Airbus confounded its sceptics with the A380's launch. Closer examination of its customers, and the routes where they will use the aircraft, reveals it is currently only required for the heaviest routes in the busiest markets. The A380's target markets may still require another decade of growth before large numbers are needed.

When will the A380 come into its own?

The issue of the requirement for an aircraft larger than the A380 appears to be resolved. Six major passenger airlines have ordered the aircraft, and commitments already stand at 70 units. The A380 will only be required on routes with the highest traffic densities.

Initial customers have placed small orders, and will operate the A380 on their routes with the most constrained frequency and capacity. Demand for further orders depends on market development. How soon are existing customers and other airlines likely to need the A380?

Market rationale

The rationale for the A380 is that there will be a sufficient number of global city-pairs with enough traffic to require its size.

There are four main markets which could require the A380: the trans-Atlantic, trans-Pacific, Europe-Asia and intra-Asia. The world's routes with the highest capacity are in these four markets. A few exceptions are London to Johannesburg and Dubai.

In turn, these routes are dominated by a minority of large airlines, some of which have already ordered the A380. These are Emirates, Air France, Singapore Airlines, Qantas and Virgin Atlantic. Other likely customers are the other major operators serving these markets.

The most likely customers that could next order the A380 are United, Northwest, Lufthansa, British Airways, Japan Airlines (JAL), All Nippon Airways (ANA), China Airlines, Korean Air, EVA Air, Asiana, Thai, Cathay Pacific, Malaysian and South African Airways. This is on the basis that these airlines operate routes with the highest frequencies using the 747 in these main markets.

Aircraft size requirements will depend, however, on current frequency level and aircraft size, the potential for more frequencies and larger aircraft and how these routes develop with continued traffic growth.

Traffic growth requires more capacity. Airlines generally respond to growth, first by increasing frequency, which further stimulates demand. Frequency growth is then followed by increased aircraft size. Both of these can be offset by opening new routes, which draw away traffic from existing routes.

There are scheduling limits to potential frequency, including take-off and landing slots, airspace capacity, flight times, time difference between departure and arrival cities, and airport curfews.

These factors limit most airlines to operating up to just two flights per day across the Pacific and between Europe and the Asia Pacific. British Airways, for example, operates two flights per day from Hong Kong to London Heathrow (LHR), but these are scheduled within one hour of each other. "Our flights from Hong Kong and Singapore arrive at LHR early in the morning, but most outbound flights to these destinations leave London in the evening," says Dick Wyatt, general manager fleet planning at British Airways.

Once frequencies reach saturation airlines increase average aircraft size. Many airlines in these four main markets could still increase both frequency and aircraft size before requiring the A380.

In parallel with traffic growth, however, are increased competition and new routes, which draws traffic from incumbent routes. Fragmentation therefore reduces pressure on airlines to increase capacity. Competition has the same effect. Thus, capacity on many high density routes has not increased as fast as overall traffic as a result of competition and fragmentation.

"Even though high growth should theoretically lead to more capacity, it also attracts competition," says Wyatt. "We modelled specific routes and found that if we get no new competitors we would improve operating results with the A380 in six years. This was assuming strong continuous market growth and that current competition expanded its capacity on the same routes. However, the improvement was insufficient to justify the capital commitment at this time. Forecasting a requirement for A380 is not as as simple as extrapolating growth on 747 routes. For example, many of our routes have transfer traffic, and airlines could introduce new non-stop routes with a smaller long-haul aircraft". Other operators will have different factors which could lead to different conclusions. For example, Sydney-Los Angeles is an obvious route for the A380.

Traffic growth

Traffic growth in these four markets is forecast to grow by 6.3-7.0% per year, although the more mature trans-Atlantic market will be at 4.5% per annum. With pure traffic growth, and no new route proliferation, ASM capacity would have to increase by 85-97% after just 10 years, and by 240-285% after 20 years. Airbus Industrie predicts an increase of 16% more routes systemwide after 10 years, and 35% after 20 years. If new routes emerge at these rates and account for 10% and 28% of ASMs after 10 and 20 years, ASMs on current routes will have to increase by 60% and 265% over the same periods.

This has to be considered against further increases in frequencies on these routes. Some estimates are that frequencies will increase by 25% after 10 years and 48% after 20 years. On this basis, only a few airlines operating on the busiest 100 routes will require an average

British Airways says it does not have the critical mass of to generate high enough utilisation with the A380 to substitute the 747-400. BA's requirement for a larger aircraft is not a simple case of extrapolating growth on the busiest 747-400 routes.

aircraft size equal to the A380 in 10 years. On the same growth basis, the majority of the top 100 routes, and others, will have reached frequency and aircraft size saturation and will require the A380 after 10-20 years.

