The Europe-Asia Pacific market is constrained by airport congestion and practical scheduling problems. This limits the possibility for high frequencies. High traffic growth and consolidation-style strategies among the market incumbents mean aircraft sizes will have to increase.

Europe-Asia market set for larger aircraft

The Europe-Asia Pacific long-haul market is dominated by 10-12 major European and Asia Pacific flag carriers. Like the trans-Pacific, the Europe-Asia Pacific market is immature in terms of the number of city-pairs that are operated and the number of airlines that fly them. It also enjoys some of the highest traffic growth rates in the world.

Europe-Asia could be a major market for the largest widebodies, including the 747X and A3XX. Will the market fragment in the way Boeing predicts and create opportunities for more routes and new entrants, or will it consolidate to protect the major incumbents and provide a market for the largest aircraft?

Europe-Asia market

The Europe-Asia Pacific market is regulated by restrictive bilaterals that protect a major airline from each country. The market also experiences severe congestion at Asia Pacific airports. These combine to make it unlikely that the market will liberalise to the same degree as the transatlantic has done.

There are 85 city-pairs with non-stop flights *(see tables, pages 11 & 12)*. From Europe, these routes are dominated by operations from Amsterdam, Paris, Frankfurt and London. A large number of routes are also flown from Vienna, Rome and Zurich.

The European airlines that dominate these routes are the respective flag carriers that operate from these cities: British Airways (BA), Air France, Lufthansa and KLM.

Similarly, the largest Asia Pacific cities dominate these routes: Singapore, Bangkok, Tokyo, Hong Kong and Kuala Lumpur. Unlike Europe, Asia Pacific countries do not have more secondary cities that could serve international routes.

Japan Airlines (JAL), Singapore Airlines (SIA), Cathay Pacific, Malaysian and Thai are the major Asia Pacific carriers. Qantas also operates several non-stop routes, and these are the direct segments of fifth freedom routes between Europe and Australia.

Thirteen routes originate from Bangkok, the largest number to operate between the Asia Pacific region and Europe. Tokyo is the second largest city to serve Europe with 10 routes, followed by Singapore and Kuala Lumpur and Hong Kong.

Lufthansa has the largest share of available seat-mile (ASM) capacity of all routes with 9.9%, followed by JAL with 9.4%. The next largest European airlines are BA, Air France and KLM. These all operate routes, most with a minimum of a daily frequency, and many with two daily flights.

These airlines all use large aircraft types, mainly the 747 but also the 777 and A340.

Austrian Airlines and Swissair operate a similar number of routes, but with smaller types (the A340-300 and MD-11), and with weekly frequencies of only 2-4 flights.

SIA, JAL, Thai, Malaysian and Cathay Pacific operate in a similar way to the major European carriers, which is explained by the reciprocal nature of the bilateral agreements between the European and Asia Pacific countries.

The introduction of the A340 and 777 has allowed airlines to open new routes or increase frequencies to daily services on city-pairs with weaker traffic volumes.

All routes have an average aircraft size of more than 250 seats, and most have more than 300 seats *(see tables, pages 11 & 12)*. Most routes from the four major European cities have frequencies of two daily flights, while the dominant city-pairs have three or four daily flights. This includes most routes from London; Paris-Tokyo; Amsterdam-Singapore; Paris-Singapore; and routes from Frankfurt to Bangkok, Hong Kong, Tokyo and Singapore.

The domination of the Europe-Asia market by major cities and low frequencies on routes is a reflection of the market using trunk routes to connect traffic from intra-European and intra-Asian routes. KLM, for example, has codeshare agreements with Malaysian, Japan Air System (JAS) and Garuda. Similarly, KLM offers Malaysian codeshare connections on 10 routes to Scandinavia.

European airlines such as SAS, Iberia and Sabena are virtually absent in this market. The same applies to EVA Air, Korean and Philippine Airlines. Others like Alitalia and Garuda have a limited presence on just two or three routes each.

Market development

Traffic growth rates in this market average 6.3% per year. The exponential nature of traffic growth means total revenue passenger miles (RPMs) will increase by 84% in 10 years and by 340% in 20 years.

