terminal 2E. Opening of regional Terminal 2G, dedicated to French and European destinations.
2012	The satellite S4, part of terminal 2E, officially opened in June 2012. Dedicated to long-haul flights, it has the ability to handle 16 aircraft at the same time, with an expected capacity of 7.8 million passengers per year.

Runways, terminal, airfield

CDG has an efficient runway system owing to its two pairs of runways whose physical layout allows independent use. For each pair of runways, one runway is specialised for takeoffs and the other for landings, which also enables the limitation of noise caused by traffic. This runway system has been adapted to host very large aircraft (Airbus A380). Programming capacity in 2011 was 115 aircraft movements (arrivals/departures)

per hour, with projected capacity for 2015-2020 of 120 movements per hour⁵. It is estimated that CDG's runways are currently operating at around 75% of capacity, implying an annual capacity of around 660,000 movements. Given the increase in hourly capacity, it is expected that runway capacity could increase to around 690,000⁶ movements by 2020.

Figure 24: Runway information

Runway	Length (meters)	Width (meters)
08L/26R	4,215	60
08R/26L	2,700	60
09L/27R	2,700	60
09R/27L	4,200	60

There are a total of 300 aircraft stands at CDG.

Figure 25: Aircraft stands

Type	Stands
Connected	130
Disconnected	170
Total	300

CDG has three passenger terminals (Terminals 1, 2 and 3).

Figure 26: Terminal information

Terminal	Opened	Description
1	1974	Oldest terminal, configured in the shape of an octopus. Handles international and Schengen traffic and includes Star Alliance member companies.
2	1981	Consists of seven terminals: 2A, 2B, 2C, 2D, 2E, 2F and 2G. Handles international and Schengen traffic including Air France, its SkyTeam alliance partners and those companies in the oneworld alliance.
3	2002	Handles charter and low cost carrier traffic.

Site size / constraints

The massive 3,238 hectare site at Roissy, north of Paris, is often held as the prime example of 'best practice' in the development of a major international hub. With CDG's runways operating at less than 75% of their capacity and ample land on which to build, there is significant scope for expansion of the airport.

Expansion plans

Future development of CDG is focused on:

- increasing the capacity of the airport
- improving the operational management
- developing intermodality by taking the best advantage of TGV complementarity

⁵ Aéroports de Paris website

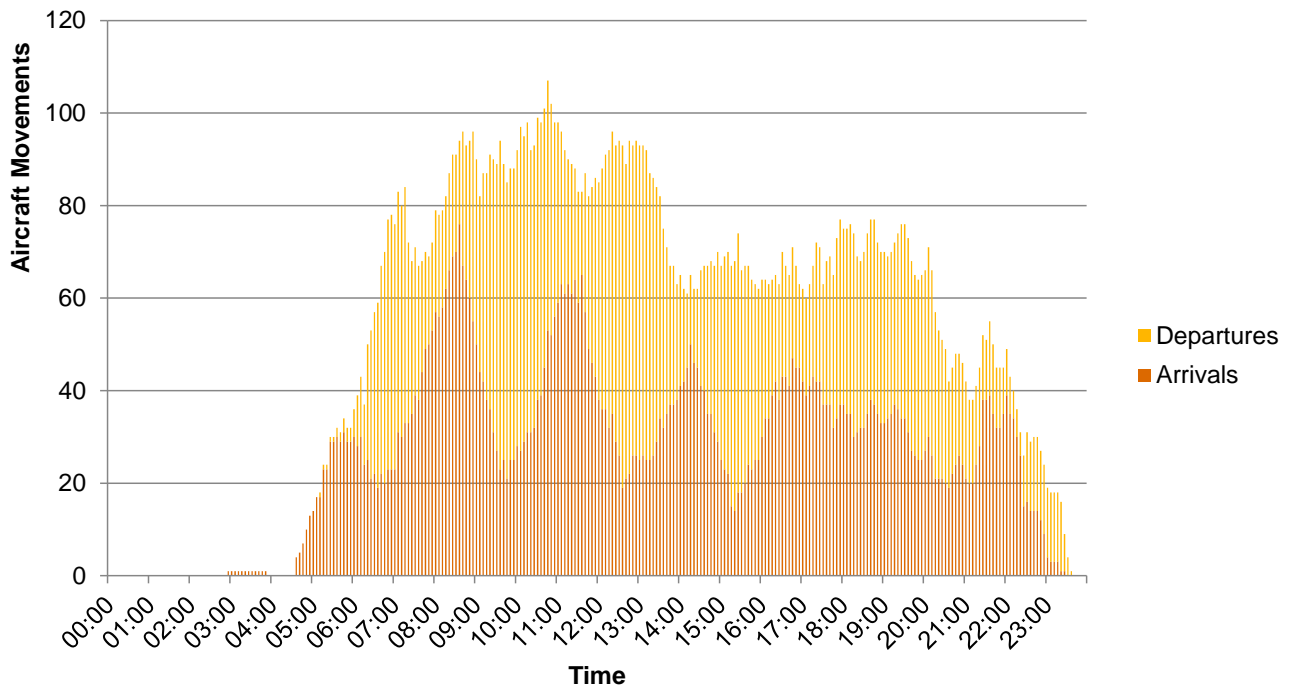
⁶ Inferred based on assumed scaling up of hourly movements

- improving the quality of service (quality commitments, development of new services, technological innovations, increased attention to transit passengers and passengers with disabilities or reduced mobility)
- implementing a competitive trade policy by boosting the 36,700 m² of retail space and improving the supply of parking

Peak profile

Figure 26 illustrates the rolling hourly profile of aircraft movements at CDG. The chart demonstrates that the airport is not currently operating at full capacity throughout the day.

Figure 27: Rolling hourly scheduled arrivals and departures – CDG

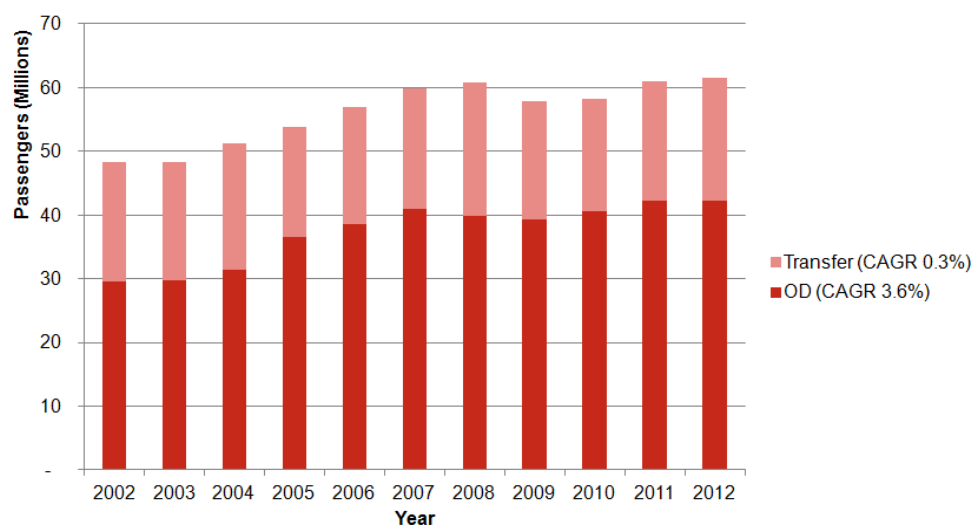


Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2013)