Trans-Atlantic

The trans-Atlantic has experienced the highest level of fragmentation. Aircraft size in this market declined during the 1980s and early 1990s. With continued traffic growth, but fragmentation reaching maturity, average aircraft size will have to increase again.

While the 747 is larger than average aircraft size on the Europe-US market, there are many city-pairs which already have high daily 747 frequencies operated by each carrier. "Virgin is slot constrained at LHR, and so we have to maximise passengers per slot. We are already capacity constrained on routes from LHR to New York, Los Angeles and San Francisco, so we have ordered the A380 to fly these routes," says Conrad Clifford, director corporate planning at Virgin Atlantic. "These markets are already saturated, because demand already equals capacity. I do not expect fragmentation on routes where we plan to operate the A380. Passenger demand is still strong at slot constrained airports, despite other routes opening. Although US carriers operate into secondary airports with smaller long-haul aircraft, there is still strong underlying demand at major airports."

BA is another example of a European airline which operates high frequency services to the US with 747s, although in recent years it has downsized to the 777-200 on many of its trans-Atlantic routes. Besides a few exceptional routes operated by United, all major US carriers operate the 777-200 or smaller aircraft across the Atlantic to major European cities. Air France may operate the A380 to New York or Washington, but the number of trans-Atlantic routes that will require the A380 will probably remain limited, even after 20 years.

Asia Pacific

The trans-Pacific has been controlled by bilateral agreements between the US and various Asia Pacific countries for decades. The development of agreements has been slow, and so prevented the opening of new routes and entry of new carriers. Also, the fifth-freedom rights granted to Japan Airlines (JAL), Northwest and United on trans-Pacific routes via Tokyo has provided them with strong traffic feed to major cities in the Asia Pacific. These four carriers account for more than half the ASMs on the trans-Pacific market, while another 20 airlines provide the rest.

Other US majors have been granted route rights to major Asia Pacific cities, but the lack of ultra long-range aircraft means these airlines would require re-fuelling stops in Japan. This is without the aid of fifth-freedom rights that would give them the same level of traffic potential. The trans-Pacific has remained dominated by incumbent carriers, maintaining a requirement for the 747.

Continued growth could then stimulate the need for the A380. Many routes only have one operator, which operates a single daily flight. Further traffic growth could thus see frequencies increased before aircraft size. Long distances and larger time zone differences make it harder, however, to increase frequencies.

Proliferation of more routes may be slow, since there are a small number of major cities in the Asia Pacific. Most routes would require non-stop service and the range performance of the A340-500 and 777-200LR. Airlines would also want to start operations with seven daily flights. Routes with enough traffic to be viable are limited.

Incumbent airlines expect slow proliferation. Frequencies operated by Northwest and United are only one daily flight in most cases, and each airline may seek two daily frequencies. Traffic growth is high, however, and key routes will require the A380. Singapore Airlines, for example, will operate the A380, via technical stops to New York, Los Angeles and San Francisco.

Europe-Asia

Maximum frequency on many routes between Europe and the Asia Pacific will only be two flights per day per airline. This level of frequency has already been reached on routes operating in these markets, and in many cases the 747 is the only aircraft operated.

Two of the heaviest routes in the Europe-Asia Pacific market are London to both Hong Kong and Singapore. In the case of London-Singapore, Singapore Airlines (SIA), another A380 customer, already operates three 747-400 frequencies per day and will now have to increase aircraft size to satisfy higher demand.

While SIA has the requirement for the A380 on routes both easterly and westerly from Singapore, British Airways cannot find a case for the A380 on enough of its routes to generate a satisfactory utilisation and seat-mile unit cost performance. "The case for the A380 has not yet been compelling enough for us to order the aircraft five or six years in advance," says Wyatt. "We studied routes which have a narrow scheduling window, and thus be more likely to be capacity constrained. For example, LHR to Singapore and Hong Kong. Because of the awkward arrival and departure times of the Asia routes, we would achieve low utilisation, since the aircraft would not be used during the day at LHR. We would then have to mix these A380 operations

Singapore Airlines has enough routes eastwards and westwards of Singapore and within the Asia Pacific to justify the A380. SIA has the highest ASM capacity on the London-Singapore route.

with routes west from LHR to Los Angeles, and drop prices to fill the aircraft. This would provide an overall yield mix too weak to economically justify the aircraft. The practical scheduling problems to Singapore and Hong Kong mean the A380 could actually cost more than the 747-400. We would need a larger network to operate the aircraft on to make it viable, but we do not have enough routes that require its capacity."