This growth will be accommodated by a slight increase in aircraft load factor, but total ASMs across the whole network will probably have to rise by 76% in the next 10 years.

There are three ways this could occur. The first will be through increased frequency on current routes. The second is by using larger aircraft. Frequencies on many routes are low, with only one or two daily flights in most cases. Increased frequency is something most airlines are likely to look at first, considering current schedules and that it will be another six years before aircraft larger than the 747 become available. The third is by new routes being opened. It is virtually certain

that incumbent airlines will not reduce frequencies, but new airlines entering the market and new routes would draw traffic from current routes. This could then influence aircraft size, with capacity changing across the network.

Frequencies

Frequencies on a route are unlikely to increase if there are already three or four daily flights. This is because of scheduling difficulties associated with flight times, time zone differences, airport curfews and attractive departure and arrival times. In this case, larger aircraft would have to absorb all traffic growth. Average aircraft size would probably have to increase in proportion with traffic; that is, by 76%.

Frequencies are, however, likely to increase to at least three flights a day where this level of service does not already exist. Examples are Amsterdam-Hong Kong, Amsterdam-Tokyo, Paris-Seoul, Frankfurt-Kuala Lumpur and London-Beijing.

This means a frequency increase in the range of 40-60% in many cases. A small increase in frequency might be possible or be required on heavier routes with between two and three daily flights, such as Amsterdam-Bangkok, Amsterdam-Singapore and Paris-Singapore. These will then require a smaller increase of 25-30%.

While total flight numbers and average aircraft sizes of all carriers on each route provide an indication of how development might progress, detailed examination of the capacity provided by each airline will also indicate what could happen over the next decade.

Paris-Singapore, for example, is operated by Air France, Qantas and SIA. Air France and SIA have a daily flight, but Air France uses a 777 while SIA deploys a 747-400. Traffic growth could therefore initially be absorbed by Air France using larger aircraft, while SIA has to maintain capacity.

The effects of global alliances will see partners cooperate where possible. For example, Lufthansa and SIA, both in the Star Alliance, between them have three daily flights between Frankfurt and Singapore. They could add capacity through larger aircraft, and avoid adding unnecessary flights.

Lufthansa still views frequencies on its network as a priority and would like to increase them with traffic growth. "Higher frequencies with existing aircraft on routes will prevail," says Karsten Benz, vice president network planning at Lufthansa. "We serve many of our business markets only once a day, and can have a much higher frequency".

Other carriers take a different view. Air France serves a similar number of destinations as Lufthansa and almost at the same level of frequency. "We do not

EUROPE-ASIA PACIFIC NON-STOP CITY-PAIR CAPACITY, FREQUENCY, AIRCRAFT SIZE & FUTURE AIRCRAFT SIZE AFTER 10 YEARS' GROWTH

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with five daily frequencies	Aircraft size with six daily frequencies
LHR-SIN	2,364	5,490	396	903	752
LHR-NRT	1,968	3,968	390	740	617
LHR-HKG	1,860	3,560	368	660	550
LHR-BKK	1,584	3,106	380	581	484
CDG-NRT	1,464	3,230	421	595	496

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with four daily frequencies	Aircraft size with five daily frequencies
FRA-NRT	1,392	2,805	399	670	536
FRA-SIN	1,368	2,857	377	622	497
FRA-BKK	1,212	2,224	379	554	443
AMS-SIN	1,080	2,119	346	451	361
LHR-KUL	1,068	2,168	356	458	367

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with three daily frequencies	Aircraft size with four daily frequencies
AMS-BKK	912	326	326	478	358
FRA-HKG	900	1,625	365	528	396
CDG-SIN	852	1,673	339	465	349

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with two daily frequencies	Aircraft size with three daily frequencies
CDG-HKG	744	1,305	339	608	405
CDG-BKK	744	1,253	331	594	396
ZRH-BKK	744	966	267	478	319
AMS-NRT	696	1,454	416	698	465
FRA-SEL	696	1,043	324	545	363
LHR-KIX	612	1,360	432	638	425
AMS-HKG	588	971	330	468	312
AMS-KUL	588	906	280	397	265
CDG-PEK	588	710	273	388	258
FRA-PEK	576	925	382	531	354
CPH-BKK	576	818	306	425	283

