

Continued exponential growth should see annual industry passenger numbers almost double by 2036. Charles Williams examines the various challenges the industry will face.

The challenges presented by continual growth

The air transport industry has always grown at an annual rate equal to a factor of 2.0 times the annual increase in global gross domestic product (GDP). That is, an annual growth in GDP of 2% results in annual air traffic growth of about 4%.

This general rule applies to the overall market. The multiplication factor is lower in mature markets, but higher rate in young markets. Global economic growth is expected to maintain its historic levels for the next 20 years, so global passenger numbers carried by airlines, and traffic volumes will continue to grow exponentially. Annual passenger numbers grew to one billion over the 41 years from 1946 to 1987, to two billion over the 18 years to 2005, and then to three billion over the seven years to 2012. Four billion passengers per year were surpassed in 2017, so the increase of the last one billion passengers was reached in just five years, a shorter period by two years than the previous increase of one billion.

This continued growth means that airlines and the industry as a whole will start to encounter severe capacity constraints and congestion over the next 10 years. These looming issues will need a holistic, global and industry-wide approach to resolve. Parts of the industry have, however, instead focused separately on achieving lower unit costs for air travel, improving the passenger experience via on-board connectivity, adding to the capability of avionics and aircraft surveillance systems, improving air traffic control technology, and expanding individual airports via government projects.

Air transport is forecast to experience an average annual growth of 3.5-4.5%.

Even at a modest growth rate of 3.5% per year, passenger numbers will increase by 99-140% over the next 20 years. This will equate to at least 7.6 billion and as many as 9.1 billion passengers per year by 2038.

The busiest airports, regions and cities have already been suffering capacity constraints and congestion issues for several decades, and these are only expected to get worse. In addition, an increasing number of airspace zones and regions, and airports will suffer the same issues as passenger numbers and traffic volumes continue to rise exponentially.

Current situation

Insight into the type and scale of capacity constraints and congestion problems can be gained by examining key factors, including: overall size and categorisation of the world airliner fleet; identifying the world's busiest markets and individual routes; examining average aircraft size in these markets and routes; and identifying the world's busiest airports.

Current fleet

The global fleet of mainline jet aircraft with more than 100-seat capacity comprised 20,360 passenger-configured widebodies and narrowbodies at the end of 2016. There were also 4,538 turboprops and 3,531 regional jets (RJ) in passenger service. This takes the total airline passenger fleet to 28,250 aircraft. Including 1,610 freighter aircraft of the same types, the global fleet comprised 29,860 aircraft in operation at the end of 2016.

Three regions account for more than half the widebody and narrowbody fleet:

North America (5,216 aircraft), Europe (4,697), and the Asia-Pacific, including China (6,456). These three regions account for an aggregate 16,369 units.

The four remaining regions are Latin America (1,411), the Middle East (1,249), the Commonwealth of Independent States (CIS) (831), and Africa (640).

The global and regional jetliner fleet can be sub-divided into narrowbodies and widebodies, but the overall size of the fleet and the number in each global region gives some indication of the size of the industry in different parts of the world.

Passengers & traffic

The total number of passengers carried by airlines in 2017 was just in excess of four billion.

Passenger numbers carried to and from airlines domiciled in a country, provided by the International Air Transport Association (IATA), break this total down into separate markets. The largest accounted for about 2.6 billion, 70% of the industry's total passenger numbers in 2017.

Airlines in the US accounted for the most passengers, with 700 million. China is the world's second-largest market, with 550 million passengers.

In addition to China, other main markets serve the Indian sub-continent (130 million), Indonesia (120 million), Japan (166 million) and Thailand (89 million).

The main markets in Europe include the United Kingdom (UK), Germany, Italy, France, Spain and Turkey, with a combined total of 860 million passengers in 2016.

These markets combined accounted for 2.6 billion passengers in 2017. The





Continued exponential growth will see current annual passenger numbers increase from current levels of about 4 billion to 7.6 per year by 2036. This growth will see the number of annual flights increase by at least 50% to about 52 million per annum, and the passenger-configured fleet grow from 28,000 to about 51,000 units.

remaining 1.4 billion passengers were accounted for by markets such as Canada, and smaller countries in Europe, the Asia-Pacific, the Middle East, Latin America and Africa.