Despite this, Wyatt concedes BA is frequency saturated between LHR and Singapore/Hong Kong, but only in one direction.

Other routes between Europe and the Asia Pacific, which have reached high frequencies with 747 operations, are those serving Frankfurt and Paris. Many routes serving most other European cities have less than two flights per day per carrier, and also operate types smaller than the 747. There is therefore plenty of potential to increase frequencies and aircraft size before being capacity constrained. While Virgin may consider operating the A380 to Hong Kong on a daily flight, for example, it will not consider using the aircraft on any other services to the Asia Pacific.

Air France, however, will operate the A380 to Tokyo, and does not expect to increase frequencies on many of its routes to the Asia Pacific. In fact, Air France may consolidate its position in the Europe-Asian market rather than increase frequencies and add routes. Other incumbents in the Europe-Asia market do not expect much liberalisation, since it is a difficult market to enter.

Many of the busiest routes in the Europe-Asia market will require the A380 in 10 years, and most in 20 years.

Intra-Asia

Another market that already sees the operation of mainly large aircraft is the mature routes in the Asia Pacific. Routes to and from Seoul, Tokyo, Osaka, Hong Kong, Singapore, Bangkok and Kuala Lumpur all have high numbers of large widebody aircraft. Cathay Pacific, Korean Air, Thai, SIA, Thai, and JAL all operate the 777-300 on high density routes. Several of these carriers already operate the 747 on intra-Asian routes, as also do China Airlines, Asiana and Garuda.

These airlines also have pure or nearly-all widebody fleets. JAL and ANA also operate high frequency domestic Japanese services with 747s. Larger aircraft will be therefore be required by many Asia Pacific airlines. SIA intends to operate the A380 to Tokyo, Hong Kong and Sydney.

Frequencies are now close to saturation on many routes. With predicted traffic growth, route and frequency proliferation, at least 25 intra-Asian routes will require the A380 in 10-20 years.

Other markets

Orders placed by Emirates indicate other potential markets for the A380. Emirates has been successful in using Dubai as a connecting hub. Dubai also attracts a lot of origin and destination traffic, and has experienced a tourism boom. Consequently the carrier has experienced high traffic growth. Traffic on Dubai-London has grown at 20% per year. The airline is slot constrained in London, and thus requires more capacity. Emirates will first use the A380 to serve London, Bangkok and Australia.

High traffic growth to Dubai is also experienced by Lufthansa, which was expected to order the A380 for its Frankfurt-Dubai services, since it is already at load factor saturation with its two daily 747-400 flights.

Another major market is London-Johannesburg. British Airways and South African Airways already operate two daily flights, and slot restrictions at LHR could soon dictate the need for larger aircraft. Despite the possibility of general market fragmentation, new routes are unlikely to draw traffic away from London-Johannesburg.

Economic performance

In addition to demand for the A380 on a capacity basis, the other rationale for its requirement lies with its ability to provide a unit cost advantage per seat-mile over the 747-400. Initial fleets will be small, and airlines will be challenged to make the economies of scale necessary to justify the A380. As Wyatt indicates, a critical mass of routes in a network is required with well matched schedule times to generate efficient levels of utilisation.

The operating cost elements that will have the largest influence on the A380's ability to offer a large enough cost per seat-mile advantage over the 747-400 are fuel, maintenance, flight crew and flight attendants, and finance charges. Spare belly freight capacity will also subsidise cost per seat through additional revenue earning capacity.

Fuel burn per seat, on a 5,700nm trip, is similar for both aircraft. This leaves other operating cost categories to generate a difference between the two.

Flight employment costs depend on airline salary scales. Few airlines award salary scales in proportion to aircraft size. A typical 747 captain salary operating for a European, Asia Pacific or US airline is in the region of $150,000-190,000. Taking a salary of $165,000, captains on the A380 are likely to only receive $10,000 more per year. A similar difference will apply to first officer salaries. These differences will provide the A380 with an advantage, since its seat numbers are higher in proportion to flight crew salaries. Flight crew employment costs will be complicated by additional

Despite market fragmentation, Virgin Atlantic is capacity constrained on a few trans-Atlantic routes. It has ordered six aircraft to serve New York, San Francisco and Los Angeles from London.

costs for allowances, benefits, training, subsistence and transport. These will be similar in magnitude, irrespective of aircraft type. Individual airlines may gain advantage with one type over the other via commonality with other types in their fleets. Thus, A340 operators will be able to practice mixed fleet flying with the A380, leading to improved crew utilisation and reduced training costs. Virgin will have a common pilot pool for its A340s and A380s.

