Market forecast analyses by Airbus and Boeing indicate aircraft size requirements and route network development could occur in two very different ways. Closer analysis reveals the outcome may fall between the two predictions, creating markets for the A3XX and the 747-X Stretch. The two may also have close unit direct operating costs.

The fine line between the A3XX and 747-X

There is a fine line between the need for a 555-seat and a 522-seat aircraft over the next 10-20 years, and yet Airbus and Boeing are each advocating they have the product strategy with the A3XX and 747-X to best satisfy market requirements.

While the two manufacturers argue a case for their products, the major issue is what size of aircraft will really be required? The second issue is that if the real market demand is close to both Airbus' and Boeing's predictions of 520-550 seats, can either product offer a decisive operating cost (DOC) advantage?

Airbus is taking a risk by developing an all-new family. It will at least get a headstart with the few airlines out of a limited number that will require 550-seat and larger aircraft if its prediction of a need for the A3XX-100 and -200 is correct. Boeing has a low-cost and low-risk option, but could lose vital customers if it has under-estimated the market's needs.

Boeing, then, only has a chance of winning majority market share if airlines do not want more than 530 seats and the 747-X Stretch can offer lower or similar DOCs per available seat-mile (ASM) than the A3XX-100.

Market development

The issue first revolves around traffic growth, network development and aircraft size requirement.

The most likely markets for the A3XX or 747-X are those with the highest traffic and ASM capacity. Even this is a generalisation, since Emirates is planning to use the A3XX on fifth freedom routes via its base at Dubai. The airline is experiencing 20% annual traffic growth and has slot restrictions at London Heathrow.

The 100 routes with the highest ASM capacity are summarised *(see tables, pages 20 and 22)*. These tables show the city-pair, current annual ASMs, number of return flights and average aircraft size offered by the airlines serving the route. These routes are largely dominated by four markets: the trans Asia-Pacific, trans-Atlantic, Europe-Asia and trans-Pacific.

Traffic growth is predicted to average about 5% annually in the next 10-20 years. Growth rates are higher in the Asia-Pacific, trans-Pacific and Europe-Asia markets than the more mature trans-Atlantic market *(see table, this page)*.

Annual growth rates translate into network ASM capacity increases of 50-89% over 10 years in the three markets with routes in or into the Asia-Pacific region. Over 20 years the increase for the same three markets are 230-370%.

Absorbing growth

There are several ways airlines can absorb traffic growth.

One way is increased passenger load factor. Average load factors are assumed to increase by three percentage points.

Once load factor has absorbed some growth, the remainder has to be taken up by additional ASM capacity. ASMs can be increased in four ways.

The first is higher aircraft utilisation. This is unlikely because of airport congestion, which lengths turnaround times.

The second is through higher flight frequencies on each route. Higher frequencies will diminish the need for larger aircraft. Flight frequencies can only be increased to a practical level, after which aircraft size has to increase.

10- & 20-YEAR INDIVIDUAL CURRENT ROUTE ASM CAPACITY GROWTH FACTORS, WITH 3% RISE IN PASSENGER LOAD FACTOR AND ROUTE PROLIFERATION OF 16% & 35%

Global region	Annual growth rate %	Growth factor over 10 years	Growth factor over 20 years
New route growth (%)	–	16	35
Intra-Asia	6.3	1.58	2.65
Trans-Atlantic	4.5	1.33	1.89
Europe-Asia	6.3	1.58	2.65
Trans-Pacific	7.0	1.70	3.03