Global traffic in 2017 reached 7.164 trillion revenue passenger kilometres (RPKs), provided by a capacity of 8.9 trillion available seat-kilometres (ASKs), and equal to a load factor of 80.4%.

The four billion passengers were carried by 4.98 billion seats, equal to a seat rate load factor of 80.35%, and 34 million flights. The average aircraft size used across the industry was 146 seats. Average aircraft size varied by market, with the Middle East having the largest at 217 seats.

Busiest markets

The world's 20 main air transport markets can be divided into intra-regional or domestic, and inter-regional or long-haul.

The largest intra-regional markets are those of North America, Europe and the Asia-Pacific.

The largest, with 16.9% of total RPKs, is the intra-European market, followed by the intra-Asia-Pacific (11.6%), which includes domestic services in China, Japan and on the Indian sub-continent. The third largest is intra-North-America, which includes the US domestic market (11.2%). There are, therefore, five large intra-regional markets.

If these are regarded individually, then the largest, in terms of total number of flights and available seats on a bi-directional basis provided by all airlines each year on their route networks, is intra-North-America. In 2018 this has an

expected total capacity of 10.48 million flights, 1,167 million seats, and 1,672 billion ASKs (see table, page 6).

The intra-European market is the second-largest, with an annual capacity of 7.7 million flights, 1,133 billion seats, and 1,239 billion ASKs.

The Chinese domestic market has grown to become the third-largest intra-regional market. Annual activity and operational capacity is marked by 4.2 million flights, 683 million seats, and 803 billion ASKs (see table, page 6).

The fourth-largest intra-regional market is intra-Asia-Pacific, which includes routes serving China and India to and from other Asia-Pacific countries. It also includes domestic operations within, and to and from Australasian countries served from other Asia-Pacific states.

Intra-Asia-Pacific operations are accounted for by 1.48 million flights, 241 million seats, and 424 billion ASKs (see table, page 6).

The domestic Indian market is the fifth-largest intra-regional market. Annual capacity is 1.05 million flights, 167 million seats, and 152.6 billion ASKs (see table, page 6).

These five main intra-regional markets account for 24.93 million flights, 3.39 billion seats, and 4.29 trillion ASKs in 2018.

Other intra-regional markets include Latin America, Africa, the Middle East and the CIS. All intra-regional markets collectively account for 40.8% of global RPKs, and a similar share of ASK capacity.

The next seven largest markets are all inter-continental or long-haul. The three largest inter-regional markets are the northern transatlantic (10.5% of global

RPKs), Europe-Asia-Pacific (9.6%), and the trans-Pacific (7.1%).

Over the past 20 years these have been added to by the Europe-Middle East, and the Middle East-Asia-Pacific markets. These two main long-haul markets serving the Middle East have grown quickly, following the success of Emirates, Etihad and Qatar Airways in providing connecting long-haul services via their respective hubs in the Persian Gulf. The Middle East-Asia-Pacific market accounts for 6.6% of total RPKs, while Europe-Middle East accounts for 5.1%.

While the transatlantic has been the longest established and largest long-haul market, other markets have now grown to exceed the transatlantic in terms of number of flights and seats.

The Middle East-Asia-Pacific has become the largest inter-regional market in terms of number of flights and seats provided by all operating airlines on an annual, bi-directional basis. This market hosts a total of 504 million flights and 123.53 million seats per year. Annual capacity is 528 billion ASKs in 2018 (see table, page 6).

Europe-Asia-Pacific is the second-largest market with a total annual capacity of 497 million flights, 112 million seats and 695.2 billion ASKs (see table, page 6).

The Europe-Middle East is now the third-largest market. Annual size of operations and capacity is 417 million flights, 99.7 million seats, and 367.6 billion ASKs (see table, page 6).