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with 12 weekly frequencies	Aircraft size with 14 weekly frequencies
CDG-SEL	540	808	310	473	404
MXP-NRT	540	1,265	445	679	580
ZRH-SIN	528	1,027	350	522	446
CDG-KIX	528	898	328	488	417
ZRH-HKG	504	628	248	353	302
FCO-BKK	480	936	408	553	473
ZRH-NRT	480	671	270	366	313
FRA-KIX	468	884	378	500	427
FRA-PVG	432	747	362	441	377
VIE-KUL	420	665	312	370	316
AMS-KIX	372	626	338	354	303
AMS-SEL	372	537	312	328	280
VIE-BKK	372	473	279	293	250
LHR-PEK	372	453	276	290	248
CPH-NRT	372	439	251	264	225

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with nine weekly frequencies	Aircraft size with 10 weekly frequencies
ZRH-KIX	348	441	248	325	292
CPH-PEK	324	316	251	306	275
MXP-BKK	276	517	383	398	358
ATH-BKK	276	401	340	353	318
FRA-KUL	264	548	386	383	345
LHR-SEL	264	486	384	381	343
MUC-BKK	264	351	281	279	251
AMS-PEK	264	338	303	301	271
FRA-MNL	252	542	387	367	330

Source: OAG via BACK Aviation Solutions

EUROPE-ASIA PACIFIC NON-STOP CITY-PAIR CAPACITY, FREQUENCY, AIRCRAFT SIZE & FUTURE AIRCRAFT SIZE AFTER 10 YEARS GROWTH

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with seven weekly frequencies	Aircraft size with eight weekly frequencies
VIE-KIX	252	332	271	330	289
ZRH-PEK	252	269	248	302	265
CDG-PVG	228	316	277	305	267

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with five weekly frequencies	Aircraft size with six weekly frequencies
ATH-SIN	228	295	265	409	341
HEL-BKK	216	331	360	527	439
CPH-SIN	216	308	265	388	323
ZRH-KUL	204	306	278	384	320
BRU-NRT	204	304	292	403	336
FCO-HKG	204	255	249	344	287
MAN-KUL	168	372	386	439	366
CDG-KUL	168	364	386	439	366
ARN-BKK	168	304	405	461	384
VIE-NRT	168	273	330	375	312
MXP-KIX	156	324	400	423	352
FCO-KUL	156	228	278	294	245
MXP-HKG	156	225	285	301	251
FCO-SIN	156	224	265	280	233
FCO-PEK	156	197	287	303	253
MXP-PEK	156	193	283	299	249
HEL-PEK	156	191	360	380	317

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size (seats)	Aircraft size with four weekly frequencies	Aircraft size with five weekly frequencies
VIE-PEK	156	166	265	467	350
CDG-SHA	132	171	260	387	291
LGW-BKK	108	225	405	494	370
FCO-SEL	108	201	384	468	351
AMS-CTS	108	190	377	460	345
LHR-NGO	108	166	300	366	274
HEL-NRT	108	164	360	439	329
AMS-PVG	108	147	283	345	259
BRU-PEK	108	126	271	330	248
MUC-PEK	108	122	271	330	248
MUC-MLE	108	117	265	323	242
ARN-PEK	108	112	287	350	262
VIE-PVG	96	121	276	299	224

Source: OAG via BACK Aviation Solutions

expect a big increase in frequencies on routes served by daily flights," explains Alain Freitel, network planning manager long-haul at Air France. "Competition on Europe to Asia routes is as strong as on transatlantic routes, but there is a big difference in scheduling opportunities. You can schedule up to five daily flights on transatlantic routes without overlap, but you cannot on Europe-Asia routes. Only two flights a day to each destination are reasonable. All carriers depart to Bangkok within the same period, because there is a small window of opportunity for departure and arrival times".

KLM, which also operates to most of its destinations once a day, would like to increase frequencies before increasing aircraft size, but concedes there are limited possibilities because of political and physical constraints. KLM has already effectively increased frequencies to twice a day to Kuala Lumpur through its codeshare agreement with Malaysian. Additional flights over the existing schedule will be harder.