Traffic Trends

Historical growth

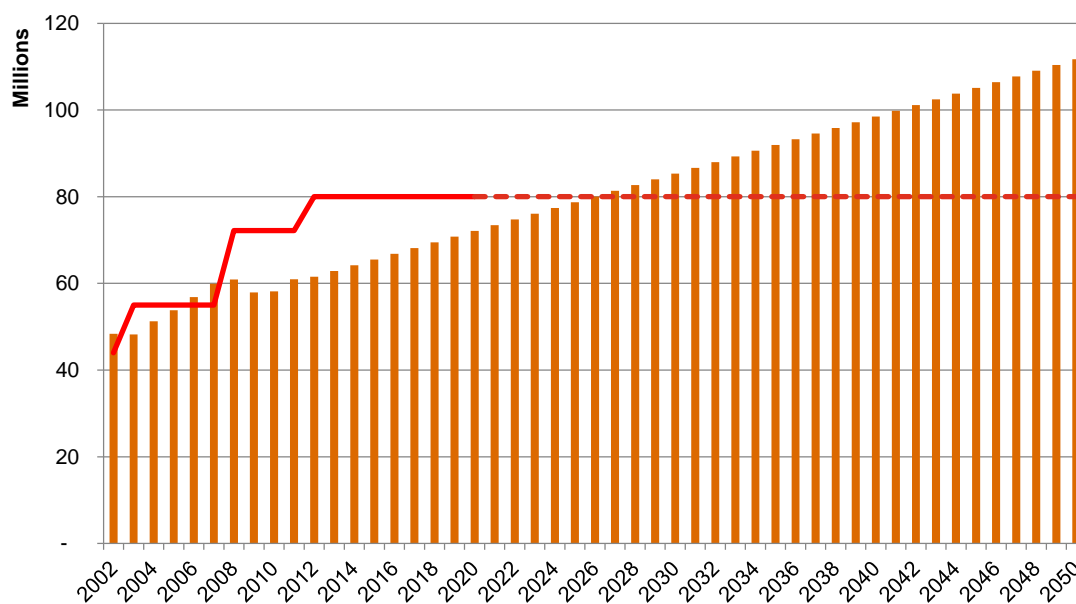
Passengers have grown at a compound annual growth rate of 2.4% over the last decade, with growth in OD passengers outstripping growth in transfer passengers, which have remained stagnant over the last decade.

Figure 28: Historical passenger movements at CDG (2002 to 2012)

Source: Union des Aeroports Français, Aeroports de Paris

Future growth outlook

Due to the lack of readily available forecasts for CDG, estimates were made based on the historical trends of passenger increases at CDG. The forecast implies that current planned terminal capacity will be reached in approximately 2025.

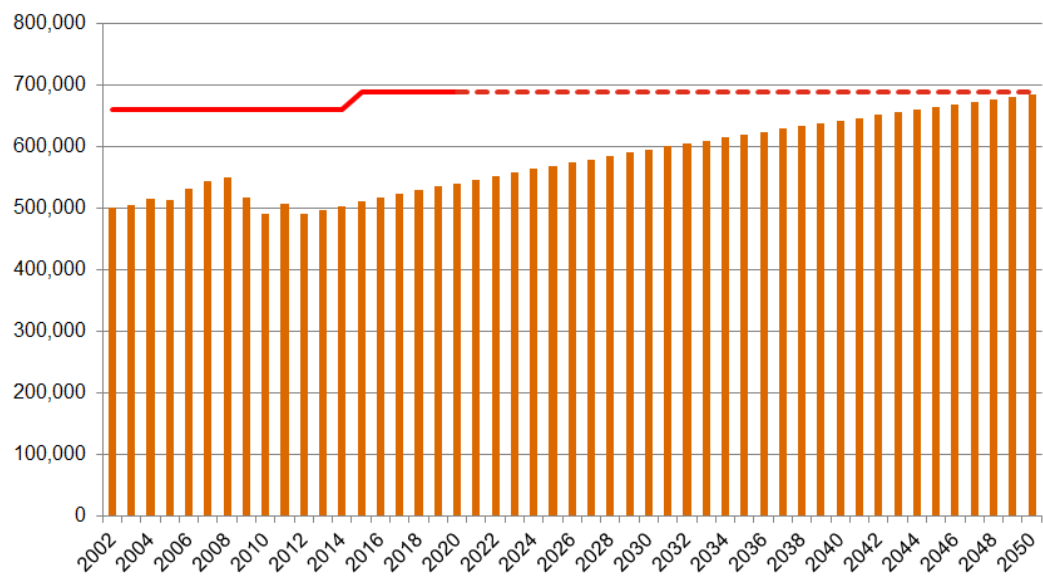
Figure 29: Forecasted passenger movements at CDG

Note: The red line indicates expected capacity

Source: Union des Aeroports Français, Aeroports de Paris, PwC analysis

Future aircraft movements were estimated based on passenger projections and an assumed continued increase in passengers per movement. With CDG currently operating at around 75% of runway capacity there is room for future traffic growth, although this would require realisation of the increase in hourly movements to 120 and peak spreading along with the required apron and gate capacity. In addition, the site at Roissy has available land for development to increase capacity and it is understood that planning permission has been requested for additional capacity.

Figure 30: Forecasted aircraft movements at CDG



Note: The red line indicates expected capacity
Source: Union des Aeroports Francais, Aeroports de Paris, PwC analysis

Dubai International Airport (DXB)

DXB is ranked the second busiest airport in the world (after LHR) in terms of international passengers served. With 2/3 of the world's population living within 8 hrs flight from Dubai, DXB is ideally placed to cement its position as a major international hub connecting Europe and North America with the rapidly growing economies of Asia and Africa. The opening of Concourse A in January 2013 has increased the collective capacity of T1, T2, and T3 to 75 million and, with further plans to develop terminal infrastructure, total passenger capacity is expected to increase to 98.5 million by 2020.

The new Dubai World Central Al Maktoum International Airport (DWC) opened in 2010. The site is more than double the size of the current Dubai Airport at 7,200 ha with a single long runway of 5,400m currently in operation and plans for 4 additional parallel runways (all 5,400m) to be built over the next decade and there are plans to build terminals to cater for up to 160 million passengers per annum in the longer term.

PAX 2012: 58 million

ATMs 2012: 344 thousand

Hub for: Emirates Airline, flydubai

Terminals: T1, T2 & T3

Runways: 4,680m & 4,320m

Airport Overview

Infrastructure description

DXB lies 2.5 miles (4 km) northeast of Dubai, and has two parallel runways along with three operational terminals on a site that covers 3,500 hectares.

Brief history of how infrastructure has evolved

Figure 31: Key milestones

Year	Milestone
1960	Dubai Airport opened and was capable of handling aircraft up to the size of a DC-3.
1970	The 70's witnessed many developments, starting with a new three-storey terminal building, control tower, additional taxiways and lengthening of the runway.
1984	The second runway opens.
1998	Terminal 2 opens boosting capacity by two million passengers per year.
2000	Sheikh Rashid Terminal, also known as Terminal 1, opens increasing the airport's capacity from 10 million to 23 million passengers.
2008	The world's largest terminal - Emirates Terminal 3 - opens, expanding Dubai International's capacity to 60 million passengers.
2009	Dubai International becomes the world's fastest growing airport among the top 50 major hubs. Work begins on Concourse 3 and Terminal 2 undergoes major refurbishment for the launch of flydubai.
2013	Concourse A opened in January 2013, increasing total terminal capacity to 75 million passengers per annum.