The transatlantic has become the fourth-largest inter-regional market with 404 million flights, 111.65 million seats, and 768 billion ASKs annually (see table, page 6).

SUMMARY OF CURRENT AND PROJECTED 20-YEAR CAPACITY STATISTICS

MARKET REGION	NO. OF FLIGHTS ('000s)	NO. OF SEATS (million)	AVG NO. OF SEAT	AVG KM	TOTAL ASKs (billions)	GROWTH FACTOR	PROJECTED ASKs (millions)	No. of	No. of	AVG SEAT SIZE WITH +50% - '000s
								FLIGHTS WITH EQUAL SEAT SIZE - '000s	FLIGHTS WITH +50% SEAT SIZE - '000s	
Intra-Europe	7,718	1,133	147	1,093	1,239	1.6	1,982	12,350	8,233	220
Intra-Asia	1,476	241	163	1,759	424	3.7	1,569	5,463	3,642	245
Intra-China	4,213	683	162	1,177	804	3.6	2,893	15,170	10,113	243
Intra-India	1,048	167	160	912	153	5.4	824	5,661	3,774	239
Intra-N.America	10,476	1,167	111	1,433	1,672	1.5	2,508	15,714	10,476	167
Other intra-continental markets										
Transatlantic	404	112	276	6,879	768	1.8	1,383	727	485	414
Europe-Asia	497	112	226	6,197	695	1.7	1,161	830	553	338
Trans-Pacific	219	60	276	9,657	586	1.8	1,077	404	269	415
Middle East-Asia	504	124	245	4,278	528	3.4	1,797	1,715	1,143	367
Europe-Middle East	417	100	239	3,688	368	2.5	919	1,042	695	359
Other inter-continental markets										
Industry total	34,000	4,980	146		8,900		20,500	78,300	51,943	220

The trans-Pacific market is smaller than other long-haul and inter-regional markets. It features an annual operation of 219 million flights, 60.6 million seats and 585.5 billion ASKs (see table, this page).

These five markets account for an annual total of 2.04 million flights, 507.7 million seats and 2.94 trillion ASKs.

Other inter-regional or long-haul markets include the southern transatlantic, Africa-Europe, and North America-Latin America. All inter-continental markets account for 59.2% of all RPKs.

Busiest routes

The intra-regional markets account for some of the world's busiest routes and airport-pairs. The top 10 busiest routes in each of the world's major markets are listed (see table, page 10). The intra-regional markets have busier routes than inter-continental markets. The busiest routes are those with the highest amount of capacity, calculated by number of annual flights and seats.

The intra-regional market that has by far the busiest routes is the intra-Asia-Pacific. The world's busiest route is South Korean domestic airport-pair Jeju-Seoul Gimpo. In uni-directional terms this has 42,000 flights and 8.49 million seats per year, equal to an average of 115 flights and 23,000 seats per day. Average aircraft size is 202 seats (see table, page 10).

The other nine intra-Asia-Pacific routes in the top 10 for the region are Sapporo-Tokyo Haneda, Fukuoka-Tokyo Haneda, Melbourne-Sydney, Hanoi-Ho Chi Minh, Mumbai-Delhi, Hong Kong-Taipei,

Beijing-Shanghai, Okinawa-Tokyo Haneda, and Osaka-Tokyo Haneda (see table, page 10). The amount of seat capacity on these 10 busiest routes is more than the busiest and highest capacity airport-pairs in all other intra-regional and intercontinental markets. Average aircraft size of these routes is 185-341. In many cases average aircraft size is perhaps surprisingly low, given the very high frequency of services on each route. Many Japanese domestic routes are now operated by medium-sized widebodies and narrowbodies, rather than 747s in high-density cabin configurations as in the past.

Perhaps surprisingly, the intra-Latin American market hosts the second-busiest routes when gauged in terms of annual seat numbers (see table, page 10). The route from Sao Paulo, Congonhas (CGH) to Rio de Janeiro, Santos Dumont features 20,000 flights and 3.02 million seats per year on a one-way basis. This is equal to a daily average of 55 flights and 8,270 seats each way. Average aircraft size per flight is 151 seats.