Hong Kong is one example where increasing frequencies will not be a problem. Cathay Pacific took the opportunity to overhaul its schedules when it moved to the new, unconstrained Chep Lap Kok airport. "We now have the ability to offer the best connectivity of any Asia Pacific airline," says Richard Reed, manager of airline planning at Cathay Pacific. "Chep Lap Kok has allowed us to increase frequency, and aircraft size has reduced as we have retired the 747-200/-300 fleet in favour of the 777 and A330. We think there is definitely a case for twice-daily flights on Europe-Asia routes". Cathay operates only one flight a day to most of its European destinations, except for London, which has two daily flights.

New entrants

The Europe-Asia Pacific market is always susceptible to some form of increased competition from new entrants. These have been limited, however. One example is Virgin gaining rights to Hong Kong, Tokyo and Singapore. EVA Air and All Nippon Airways (ANA) have also entered the market to Europe in the past decade.

The threat of increased competition is more likely to be in the form of smaller carriers on the network attempting to increase their presence. Airlines like SAS and Austrian are examples.

The protective nature of the market, congestion and practical scheduling constraints provide barriers to entry. This can be countered by airline strategy. "We are well positioned in the Star Alliance with our partners Thai, SIA and ANA, to stave off threats from new entrants," explains Benz. "The high air traffic control charges over Russian airspace is one example of the economic difficulties of entering the market".

Air France and KLM share the same view. "We are not worried about new entrants coming in, but are actually more concerned about Lufthansa's power and development," comments Freitel. "We are almost certain that slot restrictions will keep competition to a minimum".

KLM adds that the market is not liberalised enough to give existing carriers a problem.

Predictions that few new airlines will enter the market means incumbent carriers will not have to alter their fleet plans because of competitive threats. Market development in terms of frequencies, aircraft sizes and new routes will thus be determined by their own strategies.

New routes

Each of the incumbents will find it easier to make an economic case for opening new routes without the threat of competition.

Few incumbents actually have plans to open new city-pairs. Irrespective of bilateral and physical constraints, most airlines will need to be able to fill aircraft the size of the A340 and start a service at what they regard as a minimum acceptable frequency.

This may be only three or four flights a week. Although it is argued that a minimum daily frequency is required, Finnair, for example, flies only twice a week to Tokyo. Traffic to and from Helsinki is otherwise interlined by

Air France is following the strategy of improving its schedule and having non-stop flights only to the Asia Pacific. It aims to increase the proportion of flights using the 747-400. An increase in average aircraft size will allow it to attain lower unit costs, making it more competitive against Lufthansa.

Finnair on codeshare flights with its OneWorld partner, BA, via London.

The opening of new routes on a low frequency basis could be viable in several cases over the next 10 years, given predicted rates of traffic growth. The effect would be to draw away interlined traffic on current routes. This would then moderate the need for larger aircraft, or more frequencies on these city-pairs.

KLM has no plans for opening new routes, but prefers to increase cooperative agreements with its partner in Japan, JAS. In fact, this may be the only possibility because of political constraints. Bilaterals to Japan and China are restrictive. It is hard to make profits from new routes because of the large aircraft sizes involved.

Opening new routes is not Air France's priority. It is instead following the strategy of increasing its market share by improving its schedule and having non-stop flights only. "We have to counter the effect of the Star Alliance. The difference in strengths between us and them is not the number of routes, but our scheduling, frequencies and average aircraft size," says Freitel. "Our major challenge is to compete with Lufthansa. We are actually more likely to consolidate to compete with Lufthansa, than open new markets".

Lufthansa is following the same strategy of focusing on existing markets.

Cathay Pacific is not planning any new destinations to Europe, although it is studying its European coverage, given the capture it has with its One World Partners, BA, Iberia and Finnair.

Aircraft size

With the prospect of few new entrants and competition, and a strategy of opening few new routes, the incumbents will be consolidating their positions in the market over the next 5-10 years.

This will first involve increasing frequencies and altering schedules to make their networks more marketable. Codeshare agreements are also likely to increase, effectively adding frequencies without adding extra flights. The use of larger aircraft as traffic growth progresses will follow.