HIGHEST CAPACITY GLOBAL ROUTE CURRENT CAPACITY & AIRCRAFT SIZE REQUIREMENTS AFTER 10 & 20 YEARS OF GROWTH

Route	Annual return flights	Annual ASMs (millions)	Average aircraft size seats	Aircraft size with 25% increase in frequencies after 10 years of growth	Aircraft size with 48% increase in frequencies after 20 years of growth
Europe-Asia routes					
LHR-SIN	2,384	6,371	396	500	708
LHR-NRT	1,914	4,435	389	492	697
HKG-LHR	1,830	3,913	357	451	639
CDG-NRT	1,473	3,740	421	533	754
BKK-LHR	1,530	3,488	384	486	688
JNB-LHR	1,697	3,365	352	444	630
FRA-SIN	1,334	3,209	377	477	675
FRA-NRT	1,203	2,889	413	522	740
FRA-BKK	1,253	2,637	377	477	676
KUL-LHR	1,028	2,226	360	454	644
AMS-SIN	1,039	2,356	348	439	622
FRA-HKG	889	1,845	365	461	653
AMS-NRT	666	1,550	403	509	721
CDG-HKG	732	1,504	345	436	617
BKK-CDG	732	1,487	347	439	621
MXP-NRT	523	1,440	455	575	815
KIX-LHR	576	1,429	419	530	750
SIN-ZRH	524	1,170	349	441	625
FRA-PEK	574	1,037	374	472	669
DEL-LHR	600	1,033	412	521	738
BKK-FCO	418	941	410	518	734
Trans-Pacific routes					
LAX-NRT	3,417	7,281	392	533	802
LAX-TPE	2,085	5,316	376	512	771
LAX-SYD	1,688	5,041	399	542	816
JFK-NRT	1,673	4,904	436	593	892
HNL-LAX	6,545	4,822	289	393	591
HNL-NRT	3,051	4,725	406	552	832
NRT-ORD	1,828	4,446	389	529	796
NRT-SFO	1,773	3,725	411	559	842
LAX-SEL	1,639	3,386	347	472	710
AKL-LAX	1,227	3,196	400	544	820
HKG-YVR	1,315	3,176	379	516	777
SFO-TPE	1,311	3,155	374	508	765
HKG-LAX	959	2,765	399	542	817
HKG-SFO	1,098	2,675	353	481	723
HNL-KIX	1,479	2,294	378	514	774
KIX-LAX	889	2,227	438	595	896
TPE-YVR	943	2,158	385	523	788
SEL-SFO	1,102	1,944	314	427	643
NRT-YVR	892	1,645	396	538	810
NRT-SEA	1,096	1,615	310	421	634
GRU-LAX	745	1,455	317	432	650
DTW-NRT	489	1,304	418	568	856
MSP-NRT	485	1,160	403	548	826
HNL-NGO	733	1,135	387	526	791
KIX-MSP	120	296	400	544	819

Source: BACK Information Services

It becomes impractical for each airline to increase frequencies on longer routes to more than three or four a day. Flight times, time differences, time zones and limited slot availability all mean it is hard to have more flights. Even the number of airlines operating a route will become restricted. Saturation will be reached on these ultra-long distance routes when the number of return flights has reached between six and eight a day. Traffic growth has historically first led to increases in flight frequency, and, after this option is saturated, larger aircraft are then required.

The third and fourth ways of providing more ASM capacity will be through the opening of more city- or airport-pairs and by operating larger aircraft.

The relative portions accounted for by new routes, higher frequencies and larger aircraft are the basis for Airbus' and Boeing's differing predictions for aircraft size requirements.

Boeing argues new city- and airport-pairs and increased flight frequencies will contribute a larger increase in ASM capacity than Airbus's forecast. This will be to the extent that the 522-seat 747-X Stretch will be the largest aircraft type airlines will require for the next 20 years.

Airbus estimates a smaller number of new routes and an increase in frequencies, stimulating the need for 555-seat and 656-seat A3XX-100 and -200s over the next 20 years.

Network development

It is therefore necessary to estimate how the network might develop. Current ASM capacity on the busiest 100 routes and estimates of traffic growth indicates what future ASM network capacity requirements are likely to be. This increase in ASM capacity across the network will be absorbed by current and new routes.

Current routes will not need such a large increase, because new ones will draw some of the traffic away. The difficulty is estimating how much more capacity current routes will require, and thus what aircraft size each one needs.

A rough estimate can be made if it is assumed that new routes will take a less than proportionate share of capacity in the future. That is, the average new route in 10 and 20 years will have a smaller number of ASMs than the average current route.

Airbus estimates the number of routes system-wide will increase by 16% in 10 years and 35% in 20 years. This analysis has been made on the assumption that new routes in 10 years will have a 10% system-wide share of ASM capacity and in 20 years an 18% share of capacity.

This is in parallel with traffic growth

The market could develop in the next five to 12 years to generate demand for the 522-seat 747-X Stretch. If frequency growth is stifled, continued exponential traffic growth may result in a sudden need for large numbers of A3XXs after 10-12 years.

increases of 89% in 10 years and 370% in 20 years in the Asia-Pacific, for example. Current routes in the same market would then only require an ASM capacity increase of 58% in 10 years and 265% in 20 years. The increase in ASM capacity on each route in each major region with an adjustment made for new routes taking a portion of the increase in capacity and a 3% rise in load factor are summarised *(see table, page 17)*.

If the increase in frequencies on each route can then be estimated, the average aircraft size on current routes in 10 and 20 years can be calculated.

Frequencies

It is now necessary to analyse current frequencies and anticipate how they might increase on current routes and across the network.