The intra-North American market has some routes with high levels of capacity. The busiest is the Mexican domestic service between Cancun and Mexico City, which has 15,390 flights and 2.65 million seats each way per year, equal to an average of 42 flights and 7,250 seats each way per day (see table, page 10). The busiest US domestic routes are Los Angeles (LAX) - San Francisco, New York La Guardia-Chicago O'Hare, Las Vegas-Los Angeles, and Atlanta-Orlando.

The highest-density intra-European routes are domestic routes in Turkey,

Germany, Spain and France. The busiest route is Turkish domestic airport-pair Izmir-Istanbul Ataturk, with 9,000 flights and 1.74 million seats per year in each direction, equal to a daily average of 25 flights and 4,787 seats. Average aircraft size is 193 seats.

Examining the busiest and highest capacity routes, and the number of flights and amount of capacity deployed on them gives insight into airline capacity planning, and into the congestion and capacity constraints these markets are likely to face.

Busiest airports

Airport congestion is a significant issue affecting current and future capacity constraints. Aircraft capacity or size of operation can be gauged partially by assessing annual passenger numbers.

The world's largest airports by passenger numbers are listed (see table, page 8). One indication of size is an annual throughput of at least 20 million enplaned passengers. Airport passenger numbers are quoted by Airports Council International (ACI) as both enplaned (departing) and deplaned (arriving) passengers. While this illustrates each airport's annual passenger throughput, it effectively counts each passenger that has flown twice, because a passenger departing at one airport is counted for a second time at the arrival airport. To reconcile passenger numbers quoted by IATA with the size of the industry, the number quoted by ACI for each airport is halved, and shown only as enplaned passengers (see table, page 8).

By this standard, most of the airports

WORLD'S BUSIEST AIRPORTS - ANNUAL PASSENGER ACTIVITY

Airport	Airport code	Country	Annual enplaned passengers '000s
North America			
Atlanta Hartsfield	ATL	USA	51,952
Los Angeles	LAX	USA	42,279
Chicago	ORD	USA	39,914
Dallas Fort Worth	DFW	USA	33,546
Denver	DEN	USA	30,690
New York JFK	JFK	USA	29,673
San Francisco	SFO	USA	27,917
Las Vegas	LAS	USA	24,250
Toronto	YYZ	Canada	23,565
Seattle	SEA	USA	23,467
Charlotte	CLT	USA	22,955
Mexico City	MEX	Mexico	22,366
Orlando	MCO	USA	22,306
Miami	MIA	USA	22,036
Phoenix	PHX	USA	21,961
New York Newark	EWR	USA	21,697
Houston	IAH	USA	20,348
Europe			
London Heathrow	LHR	UK	38,994
Paris CDG	CDG	France	34,736
Amsterdam	AMS	Netherlands	34,200
Frankfurt	FRA	Germany	32,250
Istanbul	IST	Turkey	31,864
Madrid	MAD	Spain	26,702
Barcelona	BCN	Spain	23,643
London Gatwick	LGW	UK	22,781
Munich	MUC	Germany	22,298
Rome	FCO	Italy	20,486
China			
Beijing	PEK	China	47,893
Shanghai	PVG	China	35,001
Guangzhou	CAN	China	32,904
Chengdu	CTU	China	24,901
Shenzhen	SZX	China	22,806
Kunming	KMG	China	22,364
Shanghai Sha	SHA	China	20,942
Xian	XIY	China	20,929
Asia			
Tokyo Haneda	HND	Japan	42,632
Hong Kong	HKG	Hong Kong	36,434
Delhi	DEL	India	31,726
Jakarta	CGK	Indonesia	31,508
Singapore	SIN	Singapore	31,110
Seoul	ICN	South Korea	31,041
Bangkok	BKK	Thailand	29,540
Kuala Lumpur	KUL	Malaysia	29,259
Mumbai	BOM	India	23,602
Taipei	TPE	Taiwan	22,440
Sydney	SYD	Australia	21,662
Manila	MNL	Philippines	21,000
Tokyo Narita	NRT	Japan	20,344
Middle East			
Dubai	DXB	UAE	44,121

with this level of throughput or higher are based in the US, Europe, China and the Asia-Pacific. There are 50 airports in these four regions with annual throughputs of 20 million or more enplaned passengers.