"For now we will develop our network through codeshare agreements," says Benz, "and the A340-300, with 250 seats, is a good aircraft for our needs. We also use the 747 on many routes. We are considering the A3XX, and want to be able to react if the opportunity to use the aircraft is required. But this will probably not be before 2008 or 2009. There are, however, capacity restrictions to Japan, China and Korea".

KLM uses 747 Combis on most of its routes to the Asia Pacific, which have the seat capacity of a 767-300. It feels it will be better to increase frequencies before considering larger aircraft. The average seat numbers of its aircraft mean it will be many years before it needs an aircraft with greater capacity than a 747-400.

For the time being Air France is the only European airline considering aircraft larger than the 747-400. "We first want to increase the proportion of flights using the 747-400," says Freitel. "We use the 777-200 on about 40% of flights and the A340-300 on 30% of flights. Within five to seven years traffic growth will mean some routes will need the 747-400. Using the 747-400 means we can get lower unit costs per ASM, and this will help us compete against Lufthansa. After about 10-12 years continued growth means the A3XX will become viable on a few routes, and one could be to Tokyo. This would require three aircraft".

Cathay Pacific has seen average aircraft size decrease since it has been able to take advantage of Chep Lap Kok and offer more convenient services. Its aim is to have one or two daily flights on its long-haul services, which could see average aircraft size increase on these routes.

Absorbing growth

Assuming a 3% passenger load factor can be made over the next 10 years, network ASM capacity will have to increase by 76%.

This can be absorbed by ASMs provided on new routes, and extra frequencies or larger aircraft on existing ones. The lack of liberalisation and bilateral restrictions means the number of new routes being opened, and thus the effect they will have on drawing traffic away from current city-pairs, will be limited.

Current routes will thus have to provide the majority of the increase of the 76% rise in network ASMs.

This will first come from more flights being added, where physical constraints allow. Most routes will develop by the two major carriers on each cooperating through a codeshare agreement. Between airlines on all routes, minimum frequencies of two daily flights will be targeted, unless this level is already surpassed.

Less mature services, with less than seven weekly flights, will not increase frequencies to 21 or 28 per week, but may reach 7-14 per week in 10 years.

The current routes *(see tables, pages 11 & 12)* have been listed and grouped in order of annual flight frequency. The route and current annual flight frequency, ASM capacity and average aircraft size are listed in the first four columns. Ignoring the effects of new routes drawing away traffic, the average aircraft size required on each route with increased levels of frequency is shown in the two right-hand columns of the tables *(see pages 11 & 12)*.

The first group of five routes includes four operated from London Heathrow to Singapore (with an average daily frequency of almost seven flights); Tokyo (five daily flights); Hong Kong (more than five daily flights) and Bangkok (four daily flights); and Paris-Tokyo (four daily flights). This group of city-pairs has

Aircraft type	A3XX-200	A3XX-100LR	A3XX-100	747X-STR	747X	747-400
Tri-class seats	656	555	555	522	442	416
Additional freight payload (net tare) lbs	43,970	47,320	47,320	51,480	53,780	48,180
Range with full payload nm	6,300	7,200	6,200	5,950	7,000	5,600
Range with full passengers nm	7,650	8,750	7,650	7,600	8,810	7,200

Aircraft type	777-300ER	777-200LR	777-200ER	A340-600	A340-500	A340-300
Tri-class seats	365	301	301	380	313	295
Additional freight payload (net tare) lbs	53,910	38,870	40,650	38,760	32,240	32,750
Range with full payload nm	4,900	7,000	5,600	5,700	6,400	5,700
Range with full passengers nm	7,200	8,850	7,750	7,500	8,500	7,300

probably reached frequency saturation, and so all capacity increases will have to be with larger aircraft; between 484 and 617 seats, depending on attained frequency level, in 10 years. This is with the exception of London-Singapore on which, even with the same number of seven daily flights, the A3XX-200 would be too small.

Singapore Airlines and Air France have already ordered the A3XX. While BA has stated it is following a strategy of reducing capacity to increase average yields, it may still need 550-seat and larger aircraft in 10 years on a small number of routes like these. More frequencies may become available on two of the routes to Tokyo, because a second runway is being opened.