Runways, terminal, airfield

DXB operates two parallel runways.

Figure 32: Runway information

Runway	Location	Length (meters)	Width (meters)
Northern	12L/30R	4,320	60
Southern	12R/30L	4,680	60

There are a total of 144 aircraft stands at DXB, split across three passenger terminals (Terminals 1, 2 and 3).

Figure 33: Terminal information

Terminal	Opened	Area (sq meters)	Description
1	2000	246,474	Terminal 1 serves all airlines.
2	1998	13,000	Terminal 2 serves scheduled, charter, and special flights (pilgrimages).
3	2008	1,185,000	Terminal 3 is dedicated for use by Emirates airline.
Total		1,444,474	

Site size / constraints

The total size of the DXB site is 3,500 hectares.

Expansion plans

As DXB's passenger and cargo traffic continues to grow rapidly, Dubai Airports is investing \$7.8bn under its ten-year SP2020 masterplan to ensure that the airport has the infrastructure in place to meet the rapid growth. SP2020 outlines aggressive expansion plans for airspace, airfield, stands and terminal areas at DXB. The plan takes into account the need to minimise constraints on growth by delivering timely capacity, while improving service levels and generating strong cash flow to maximise capital investment.

SP2020 will focus the \$7.8bn of investment on:

- Increasing capacity to 98.5 million passengers by 2020
- 675,000 sqm of additional passenger terminal space
- 60% increase in number of stands by 2015 from 144 to 230
- Cargo growth from 2.2 million tonnes (2010) to 4.1 million tonnes by 2020
- Infrastructure development:
 - Terminal 2 expansion (2013)
 - Concourse 4 development (2015)
 - Baggage Backbone
 - DWC passenger terminal building arrivals (PTB) expansion (2018)
 - 30,000 m² additional cargo processing capacity

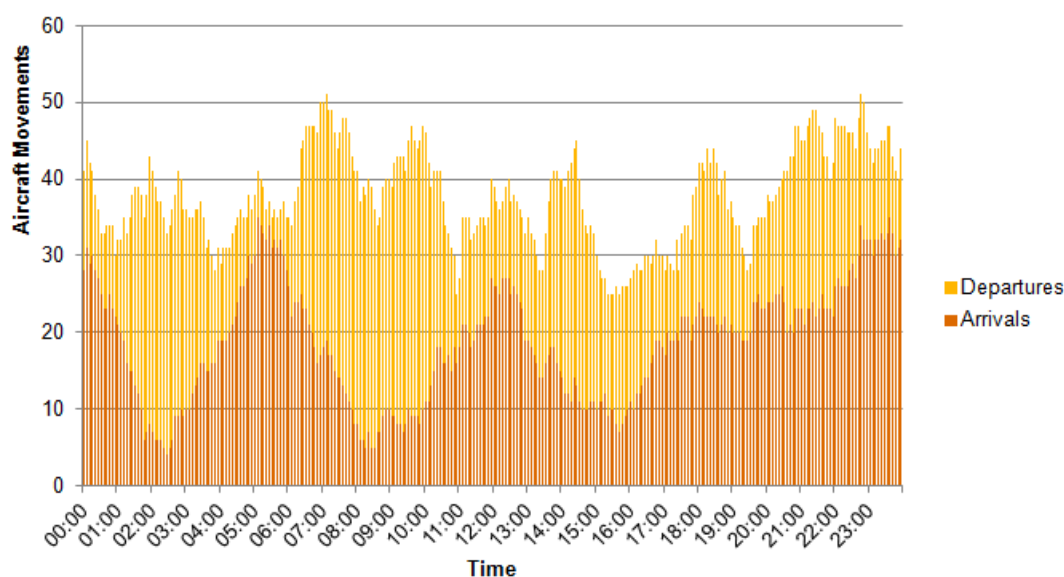
New Airport

The new Dubai World Central Al Maktoum International Airport (DWC) opened in 2010. The site is more than double the size of the current Dubai Airport at 7,200 ha with a single long runway of 5,400m currently in operation and plans for 4 additional parallel runways (all 5,400m) to be built over the next decade. Since opening, the airport has been open only to cargo operations, however, passenger services are due to commence in October 2013 and there are future plans to build terminals to cater for up to 160 million passengers per annum in the longer term. The majority of services are expected to move over from Dubai International (DXB)

to Dubai World Central (DWC) in the middle of the next decade. The new airport will enable the Dubai aviation market to continue to grow.

Peak profile

The profile of traffic throughout the day ranges from 30 to 50 aircraft movements per hour.

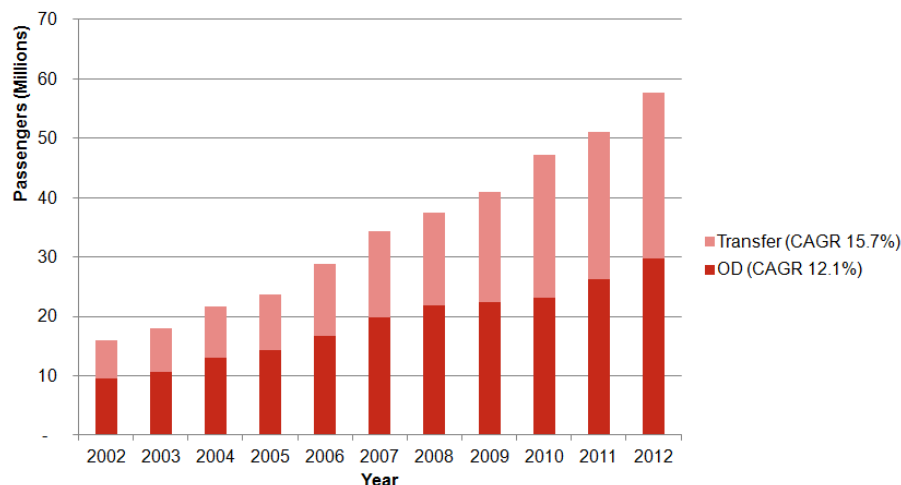
Figure 34: Rolling hourly scheduled arrivals and departures – DXB

Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2013)

Traffic Trends

Historical growth

As demonstrated in figure 35, Dubai has seen significant growth over the last decade with a compound annual growth rate of 13.7% for total passenger traffic. Transfer traffic has grown more rapidly at 15.7% CAGR compared with OD traffic at 12.1% CAGR.