More than 17 US airports had annual throughputs of 20 million passengers or more during 2016. The largest in the US, and in the world, is Atlanta Hartsfield at 51.95 million passengers. Beijing International and Tokyo Haneda had the second- and third-highest annual passenger numbers in 2016.

The top airports in the US are LAX, Chicago, Dallas Fort Worth, Denver, New York JFK and others (*see table this page*).

The largest European airport is London Heathrow, featuring annual throughput of 39 million passengers (*see table, this page*). Other top European airports include Paris Charles de Gaulle (CDG), Amsterdam, Frankfurt, Istanbul Ataturk, and Madrid.

Beijing International airport had throughput of 47.9 million passengers in 2016, and other large Chinese airports included Shanghai Pudong, Guangzhou, Chengdu, Shenzhen and Xi'an.

Tokyo Haneda saw 42.6 million passengers in 2016, followed by Hong Kong, Delhi, Jakarta, Singapore, Seoul Incheon and Bangkok (*see table, this page*).

Industry growth

The general forecast for the air transport market is for an annual compound average growth rate (CAGR) of 3.6% over the next 20 years. At this growth rate, the total number of enplaned passengers on commercial aircraft will reach almost eight billion by 2036. The industry will therefore double in size over the next 20 years.

In addition to passenger numbers, the industry has to consider traffic growth in terms of RPKs. This is a product of passenger numbers and journey length.

The total number of RPKs is expected to reach about 16.5 trillion by 2036, an increase by a factor of 2.36 since 2016. This is equal to a CAGR of 4.5% over the 20-year period, which indicates that average route length is expected to grow.

The issue of capacity growth also has to be considered. A proportionate increase in capacity will be equal to about 11 million seats and 20.5 trillion ASKs being provided (*see table, page 6*). The increase in ASKs will only be proportional to passenger numbers if passenger load factors and average route length remain the same. This is unlikely.

The projected rate of continued growth will assume there are no physical constraints to increasingly larger passenger numbers and airline operations, including issues relating to congestion. Increasing numbers of passengers can be absorbed in several ways. More capacity will clearly have to be provided in the form of

WORLD'S BUSIEST AIRPORT-PAIRS - UNI-DIRECTIONAL CAPACITY

Route	Annual Flights	Annual seats	Average flights per day	Average seats per flight
Intra-Asia Pacific				
Jeju-Seoul Gimpo	42,066	8,494,511	115	202
Sapporo-Tokyo Haneda	23,466	7,116,038	64	303
Fukuoka-Tokyo Haneda	22,643	5,995,432	62	265
Melbourne-Sydney	29,235	5,464,526	80	187
Hanoi-Ho Chi Minh	22,150	4,574,735	61	207
Mumbai-Delhi	23,994	4,431,381	66	185
Hong Kong-Taipei	14,720	4,057,584	40	276
Beijing-Shanghai Hongqiao	15,156	4,011,461	42	265
Intra-Latin America				
Sao Paulo Congonhas-Rio de Janeiro Santos Dumont	20,073	3,023,016	55	151
Bogota-Medellin	16,182	2,525,336	44	156
Intra-North America				
Cancun-Mexico City	15,389	2,646,813	42	172
Los Angeles-San Francisco	19,621	2,538,681	54	129
Mexico City-Monterrey	13,239	2,074,988	36	157
New York JFK-Los Angeles	13,103	1,997,851	36	152
Guadalajara-Mexico City	12,948	1,989,177	35	154
New York La Guardia-Chicago	15,276	1,951,161	42	128
Las Vegas-Los Angeles	12,705	1,796,714	35	141
Vancouver-Toronto	8,734	1,780,104	24	204
Atlanta-Orlando	9,181	1,684,432	25	183
Los Angeles-Chicago	8,605	1,568,300	24	182
Intra-Europe				
Izmir-Istanbul Ataturk	9,051	1,747,363	25	193
Frankfurt-Berlin Tegel	8,672	1,664,493	24	192
Paris Orly-Toulouse	8,898	1,586,436	24	178
Barcelona-Madrid	8,133	1,525,265	22	188
Munich-Berlin Tegel	8,290	1,480,745	23	179
Oslo-Trondheim	8,549	1,452,621	24	168
Bergen-Oslo	8,357	1,418,671	23	170
Ankara-Istanbul Ataturk	7,548	1,407,907	21	187