Most intra-Asian routes studied have daily frequencies of between two and 20 flights. Most trans-Atlantic airport-pairs have up to eight daily return flights.

The less mature European-Asian and trans-Pacific markets have routes with only two to five daily frequencies.

This suggests the trans-Asian and trans-Atlantic networks will experience relatively small frequency growth compared to Europe-Asia and trans-Pacific markets.

Airbus' forecast is that system-wide frequencies will increase by 45% in 10 years and 95%, or almost double, in 20 years.

This means frequency over current routes will increase by an average of 25% in 10 years and 48% in 20 years.

Future aircraft size

A simple estimation of aircraft size can be calculated by increasing ASMs on each route by the appropriate factor *(see table, page 17)*, and then dividing these by projected frequency and the distance.

Increasing ASMs and frequencies on this basis over 10 and 20 years gives rise to the projected average aircraft sizes in these four markets *(see tables, pages 20 & 22)*.

Most of the busiest routes in the trans-Asian market are unlikely to require average aircraft size larger than 500 seats after 10 years.

Continued growth will see 19 routes needing aircraft larger than the A3XX-100 in 20 years. Five others will require between 400 and 530 seats average size.

These size predictions will be moderated by the fact that these routes are mature and most have frequencies exceeding eight flights per day. This would mean current routes would have lower increases in frequency than calculated here, and so require larger aircraft.

The trans-Atlantic market, with current average aircraft size being something between the 767-300 and A340-300, with the predicted frequency and route number growth, would lead to many city-pairs needing aircraft the 747's size in 10 years' time and the 747-X Stretch's size in 20.

The trans-Atlantic is mature, however. The majority of liberalisation has already occurred and new route growth will be less than the system-wide average. It has also become almost impossible for incumbent carriers on current routes to increase frequencies from current levels. Lower frequency growth of 10% and 20% will lead to more routes requiring the 747-400 and 747-X Stretch, but still hardly any needing the A3XX-100.

The Europe-Asia and trans-Pacific markets are less mature and are expected to experience higher than average route number and frequency growth. They also tend to have the largest average aircraft size.

Europe-Asia is dominated by routes from London, Paris and Frankfurt to Singapore, Hong Kong and Tokyo. There is therefore a lot of traffic from other European cities which connects, but could potentially go direct.

There is evidence to suggest that new route proliferation from Europe to Asia could be slow. Using larger aircraft to operate trunk routes with connecting traffic may still be the way for airlines to operate most efficiently. The distances involved also imply that the A340-300 or 777-200 will be the minimum size with which an airline is prepared to open new routes. This will limit the rate of route proliferation.

Frequency growth could also be moderated by the fact that routes with more than 2.5 billion ASMs have almost reached frequency saturation due to practical limitations. This will mean aircraft size increase will have to play a major part in absorbing traffic growth. Most of these routes are predicted to need aircraft of between 400 and 510 seats in 10 years, while about six may need the A3XX-100. All 21 will require something equal to the A3XX-100 or -200 in 20 years *(see table, page 22)*.

Those with less than 2 billion ASMs have more room for frequency growth and so could require smaller aircraft in 10 and 20 years than predicted *(see table, page 22)*.

The trans-Pacific is characterised by a network of routes where the majority originate from only eight major north American gateways to five major Asia-Pacific airports. Most Asia-Pacific cities remain out of range of long-haul aircraft types, and the market also needs to liberalise more for new routes to open.

Market evolution is likely to be in two phases. The first will be that more Asia-Pacific cities will be served direct from current north American gateways, followed by more north American cities entering the market.

Despite the large number of routes not being served, the evolution of new

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HNL-LAX	6,545	4,822	289	393	591
HNL-NRT	3,051	4,725	406	552	832
NRT-ORD	1,828	4,446	389	529	796
NRT-SFO	1,773	3,725	411	559	842
LAX-SEL	1,639	3,386	347	472	710
AKL-LAX	1,227	3,196	400	544	820
HKG-YVR	1,315	3,176	379	516	777
SFO-TPE	1,311	3,155	374	508	765
HKG-LAX	959	2,765	399	542	817
HKG-SFO	1,098	2,675	353	481	723
HNL-KIX	1,479	2,294	378	514	774
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NRT-YVR	892	1,645	396	538	810
NRT-SEA	1,096	1,615	310	421	634
GRU-LAX	745	1,455	317	432	650
DTW-NRT	489	1,304	418	568	856
MSP-NRT	485	1,160	403	548	826
HNL-NGO	733	1,135	387	526	791
KIX-MSP	120	296	400	544	819

Source: BACK Information Services

city-pairs could still be slow. These routes will have the longest non-stop distances in the world and will require the A340-500 and 777-200X. Their size means route and frequency proliferation could be slower than the global system-wide average. There will also be practical difficulties increasing frequencies on current routes, because of time-zone differences and flight times.