Figure 35: Historical passenger movements at DXB (2002 to 2012)

Source: Dubai Airports

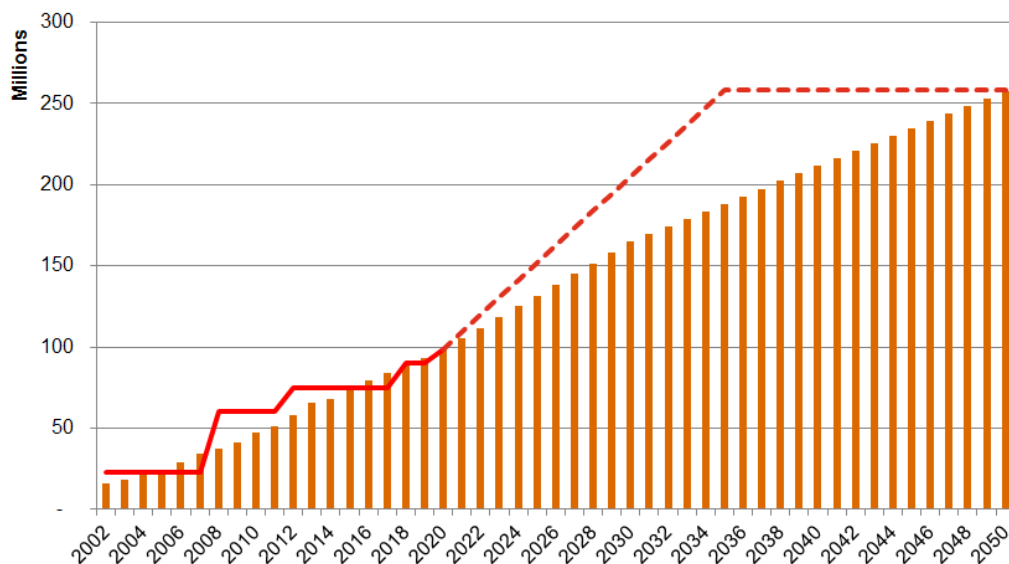
Future growth outlook

Forecast passenger growth at Dubai is based on:

- the SP2020 Master Plan to 2020
- the DWC Master Plan from 2020 to 2030 – this has been extrapolated out to 2050, at which point it is assumed Dubai will be operating at close to capacity, based on the average annual passenger increase from 2020-2030

The plan projects capacity of 98.5 million passengers to be reached at DXB by 2020. Figure 36 includes capacity at DWC from 2020 – once operational it is assumed that DWC will gradually increase to its full capacity of 160 million passenger per annum once this is required (likely by 2035).

Figure 36: Forecasted passenger movements at DXB



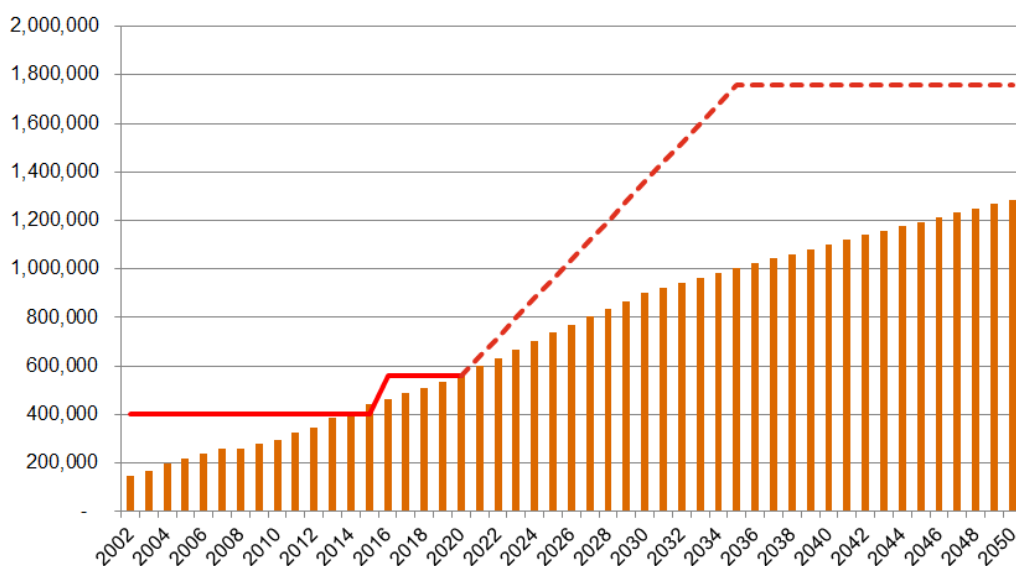
Note: The red line indicates expected capacity at DXB and DWC combined

Source: PwC estimates based on Dubai Airports Strategic Plan (SP2020)

Projections for aircraft movements have been based on a movement forecast for 2030 across both DXB and DWC of approximately 900,000 ATMs – this has been extrapolated out to 2050 based on estimated passenger forecasts and an assumption of continued up-gauging (albeit at a much slower rate than has been observed in recent years). At DXB it is assumed that airspace optimisation is achieved and 60% new aircraft stands are added by 2016 to increase annual runway capacity from around 400,000 currently to 560,000.

At DWC it is expected that additional runway capacity will be available from 2020, ramping up to 1,200,000 aircraft movements once all runways are fully operational (likely by 2035).

Figure 37: Forecasted aircraft movements at DXB



Note: The red line indicates expected capacity at DXB and DWC combined

Source: PwC estimates based on Dubai Airports Strategic Plan (SP2020)

Frankfurt Airport (FRA)

FRA is the third busiest airport in Europe and serves the most international destinations in the world (295 destinations in 107 countries). The fourth runway became operational in October 2011, giving capacity of 700 thousand aircraft movements by 2020. With plans to build a large new Terminal 3 south of the existing terminals, with capacity for 25 million passengers and featuring 75 new aircraft positions, total PAX capacity is expected to increase to 88 million by 2020.

PAX 2012: 58 million

ATMs 2012: 482 thousand

Hub for: Lufthansa, Condor

Terminals: T1 & T2

Runways: 4,000m, 4,000m, 4,000m & 2,800m

Airport Overview

Infrastructure description

FRA lies 7.5 miles (12 km) southwest of Central Frankfurt, and has four runways along with two operational terminals on a site that covers 2,000 hectares.

Brief history of how infrastructure has evolved

The airport has been expanded several times since its opening in 1936, with a system of parallel takeoff and landing runways completed in 1949 and the opening of Terminal 1 in 1972. In October 2011, the new Runway Northwest at Frankfurt Airport was inaugurated. This new Runway Northwest, a third terminal and the new A380 maintenance base are meeting the prerequisites for Frankfurt Airport to keep pace long-term with growing aviation volumes.

Figure 38: Key milestones

Year	Milestone
1936	The “Rhine-Main Airfield” begins operating.
1949	System of parallel takeoff and landing runways completed.
1972	Terminal 1 and the subterranean train station open.
1984	Takeoff Runway 18 West begins operating.
1994	Terminal 2 and the SkyLine overhead railway open.
1997	Pier D starts operating.
1999	FRA’s long-distance train station is inaugurated.
2000	The Pier A extension opens.
2008	Pier C/D and the Hall C extension open.
2010	Fraport opens two new apron control towers.
2011	Inauguration of the new Runway Northwest. Completion of The Squire.
2012	The new Pier A-Plus begins operating, offering a capacity for up to 6 million passengers.

Runways, terminal, airfield

The new Runway Northwest began operating in October 2011. Measuring 2,800m the new runway enables parallel flight movements, as a result of which the airport will now be able to gradually increase the number of hourly takeoffs and landings from 83 at present to 126. This boost in capacity will let FRA serve the burgeoning passenger volumes and meet airlines’ increasing demand.