additional ASKs, but the increase in ASKs will not necessarily have to be in proportion with RPKs. Airline load factors have increased over the past 20 years or so, and in 2017 stood at a global average of 80.4%. This increase in load factor has meant a more efficient supply of ASKs/ASMs in relation to increased passenger numbers. Further increases in load factor are possible, but are unlikely to be more than a few percentage points as airlines reach limitations in relation to passenger spill.

Passenger numbers are forecast to increase by a smaller factor of 2.09, indicating that average route length will grow over the period. This simple increase will be due to the opening of more long-haul routes over the 20-year period. Forecasts are for the overall share of total global traffic that is accounted for by domestic or inter-continental or long-haul passenger traffic to increase from 40% in the 2016-2017 period to 49% by 2040.

Intercontinental markets with the highest forecast growth rates are the

Middle East-Asia Pacific (6.4%), Middle East-Europe (4.6%) and Europe-Asia Pacific markets (4.5%) (see table, page 6). The mature northern transatlantic and trans-Pacific markets are forecast to have CAGRs of 2.9% and 3.7%.

Other intercontinental, long-haul markets include the two mature Australasia-Asia and North America-Australasia markets that are forecast to grow at relatively low rates of 2.7-2.9% per year. The remainder are young markets, and are expected to grow at higher annual rates of 4.3-6.2%.

The growth in ASKs over the next 18-20 years to accommodate this increase in traffic will be closely proportionate to the increase in RPKs. The probable ASKs required in each of the main markets are listed (see table, page 6).

These are basic projections, but the volume of ASKs is expected to increase by a factor of 5.4 for the intra-Indian sub-continent market. ASKs in the intra-China and intra-Asia-Pacific markets are expected to increase by factors of 3.6-3.7. The more

mature intra-Europe and intra-North American markets are expected to increase by smaller factors of 1.5-1.6. Total ASKs to serve these five markets should increase from 4.29 trillion in 2018 to 9.8 trillion in 2036-2038.

Inter-regional and inter-continental markets are forecast to increase by factors of 1.7-1.8 for the three large traditional intercontinental markets: the transatlantic, Europe-Asia Pacific, and trans-Pacific. The Middle East-Asia Pacific and Middle East-Europe markets are expected to increase by factors of 3.4 and 2.5 (see table, page 6). Overall, ASK capacity to serve these five main markets is forecast to increase from 2.94 trillion ASKs in 2018 to 6.35 trillion ASKs in 2038-2040.

Accommodating growth

The main issue in respect of industry growth is how this increase in traffic will be absorbed. As well as providing more seats and ASKs in their operating schedules, airlines have other options for adding capacity.

Airlines' primary strategy for growing capacity on a route is to increase frequencies to a level that optimises the stimulation of passenger traffic, particularly for premium fares. There are physical constraints, however, that limit service frequencies on a route. Frequencies can be up to 10-12 flights per day on many short-haul routes, but are 50-80 on the world's busiest routes, especially where there are no, or only one or two, time zone changes.

Service frequencies will be limited at two to four daily services on the longest intercontinental routes because of multiple limitations: a large number of time zone changes; airport curfews; flight lengths of these operations; and need for attractive departure and arrival times. These not only limit the number of daily services, but also the departure time of these multiple services to a period of a few hours in some cases. For example, the departure times of flights operated by the same airline on routes from London to Hong Kong or Singapore will be in close proximity.