Other complications to flight crew charges are supernumerary crew scheduling, that will be required for long-haul missions. The average flight crew complement will be equal, however, for the A380 and 747-400 on the same route.

For an average crew complement of three and productivity of 650 flight hours (FH), the A380's annual flight crew employment costs will only be in the region of 7% more per year than the 747-400, giving the A380 a large cost per seat advantage in this cost element.

Maintenance costs are highly variable, and can provide scope for the A380 to have a large cost advantage. Main cost elements are line, base, engine and component maintenance.

Line checks for both aircraft are likely to require equal man-hour (MH) and material inputs. Line inputs for the 747-400 are in the region of $180 per FH.

Technology and longer intervals between structural inspections compared to the 747-400, put the total cost for A, C and Structural checks at $210 per FH for the A340 *(see Technology provides A340 with partial gain in maintenance cost, Aircraft Commerce, October/November 2001, page 27)*. This compares with $331 per FH for the 747-400 *(see 747 shrugs off heavy maintenance burden of earlier classics, Aircraft Commerce, June/July 2001, page 26)*. While this does not give the A340 a large maintenance cost advantage per seat over the 747-400, it indicates the A380 will benefit from the same technological and check interval advantages. The A380's costs per FH for A, C and structural checks will be lower per seat. On the basis of the A340, the A380's A, C and structural checks will have a cost per FH in the region of $390 per FH.

The A380 will also gain advantages through a similar inventory cost per aircraft for LRUs as the 747-400, although A380 operators are likely to lose a lot of this advantage because of smaller fleets compared to the 747-400. Repairs of check-aligned components will be similar in total for both types, giving the A380 another advantage. The A380 may gain further through having more of these components maintained on an on-condition basis. Repairs and exchange fees of heavy components will be higher for the A380, although cost per seat will be lower. Engine reserves will be similar per FH for both types. Engines powering narrowbodies are known to have shop visit costs regularly higher than widebody powerplants. The A380's engine reserves may only be in the order of $10 more per engine FH than the 747-400's.

In total, the A380's total maintenance costs may only be in the region of $110 more per FH than the 747-400's, giving the A380 an 11% lower maintenance cost per seat.

Finance charges have the largest impact and ability to provide an aircraft with a large advantage. Although not representative of most cases, a lease rate factor of 0.9% per month of list price gives the A380 a finance cost advantage of about 7% per seat. This is on the basis of the two aircraft generating equal utilisations.

The total of these four cost factors gives the A380 a seat-mile cost of 3.92 cents, while the 747-400 generates a unit cost of 4.34 cents, giving the A380 an advantage of 10% over the 747-400. This cost advantage will be diminished, however, when other operating cost elements have been added.

Summary

Only a select number of airlines operating the very busiest and capacity constrained routes appear to be those which require the A380's capacity. This is reflected by the small fleets they have initially ordered. Other airlines, such as Cathay Pacific and Lufthansa, which also operate a few high traffic density routes, may need the aircraft in the next five or six years, but it will be at least 10 years before each major airline operating in the busiest markets requires the A380 on a large number of routes. There is still the possibility of fragmentation of the world's major long-haul markets. Even if these markets do not fragment, many routes require a lot of traffic growth before achieving frequency saturation with the 747 on each flight. Although there are key routes that are capacity constrained, it will be 10-20 years before a large number require the A380's capacity.

At typical average load factors of 70%, airlines still need about 100 more passengers per flight to switch from a 747-400 to an A380 before they can economically justify the larger aircraft. Although the A380 has about a 10% seat-mile cost advantage with fuel, maintenance, flight crew and finance charges, once the costs of flight attendants, ground and passenger handling, catering, and navigation and airport charges have been added, the A380's seat-mile cost advantage will be diluted. Airlines therefore cannot afford to discount fares too heavily, and will need yield mixes similar to those they achieve on the 747-400 to justify the A380.

The A380 is nevertheless in a strong position, since there is a finite number of potential customers, and many of these are already committed to the aircraft.