Most of the routes analysed here have three or four return flights per day, and most incumbents will have practical problems increasing their own daily frequencies to more than two or three. Aircraft size after 10 years may then be close to predicted *(see table, this page)*. This will stimulate the need for the 747-X Stretch and A3XX-50/-100 on about 20 routes, or most of those analysed.

Frequency growth of 50% on current routes after 20 years will not be enough on all 19 routes to prevent average aircraft size exceeding the A3XX-200. This will thus force a faster rate of new route proliferation after 10-15 years. These new city-pairs will also need large aircraft; in some cases the 480-seat A3XX-50 or bigger.

Even with Airbus' predictions of frequency growth and route proliferation, aircraft size on current routes will not grow to the point where the A3XX-100 is needed in large numbers after 10 years. About 60 of 100 routes studied here, however, are likely to require the A3XX-100/-200 in the next 10-20 years. These routes could provide a market for 650-750 aircraft.

The A3XX-100 and -200 only seem to be needed in large quantities after 10 years.

Considering the first A3XX will not enter service until late 2005, and initial production in the first five years may only be 125-150 units, the A3XX could make a timely entry into the market by being available for airlines to build larger fleets on from about 2010-12.

Boeing generally predicts higher frequency growth and route proliferation. This will reduce the aircraft sizes on each route shown. Considerably higher frequency growth in the Europe-Asia and trans-Pacific markets would still not halt the need for the A3XX-100/-200 in 20 years, but would reduce overall market demand.

Besides airline strategy, fleet and route planning will also be affected by congestion constraints and practical considerations. Airlines may also use large aircraft to consolidate their positions in existing markets. They would be able to offer lower unit ASM costs, as well as free slots to open new routes with smaller types like the A340-500. The A3XX-100/-200 may therefore create a market for itself by offering airlines the option of consolidating their positions in existing markets. Airline alliances will also play a role in consolidation and traffic protection, thus stimulating demand for large aircraft.

Operating costs

The analysis of the 100 routes and many other aspects that will influence required aircraft size suggests the market's demand could provide large sales for both the A3XX-50/-100 and 747-X Stretch. This is more likely in the next 8-13 years.

If airlines show initial interest in aircraft only up to 550 seats, it will provide Boeing with scope to compete with Airbus before demand for larger types materialises in the following years. This then raises the issue of unit DOCs and economic competitiveness.

In many cases operating costs will not be affected by aircraft type. These costs include cabin crew employment, ground handling and catering. Several others, depending in the global region of operation, will only be influenced by the aircraft in a small way. These include part of line maintenance, navigation and airport user fees.

This leaves a small number of cost categories where aircraft type can make an impact on unit DOC. These are flight crew, fuel, maintenance and depreciation or finance charges.

Airbus claims the A3XX will have 17% lower ASM unit costs than the 747-400, conceding that this will be partially because of larger seat numbers.

Boeing claims the A3XX will only be able to offer 5% lower ASM costs than the 747-400.

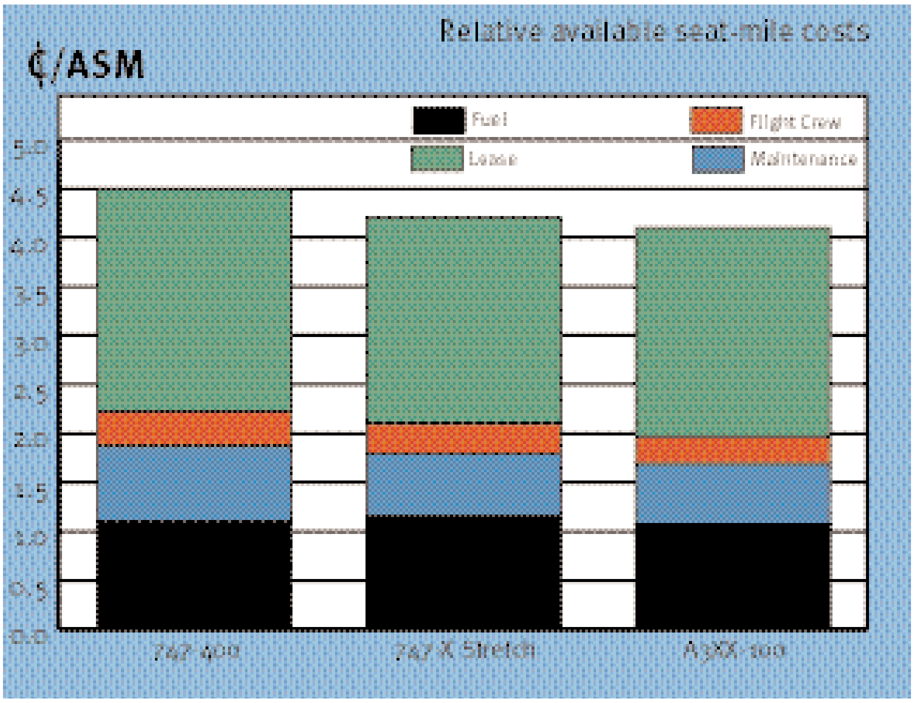
The 747-400 can be compared with the 747-X Stretch and A3XX-100. Although the 747-X Stretch and A3XX are not yet operating, close estimates can be made for fuel and maintenance.