Airlines prefer to reach optimum service frequencies on routes they serve, and will increase capacity first by adding flights. This will often result initially in a reduction in aircraft size on some existing services to avoid adding excessive capacity.

There are other practical and physical issues that limit the number of frequencies being provided on a route. Problems of airspace and airport congestion will become more pronounced as growth continues over the coming years. Many airlines have already reached optimised service frequencies on some routes.

Once frequencies have become optimised, saturated or reached physical limit, airlines will increase aircraft size as a



secondary way of adding capacity. Many airlines, for example, have downsized from the 747 or other large widebodies to the smaller A330, 777-200, 787, and A350 over the past 20 years. As a wider choice of smaller widebodies with long-range and ultra long-range performance has become available, many airlines have adopted at least two daily services on long-haul routes in markets such as Europe-Asia Pacific and the trans-Pacific.

While large or dominant carriers in these two markets have been optimising capacity with new-generation widebodies over the past 15-25 years, continued growth has led to some routes being upgauged in aircraft size. This has come as most 747s are phased out of passenger service. The A380 and 777-300ER have been used to absorb continued growth.

In addition to adjusting capacity on established routes to changing traffic volumes, an airline must consider the effect of new routes and new capacity being provided by competitors on existing routes. Typically this draws traffic away, which clearly affects an airline's capacity-planning strategy.

The opening of new routes has been steady and gradual in short-haul markets. The issue is different in intercontinental markets, and is often related to bilateral air agreements that limit the pace at which new routes are opened. While there has been an increasing degree of liberalisation in intercontinental markets, new routes in the main long-haul markets have been opened at a more limited rate.

The northern transatlantic is a clear example of a steady number of new routes being opened. This has resulted in a decrease in the average aircraft size in this market, and the 767-300ER was the most

popular type in the market in the early 1990s. While more routes have continued to be opened, traffic growth has outpaced the associated change in capacity, and average aircraft size is now 276 seats.

The Europe-Asia-Pacific market is a particular case where new entrants and additional routes have drawn traffic away from established airport-pairs. Emirates, Etihad and Qatar Airways have all established long-haul interlining operations at hubs in the Persian Gulf. Most of the activity has involved interlining services at competitive rates between Europe and the Asia-Pacific, transiting via the Middle East. This has drawn traffic away from direct services offered by established airlines in the Europe-Asia-Pacific market, and stimulated new levels of demand (*see The perpetual growth of Middle East airlines, Aircraft Commerce, August/September 2011, page 12*). This in turn has limited the size of aircraft needed by European and Asia-Pacific airlines operating these routes; led to high rates of traffic growth on inter-continental services to and from the Middle East; and led to many large and ultra-large aircraft being operated by these three airlines and others in the same markets. High traffic growth rates for this market are forecast to continue.

Capacity-planning

There are clearly several established factors that will influence airlines' fleet- and capacity-planning over the next 20 years. Airport and airspace capacity limits will also play a greater role in determining appropriate aircraft size in the future. Airports with limited remaining and available take-off and landing slots will force many airlines to increase aircraft size,

Just of the challenges continual growth poses to the industry is airport aircraft movement and passenger handling capacity. The number of flights operated by the industry will increase by at least 50% to 52 million per year.

even if this does not meet fleet-planning requirements. Frequency and route saturation is more likely to have been reached on many routes in the established intra-European markets, while passenger numbers at many of the hub airports in the US, Europe, China and Asia-Pacific are already at saturation limits. An increase in average aircraft size in these markets, therefore, is likely. The intra-North America market has the smallest average aircraft size of the nine main markets at 111 seats, but also the largest number of flights at 10.48 million (*see table, page 6*).

Average route length will either remain unchanged or change only slightly as new routes are opened. The only way that overall seat capacity can be increased is by increasing the number of flights, increasing average aircraft size, or a combination of the two. The latter will clearly occur in those markets where airspace and airport congestion are becoming almost ubiquitous. More flights will be added as frequencies on existing routes and new airport-pairs are opened. Larger aircraft will be deployed on many routes where traffic growth has continued, while service frequencies have already reached their limit or will do so over the next 20 years.