The second group of routes has between three and four daily flights, which is probably the highest level that will be achievable for most routes in 10 years, given airport congestion constraints. Increasing frequencies to four or five daily flights on each would put average aircraft size between 350 and 670 seats *(see table, page 11)*. The A3XX or 747X-Stretch may therefore be used on these city-pairs.

The third group has daily frequencies of more than two flights. Increases to three or four daily operations could keep aircraft size within the capacity of a 747-400, 747X-Stretch and A3XX *(see table, page 11)*.

The fourth group has low frequencies of between one and two flights per day. This has more scope for daily flights being taken to just two or three flights per day. This will result in average aircraft size being between the A340-300 and A3XX-200 *(see table, page 11)*. Frequencies of three flights per day are likely to be more desirable, which will moderate maximum aircraft size to the 747-400.

The fifth group of routes has less than two flights per day. It has smaller average aircraft sizes than the previous group and will require a smaller increase in frequency to prevent aircraft size reducing. Taking frequency to just two per day, or 14 per week, means average aircraft size on most would be smaller than a 747-400. This would be a strong market for the 777-300, A340-600, 777-200LR and A340-500.

Routes with less than 365 flights per year *(see tables, pages 11 & 12)* would only need to increase frequencies to between five and 10 per week, and average aircraft size not exceed the capacity of an A340-300/-500 or 777-200 in most cases. A few sectors would need the 747 or 747X, but this would be the largest aircraft.

Aircraft performance

Besides probable aircraft size requirements, other important factors are range capability and operating performance.

The aircraft under consideration by most airlines will be the A340-300/-500/-600, 777-200/-200LR/-300ER, 747-400/-400X, 747X, 747X-Stretch and A3XX.

These vary in tri-class seat capacity from 295 to 656 seats. Most routes will require the 295/313-seat A340-300/-500 or larger, since few aircraft smaller than this are operated on the current network. Although immature routes will see the largest level of increase in frequency, airlines are unlikely to reduce average aircraft size.

While operating economics and average unit cost per ASM will influence airline selection, revenue-generating capacity will be a priority factor.

The great circle distance of each city-pair will be increased by routings and ATC requirements, as well as en-route winds. While routes flown eastwards experience tailwinds, westward flights will encounter headwinds, increasing further the equivalent still air distances (ESADs).

The longest great circle distance is London-Singapore, with 5,869nm. This will be increased to an ESAD of about 6,430nm with a 20 knot headwind. Several other city-pairs have their great circle distances increased to more than 6,000nm. These include Kuala Lumpur-Amsterdam (6,031nm), Singapore-Amsterdam (6,212nm), Kuala Lumpur-Paris (6,154nm), Manila-Frankfurt (6,087nm) and Kuala Lumpur-Manchester (6,295nm). Most other routes have ESADs exceeding 5,500nm.

Candidate aircraft will thus need performance capability that can carry a full load of passengers, and preferably a full and unrestricted payload of additional freight up to 6,500nm. Types with this capability will have advantages over those with shorter range performance.

All aircraft types have the capability of carrying a full load of passengers on the longest route from Singapore to London; a distance of 6,431nm *(see table, this page)*, where the maximum take-off weight is not restricted by high ambient temperature.

The case is different when full payloads, where additional freight is carried, are considered. The aircraft with the longest range with a full payload is the 777-200LR, at 7,000nm. The A3XX-100LR and 747X have similar performance capabilities to this, but they have not yet been launched.

The additional net available payload over a full complement of passengers will provide additional revenue.

In the 300-seat class aircraft, (the 777-200 and A340-300/-500) the 777-200 has the largest extra freight-payload capacity, once tare weights of belly containers have been deducted. The 777-200LR has a higher operating empty weight (OEW) than the 777-

Cathay Pacific is one of the few Asia Pacific carriers that does not experience congestion constraints at its hub. This has allowed it to improve its schedule. It still aims to offer one or two daily flights on its long-haul network. On this basis, average aircraft size will have to increase on busier routes, while types like the A340 will still be appropriate on less dense city-pairs.

200ER, because of extra fuel tanks. The two 777-200 variants still have about 6,000lbs and 8,000lbs more freight capacity than their A340-300/-500 counterparts *(see table, page 16)*.