Figure 39: Runway information

Runway	Location	Length (meters)	Width (meters)
Runway North	07R/25L	4,000	60
Runway South	07C/25C	4,000	45
Runway West (takeoffs only)	18	4,000	45
Runway Northwest (landings only)	07L/25R	2,800	45

There are a total of 175 aircraft stands at FRA.

Figure 40: Aircraft stands

Type	Stands
Connected	65
Disconnected	110
Total	175

Frankfurt Airport has two large passenger terminals (Terminals 1 and 2) and a smaller First-Class-Terminal which is exclusively used by Lufthansa. Unlike other international airports, the terminal operations are grouped for airlines and airline alliances rather than flight destinations.

Figure 41: Terminal information

Terminal	Opened	Description
1	1972	Oldest terminal, it is divided into concourses A, B, C and Z and has a passenger capacity of approximately 50 million.
2	1994	Divided into concourses D and E, Terminal 2 has a passenger capacity of approximately 15 million.

Site size / constraints

The total size of the FRA site is 2,000 hectares.

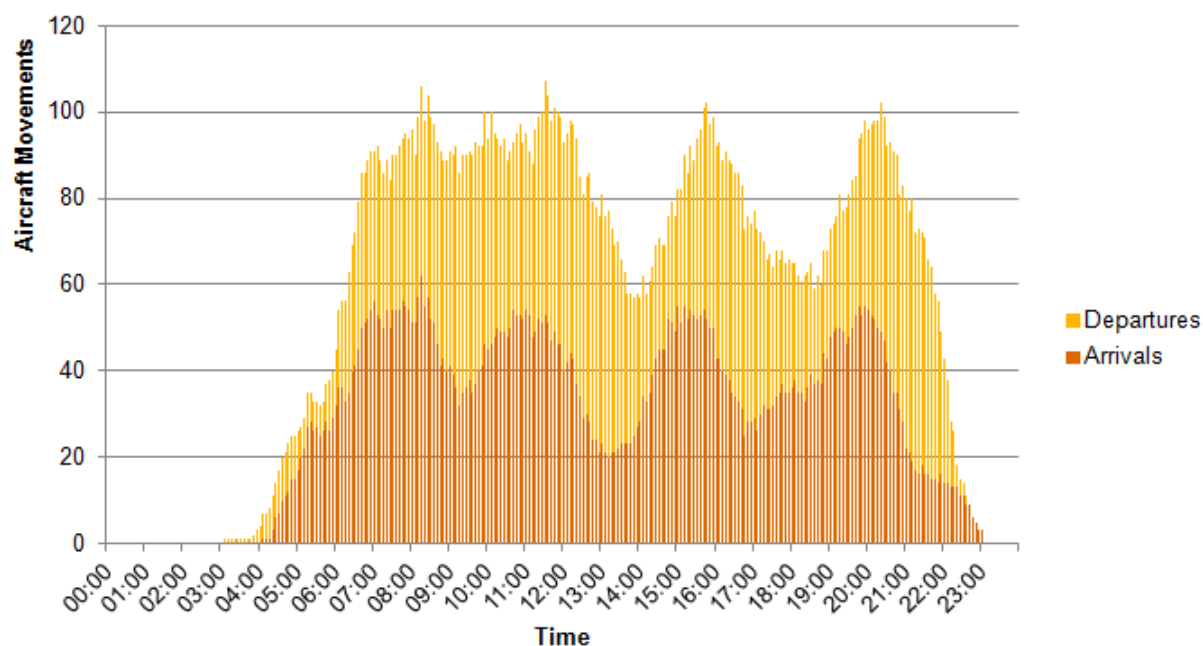
Expansion plans

Frankfurt Airport has planned capacity up to 88 million passengers per annum. This growth will necessitate additional passenger and luggage handling systems as well as new aircraft maintenance facilities. Thus, there are plans to build a new passenger terminal in the south of the airport, which will add capacity for another 25 million passengers to the current figure of 65 million a year.

These expansion activities are being supplemented by Lufthansa's new A380 hangar, the first section of which has already been completed, while the hourly availability of slots will also be increased from 80 to 126 (an increase of approximately 50 percent).

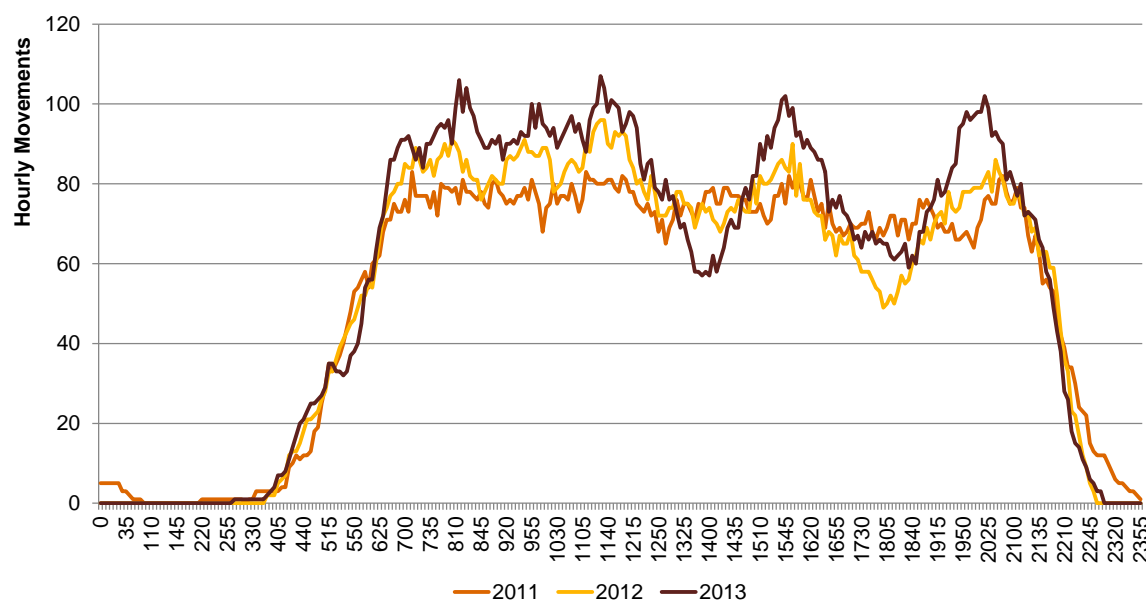
Peak profile

Frankfurt airport sees 3 main peaks throughout the day, with a long peak period during the morning and two peaks in the evening. The hourly profile indicates room for peak spreading.

Figure 42: Rolling hourly scheduled arrivals and departures – FRA

Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2013)

Figure 42 shows how the hourly movement profile has change for FRA since new runway capacity came online in October 2011. For the example day in 2011, movements did not exceed around 80 per hour, however, in 2012 and 2013 hourly movements are peaking at between 80 and 100.