The overall effects of two simple scenarios on average aircraft size can be examined: with the first, the number of flights in each market increases while average aircraft size does not change over a 20-year forecast period; the second models the total number of flights needed in each market if the average aircraft size increases by 50% over the next years. These are summarised (*see table, page 6*).

Where average aircraft size does not change, the number of flights has to increase in proportion to growth in ASKs. Total ASKs will reach about 20.5 trillion. If average aircraft size remains the same, the number of flights has to increase to 78.3 million (*see table, page 6*). This is equal to the number of flights increasing by 130%.

Where average aircraft size increases by 50%, average seat sizes on all intra-regional markets increase from 167 to 245 (*see table, page 6*). In this case, 51.9 million flights per year will be required; a 53% increase in number of operations by airlines.

The number of flights under this scenario still has to increase by a factor of 2.40-3.60 in the three Asia-Pacific markets that are forecast to experience the highest rates of traffic growth over the next 20 years. This is the case where average

aircraft size in these three markets increases by 50% to 240-245 seats. This suggests that small- and medium-sized widebodies would dominate over narrowbodies.

Given that such a large increase in number of flights may not be possible due to airspace and capacity constraints, average aircraft size may have to increase further. This would be a repeat of fleet-planning strategies followed by many airlines in these markets in the 1980s.

A 50% increase in average aircraft size in the intra-European and intra-North American markets would mean little or no change in the number of flights. Given that the number of flights could probably increase as a result of planned, new ATC technologies and systems, average aircraft size would not have to increase by 50%.

Intercontinental markets have fewer overall flights than intra-regional markets. Nevertheless, service frequencies are already high and optimised on many routes. Moreover, major airports have already reached saturation levels in terms of number of flight movements. Increasing average aircraft size by 50% is, therefore, still a likely outcome. This would take average aircraft size back up to 340-415 seats, levels that were previously seen in the 1970s and 1980s before traffic on some routes was fragmented with the opening of new airport-pairs. In this case there would also be a 15-65% increase in the number

of flights in most markets, and a more than doubling of flights in the Middle East-Asia-Pacific market (see table, page 6).

Fleet forecast

Various aerospace manufacturers have made market forecasts on how this growth in demand will affect capacity. In Summary, the global commercial aircraft fleet will grow from 28,000 passenger-configured aircraft to 51,000 units.

The forecast indicates small increases in the turboprop and RJ fleets of 21% and 17%. This is perhaps surprising, since continuous traffic in most intra-regional markets has stimulated route development, including from a large number of secondary airports.

The forecast increase in narrowbody aircraft is by 113% to 31,892 units, while the increase in the widebody fleet is forecast to be 84% to 9,907 units. This relatively large increase in narrowbodies suggests that airport and airspace congestion are forecast to cause few issues in allowing a near-doubling of the number of flights and services.

The large increase in narrowbodies and a small increase in turboprops and RJs clearly indicates that many routes and services are expected to migrate from regional to mainline jet services. Average aircraft size is, therefore, expected to

increase in intra-regional markets.

The less than doubling of widebodies indicates that some predict the number of airline operations and services to grow at least in proportion or even at a slower rate than overall traffic volumes.

Summary

Even with the issues of airspace and airport capacity constraints, the projected growth over the next 18-20 years will present some enormous challenges for the industry. The minimal increase of 50% in the number of aircraft operations will put large pressure on airports, both in terms of passenger numbers and aircraft movements; and airspace. The former is likely to be the bigger challenge.

A further issue is the increased emissions of carbon dioxide (CO₂) and nitrous oxide that will accompany a larger fleet, and more flights and operations. Despite gains in fuel efficiency and savings made through reduced congestion, if achieved, the industry still does not have an economically acceptable solution to finding a fuel that has lower net CO₂ emissions than Jet A-1. **AC**

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