A typical route where these three types will compete for airline orders is London-Bangkok. Tracked distance will be about 5,700nm and aircraft will achieve utilisations of about 5,000FH per year.

The aircraft have been analysed with their manufacturer's standard tri-class seat numbers. Fuel price is taken to be 65 cents per US gallon. Fuel efficiency and size provide the 747-X Stretch and A3XX-100 a 3% and 4% ASM fuel cost advantage over the 747-400.

Some elements of maintenance costs will be virtually equal. The same line checks, for example, will be performed on each aircraft type and the labour and materials used will hardly differ. Only small increases will be experienced for larger types.

The same will be true for line checks. The 747-400 consumes an average of 4,500-5,000 manhours (MH) and $75,000-$100,000 for A checks. The



747-X Stretch and A3XX-100 are likely to only require less than proportionate increases in inputs. The same will apply to C checks and, in the 747's case, the D checks. Although Airbus aircraft have a different system of structural checks, overall costs per FH will only be higher than the 747-400 in the order of $5-15.

The same will apply to heavy components and line replaceable units. Engine shop visit and overhaul costs will all be kept low by operating long average cycle times exceeding eight flight hours (FH).

The PW4000 and CF6-80C2 are capable of average costs in the region of $120 per engine flight hour (EFH). Engine manufacturers are likely to offer 747-X Stretch and A3XX operators power-by-the-hour deals. These will be marginally higher than the 747-400's costs; probably in the region of $130-135 per EFH.

The 747-400's maintenance costs will total in the region of $1,600 per FH, the 747-X Stretch's and A3XX-100's will be $1,650-1,700 and $1,700-1,750 per FH. This will produce ASM costs of 0.77, 0.65 and 0.62 cents per ASM for the three types.

Flight crew charges depend on airline salary and promotion policy, as well as savings that can be gained from commonality benefits. Average 747-400 captain and senior first officer salaries and benefits in north American, European and Asia-Pacific carriers are $125,000 and $85,000.

Long routes means supernumerary crew will have to be rostered. On a 5,700nm sector a third pilot will be carried. Additional employment costs and extra crew means a crew complement annual employment cost will be about $410,000 for a 747-400. Average FH productivity of 650FH per year will mean eight crews per aircraft will have to be employed.

Flight crew charges for the 747-X Stretch and A3XX-100 will not be higher in all airlines. Salaries and benefits often depend on route structure operated, rather than aircraft type. If higher salaries are paid to 747-X Stretch and A3XX-100 flight crew, they will only be a few percent higher. Overall, crew costs per ASM will be 0.35, 0.30 and 0.28 per ASM for the 747-400, 747-X Stretch and A3XX-100.

Finance charges will depend on how the aircraft is acquired. The A3XX and 747-X Stretch are likely to be marketed with generous discounts to early customers. This analysis has assumed list price has been paid, and the aircraft financed with a finance lease with a monthly lease rate factor of 1.05%. The A3XX-100, with a $230 million list price, would have a unit finance charge of 2.13 cents per ASM. This compares to 2.28 cents for the 747-400 financed at $185 million. The 747-X Stretch will have to be priced between the other two; probably in the region of $215 million. Finance charges will be 2.11 cents per ASM.

The unit cost for these four cost categories is 4.09 cents for the A3XX-100 and 4.50 cents for the 747-400. The A3XX-100 thus has 9% lower unit costs than the 747-400. The 747-X Stretch has unit costs of 4.20 cents per ASM; 7% lower than the 747-400.

This is comparing the two with list prices. If A3XX operators can get a larger purchase discount than the 747-400, the 15% difference may be achievable with these four cost categories. AC