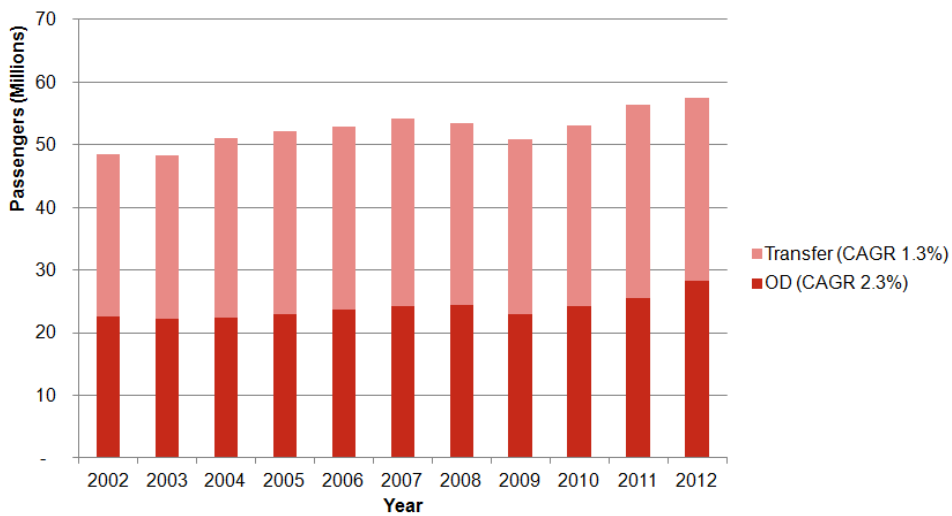
Figure 43: Rolling hourly scheduled movements 2011, 2012 and 2012 – FRA

Source: Sabre Airport Data Intelligence, Schedules Report (based on schedules for 1 August 2011, 2012 and 2013)

Traffic Trends

Historical growth

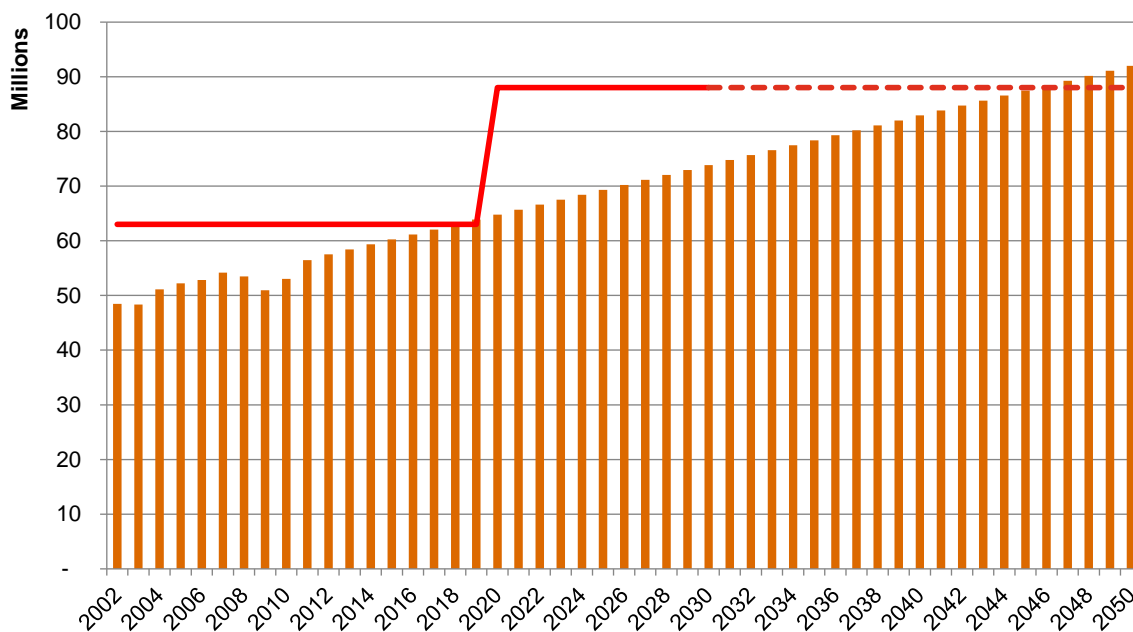
Total passengers have grown at a compound average growth rate of 1.7% over the past decade, with OD passenger growth higher compared with transfer passenger growth.

Figure 44: Historical passenger movements at FRA (2002 to 2012)

Source: Sabre Airport Data Intelligence, Market Details Report

Future growth outlook

Since official Frankfurt Airport passenger forecasts were not available via desk-top research, estimates were made based on historical trend analysis of Frankfurt airport passengers. The forecast implies that planned terminal capacity will not be reached until after 2040.

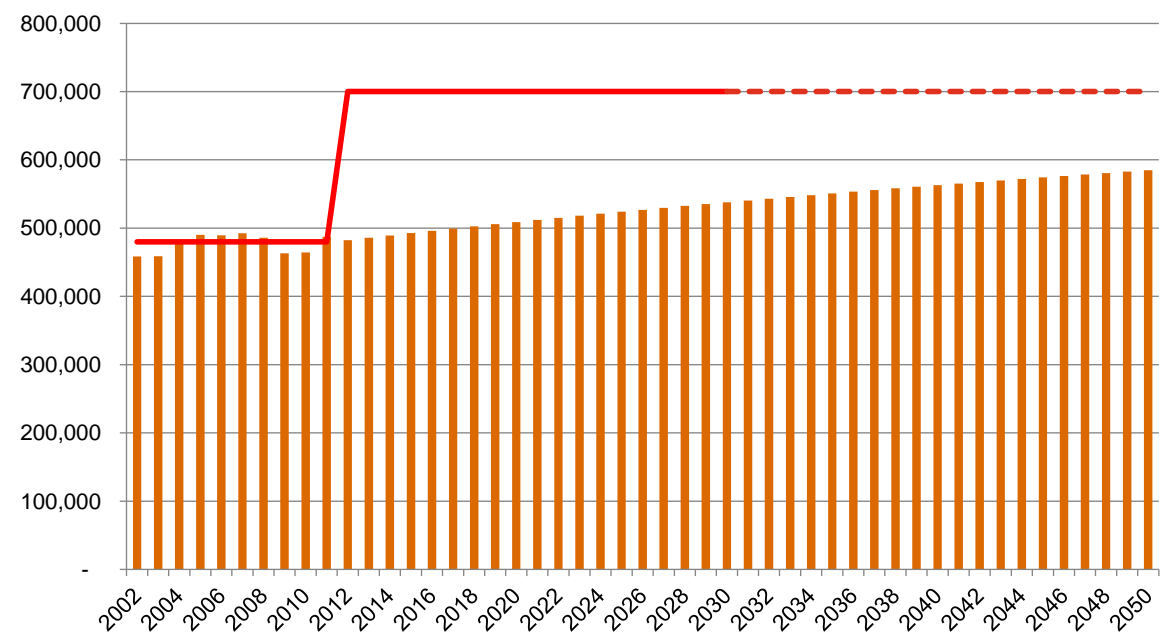
Figure 45: Forecasted passenger movements at FRA

Note: The red line indicates expected capacity

Source: Sabre Airport Data Intelligence, Market Details Report

Forecast ATMs were based on passenger growth and assumed up-gauging. Since FRA has significant available annual ATM capacity, it is not projected that this is reached until after 2050.

Figure 46: Forecasted aircraft movements at FRA



Note: The red line indicates expected capacity
Source: Sabre Airport Data Intelligence, Market Details Report

Summary and Conclusions

Summary

Based on the projections above, we have estimated the year in which stated capacity is reached for both terminal and runway capacity.