The 777-200ER has a similar range with a full payload to the A340-300, but the 777-200LR has a 600nm advantage over the A340-500. The 777-200ER/-200LR are therefore more likely to have a payload and performance advantage over their direct A340 competitors.

The 777-300ER does not compare as well to the A340-600, as the 777-200 does to the shorter A340 variants. First, the 777-300ER has 15 fewer seats in its standard tri-class configuration than the A340-600. These differences are explained by the A340 having 12 first- and 42 business-class seats, leaving room for 314 economy seats. The 777-300ER has 22 first- and 70 business-class seats, leaving room for a smaller economy cabin of 273. The A340-600 would have to add two rows of first- and three of business-class seats if it were to match the 777-300's premium cabins, leaving the A340-600 with seven or eight fewer rows of economy seats. This would bring the A340-600's total capacity down to 342 seats, 23 less than that of the 777-300ER.

With the manufacturer's tri-class seat numbers, the 777-300ER has 15,000lbs more additional freight capacity than the A340-600. The 777-300ER suffers, however, by having an 800nm shorter range than the A340-600 with a full payload. The A340-600 could operate most of the routes studied here westwards without a payload restriction, unless affected by severe temperatures, with the exception of the longest routes to Europe from Singapore, Tokyo and Kuala Lumpur.

The 777-300ER fares worse. Its shorter range means all routes from major points in the Asia Pacific to Europe would not be able to carry a full payload. The restriction means the 777-300ER would be limited to carrying less additional freight than the A340-600 on top of a full passenger payload.

All A3XX models are closely matched in terms of payload limitation on the most demanding routes in this network. The A3XX-200 and -100 have a small range deficit with a full payload on the longest routes, and so would suffer a small payload restriction. The A3XX-100LR will have no restrictions.

The 747X-Stretch will have limitations on the same routes as the A340-600. The 747X-Stretch, however, only has a 250nm shorter range than the A3XX-100. Compared to the A3XX-100, the 747X-Stretch, however, has a 4,000lbs higher additional payload, and so will be able to make up for some of its 33-seat smaller size.

The 442-seat 747X will have unlimited performance, because of its ultra long-range capability, and has the largest additional freight payload capabilities of all aircraft at 53,780lbs *(see table, page 16)*. This is about 10,000lbs more than the A3XX-200 can offer. The 747X will provide a good substitute for the 747-400, which has 26 less seats and a range shortfall with a full payload on many routes.

Summary

The 777-200LR/-300ER were launched in 2000. So far, nine firm orders have been placed by EVA Air and Alitalia for the -200LR, and 22 firm orders for the -300ER by EVA, JAL and Air France.

The A340-500/-600 were first launched in 1997. The only airline to place orders for the A340-500 to operate routes between Europe and the Asia Pacific is SIA, with a firm commitment for five aircraft. Swissair has firm orders for nine A340-600s, and Lufthansa and Virgin for 10 each.

None of the 747X variants have won orders to date. The only airlines operating routes in the Europe-Asia Pacific market with orders for the A3XX are Air France and SIA, although Qantas may make a firm commitment.

The incumbents in the market clearly do not expect liberalisation or competition for at least the next 10 years. In this timeframe capacity will have to increase by about 80% if growth rates are maintained. Airlines will respond to higher demand by consolidating their route networks and taking frequencies up to a more acceptable level of two to four daily flights, until congestion and physical constraints prevent further flights. This will be done while maintaining or possibly increasing average aircraft size.

Once frequencies have been saturated average aircraft size will increase. For the next 10 years, while frequencies are increased on most routes, average aircraft sizes may not have to increase to more than a 747-400 *(see tables, pages 11 & 12)*. This will then provide a large market for the A340-500/-600, 777-200/-300 and 747-400X.

If only a small increase in frequencies can be accomplished, then the A3XX and 747X/747X-Stretch will be required on up to 40 routes *(see tables, pages 11 & 12)*. The remainder of the network will still provide a large market for the A340 and 777 families.

Liberalisation is more likely to occur after 10 years. After 20 years, with sustained growth, traffic will be 3.4 times greater than the current level. Although new routes opened during the next 10-20 years will draw traffic away from the existing network, the large increase in traffic on most of the current routes will mean the majority are able to sustain the use of the A3XX and 747X family of aircraft. AC