Figure 47: Estimated timing of airports reaching planned capacity

Airport	Future Terminal Capacity (mppa)	Estimated to reach capacity by 2050 (Y/N)	Future Runway Capacity (ATM 000s)	Estimated to reach capacity by 2050 (Y/N)	Constraints
LHR	86	N	480	Y – 2013	Infrastructure (runway), site
AMS	85	Y – 2037	750 ¹⁾	N	Regulatory (noise)
CDG	80	Y – 2026	690 ²⁾	N	Infrastructure (terminals)
DXB	98.5	N ²⁾	560	N ³⁾	Infrastructure, Site
DWC	160	N	800	N	n/a
FRA	88	Y – 2046	700	N	Site ⁴⁾

- 1) Movements are limited to 510,000 until 2020 increasing to around 750,000 by 2040 due to quieter aircraft.
- 2) Taking a three year average at CDG for 2010-2012 of 497k ATMs and assuming the airport's runways are only operating at 75% capacity, the implied capacity is currently 660k movements. Applying the expected increase in hourly movements from 115 to 120, gives a projected cap in 2015 of approximately 690k movements.
- 3) DXB is expected to be constrained prior to the opening of DWC, however, it could be assumed that capacity will incrementally increase to cater for demand.
- 4) The current Frankfurt Airport site would restrict further runway developments.

AMS

It is estimated that passenger demand will reach capacity of 85 million at AMS by 2039. However, this is beyond the master planning period and it seems reasonable to assume that there would be incremental terminal expansion to enable further growth. Runway capacity is currently limited to 510,000 movements, however, from 2020, aircraft noise reduction is expected, enabling the movement cap to be increased to around 750,000 movements between 2020 and 2040.

CDG

CDG has a vast amount of airport land enabling expansion. It is understood that CDG has submitted requests for planning permission for additional runway capacity, so it is assumed that there is potential for the stated capacity to expand further. It could also be assumed that terminal capacity increases incrementally as required.

DXB

DXB is nearing capacity; however, Dubai World Central (DWC) Airport is due to open in the next decade, which will relieve the pressure from DXB.

FRA

Given the current site size, there is limited scope for further runway expansion at FRA, however, with the recently built runway; the airport will have capacity of up to 700,000 air traffic movements. Activity at FRA is not expected to reach this by 2050. Lufthansa also has a two hub system, so some transfer capacity could be

shifted between FRA and Munich (MUC), with Berlin Brandenburg airport also due capture some transfer traffic.

Overall, it is expected that the key competing hubs are likely to continue to be able to cater for future air traffic demand.

Appendix

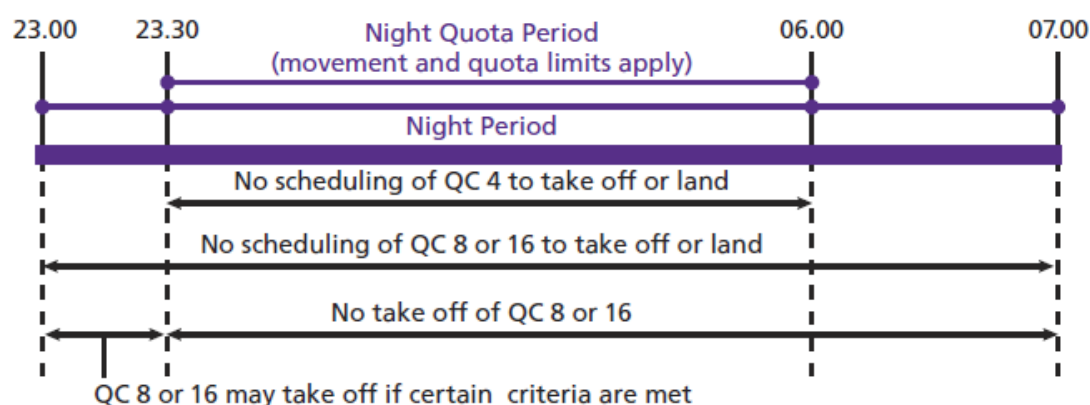
Noise Restrictions at LHR

Aeroplanes are certified by the International Civil Aviation Organisation (ICAO) according to the noise they produce. They are classified separately for both take off and landing.

Figure 48: Aircraft quota count (QC) classifications

Certified noise level (EPNdB)	Quota count
More than 101.9	QC / 16
99 – 101.9	QC / 08
96 – 98.9	QC / 04
93 – 95.9	QC / 02
90 – 92.9	QC / 01
87 – 89.9	QC / 0.5
84 – 86.9	QC / 0.25

Figure 49: Summary of aircraft restrictions



The night flying restrictions are divided into summer and winter seasons. They consist of a movements limit and a quota count system. This means that points are allocated to different aircraft types according to how noisy they are. The noisier the aircraft type, the higher the points allocated. This provides an incentive for airlines to use quieter aircraft types.

Figure 50: Movements limits and noise quotas at Heathrow

Winter	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Movement limit	2,550	2,550	2,550	2,550	2,550	2,550	2,550
Noise quota	4,140	4,140	4,140	4,140	4,140	4,140	4,080
Summer	2006	2007	2008	2009	2010	2011	2012
Movement limit	3,250	3,250	3,250	3,250	3,250	3,250	3,250
Noise quota	5,610	5,610	5,460	5,460	5,340	5,220	5,100

Passenger Projections

Forecasts to 2050 were not readily available for the four hub airports considered in this paper, so we have built on publicly available sources, such as the Master Plan for Schiphol and the Strategic Plan 2020 (SP2020) and DWC Master Plan for Dubai and extrapolated these out to 2050 to estimate future passengers at these airports. Forecasts were not available in the public domain for CDG and FRA, so we have extrapolated passengers from 2013-2050 based on the average annual increase in passengers from 2002-2012. This implicitly takes into account that passenger growth rates will moderate over time.

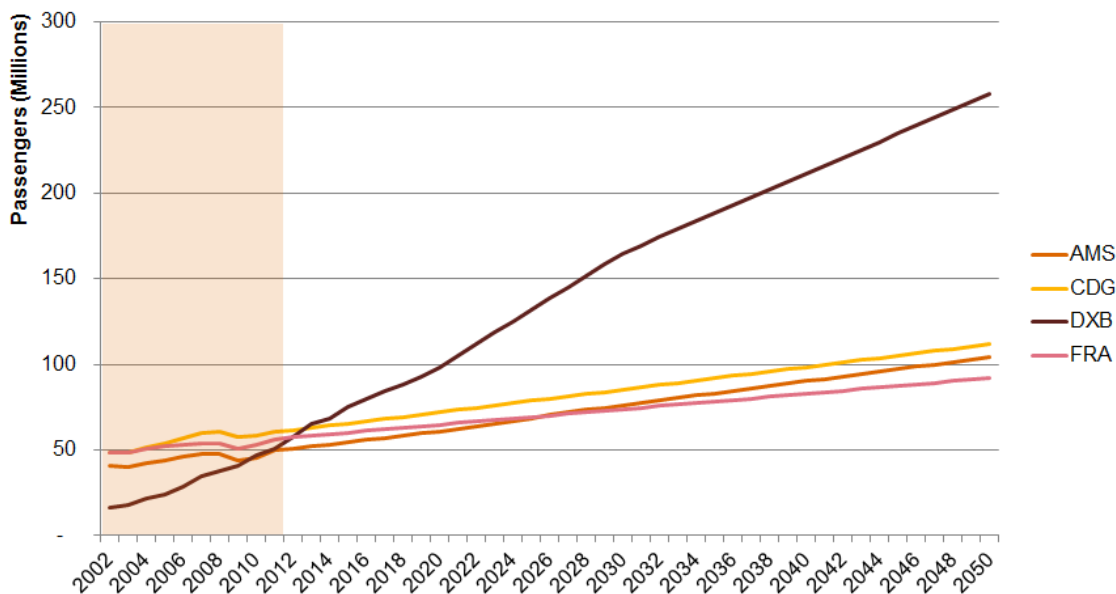
Schiphol group Master Plan forecast for AMS has traffic reaching 62 million in 2020 and 72 million for 2025, however, based on a discussion with Schiphol Group on 31 July 2013, we understand that these have been revised down recently and these forecasts are expected to be reached 1-2 years later than originally expected. The forecast of 72 million passengers has been applied to 2027 and we have assumed an annual increase in passengers for 2028 onwards based on the average annual increase in passengers from 2012-2027.

For Dubai, we have based the passenger projections to 2050 on:

- the SP2020 Master Plan to 2020
- the DWC Master Plan from 2020 to 2030 – this has been extrapolated out to 2050, at which point it is assumed Dubai will be operating at close to capacity, based on the average annual passenger increase from 2020-2030.

Figure 51 summarises the passenger projections for the four airports.

Figure 51: Passenger projections



Source: Schiphol Group, Dubai Airports, Fraport, Aeroports de Paris, PwC analysis

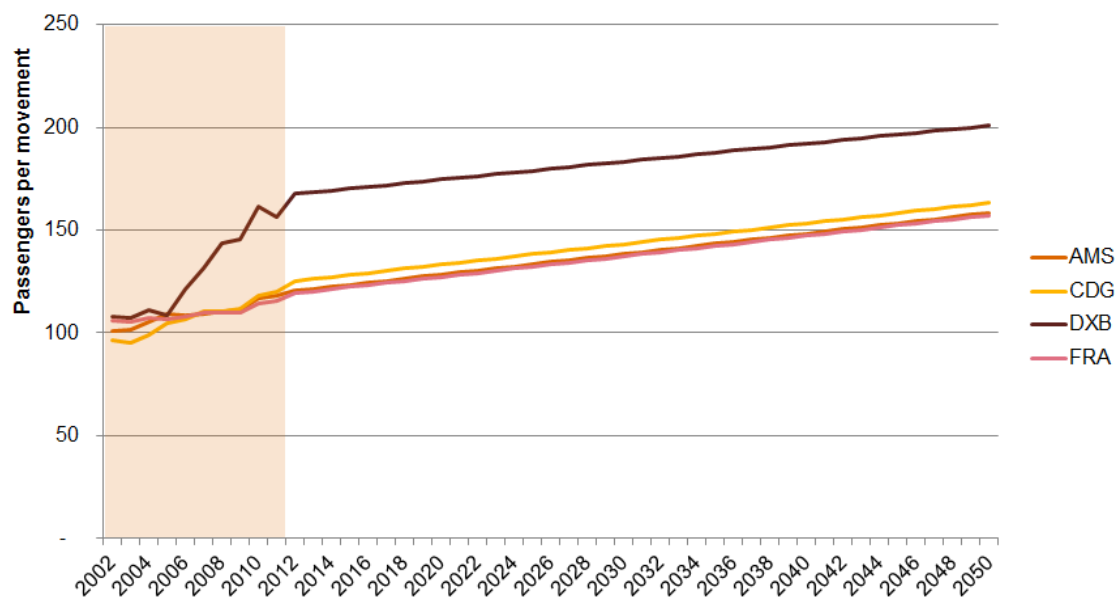
Aircraft Movement Projections

Aircraft movement forecasts were not readily available for the four hub airports; therefore, we have made high level assumptions on the average passengers per movement which implicitly incorporate up-gauging and load factor assumptions. Figures 52 and 53 summarise the passenger per aircraft movement assumptions applied to calculate aircraft movements based on the passenger projections above.

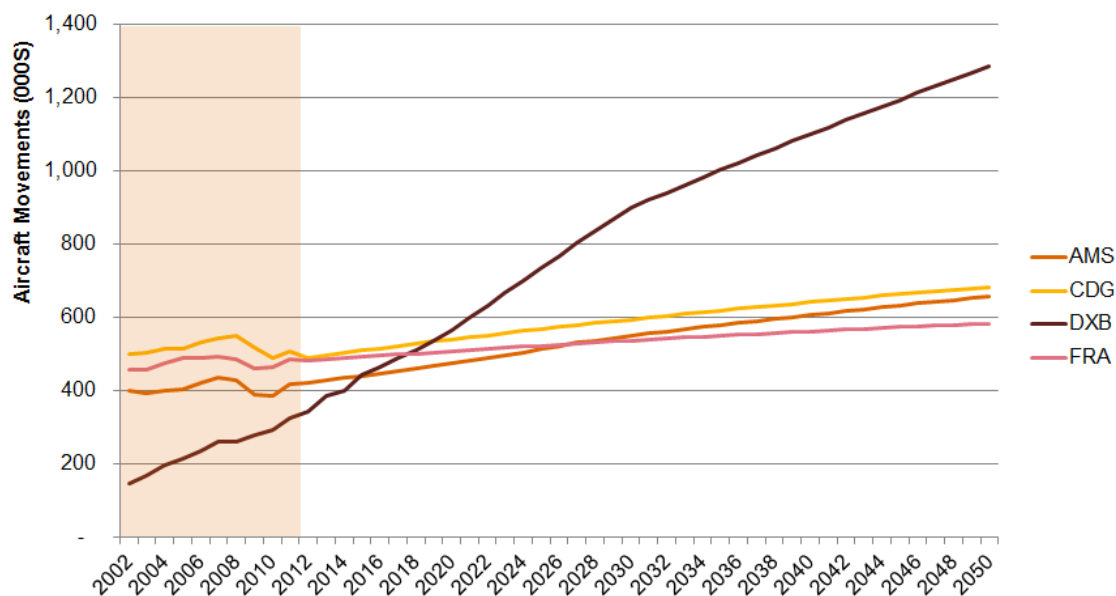
Figure 52: Average annual increase in passengers per movement

Airport	2002-2012	2012-2030	2030-2050
AMS	1.9	1.0	1.0
CDG	2.9	1.0	1.0
DXB	4.5	0.5	0.5
FRA	1.4	1.0	1.0

Source: Schiphol Group, Dubai Airports, Fraport, Aeroports de Paris, PwC analysis

Figure 53: Average annual increase in passengers per movement

Source: Schiphol Group, Dubai Airports, Fraport, Aeroports de Paris, PwC analysis

Figure 54: Aircraft movement projections

Source: Schiphol Group, Dubai Airports, Fraport, Aeroports de Paris, PwC analysis

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- ⁱ Department for Transport
 - ⁱⁱ Schiphol
 - ⁱⁱⁱ Aeroports de Paris
 - ^{iv} Dubai Airport
 - ^v Fraport
 - ^{vi} Department for Transport
 - ^{vii} Schiphol
 - ^{viii} Aeroports de Paris
 - ^{ix} Estimate based on potential increase to runway capacity from revised ATC procedures
 - ^x Fraport

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