

Freight traffic growth over 20 years means the large freighter fleet will have to treble in size, and require 770 additional aircraft. Some will come from converted MD-11s and 747s, while others will be new 747-400s, 747-Xs and A380s. What proportion each type will receive is assessed.

Carving up the large freighter market

The market for large freighters is now contested by more conversion and factory built aircraft types than ever before. This class of freight aircraft includes the MD-11, 747, 747-X and newly launched A380F.

Freight growth is expected to be higher than passenger traffic for many years, leading to a threefold increase in freighter fleet size. High traffic growth should lead to an increased number of larger aircraft being required. So how many large freight aircraft will be required in the next 20 years, and what types will the major freight carriers favour?

Freight growth

Annual freight is forecast to grow by as much as 6.4% per year, higher than the 4.8% level for passenger traffic. Although it is not expected that this rate of freight growth will be sustained for 20 years, total traffic is forecast to increase by a factor of 2.7.

"This growth will not be the same geographically because of currency strengths and weaknesses," explains Rick Hatton, president of Cargo Conversions LLC. "For example, a weak Euro means exports from Europe will be boosted, but lowers imports into Europe. Asia has low labour costs, so exports out of this region will be greater than imports. These sorts of factors stimulate one-way traffic. In terms of traffic growth, the Asia Pacific is the strongest global region and Europe the second. The US has an insatiable ability to import goods."

Freight aircraft are classified in four size brackets: small and medium types (narrowbodies) and two larger ones

(smaller and larger widebodies). Current routes and the opening of new ones will share this traffic growth, and there will be a shift in the proportions of aircraft numbers in the four size categories. Many smaller narrowbodies are expected to be replaced by larger ones on current routes, and the DC-8s and 707s are likely to be replaced by smaller widebodies in many of the same markets.

Large freighter economics

There will also be an increase in the proportion of large freighter types. This category includes MD-11s and 747s. The large bracket currently consists of about 320 aircraft, 20% of the total fleet. MD-11s and 747s are operated mainly by the largest airlines operating scheduled routes, many on a wet lease basis for major passenger airlines. The majority of these are converted passenger aircraft.

The economics of operating the largest freighter types has hinged on traffic and aircraft utilisation. Until recent years the utilisation that could be generated by airlines operating long-range routes was only high enough to justify the use of aircraft with low capital cost. This placed emphasis on converted aircraft. Most operations using converted 747s generated only up to 3,500FH per year. Few airlines could justify the capital cost of a new factory-built freighter, which could cost up to four times as much.

Other factors favouring used aircraft are traffic volumes, load factors and freight yields which, on long-distance routes, were at such a level compared to capacity that converted aircraft have been more attractive than factory built types.

The current 747 freighter fleet is

dominated by converted -100s and -200s. The lease rates of used aircraft are far lower compared to new -400Fs. Only major carriers operating the longest routes with high utilisation have bought the 747-400F.

"The case of used versus new is complicated by several factors. High capacity keeps yields depressed, but there is also a high spread in freight yields," explains Hatton. "An airline does not want to have to accept low yield materials just to fill the aircraft. Traffic therefore has to grow to quite a high level before both load factors and yields are high enough to justify a new 747 compared to a converted aircraft."

The forecast increase in freight traffic means that large freighters will have higher loads and need to operate more flights and generate higher levels of utilisation, increasing the need for new freighters.

Recent developments

In the mid 1990s the delivery of new generation widebodies, the A340 and 777, to major passenger carriers added a lot of freight capacity to the global fleet. "As a guide, the belly freight capacity of three passenger aircraft is equivalent to one freighter. These new widebody deliveries therefore reduced demand for freighters, especially large aircraft," says Hatton.

The delivery of substantial numbers of new widebodies was shortly followed by an economic downturn in the Asia Pacific region. The combination of a slowdown in freight traffic growth and depressed yields reduced demand for converted and new freighters.

Demand for large freight aircraft has



been revived in recent years by a recovery in the Asia Pacific region and continuing freight traffic growth outstripping belly capacity in passenger aircraft. This has increased yields. Increased international trade and a strong US economy has also increased demand for freight capacity. "The internet has fuelled an increase in traffic volumes, with items being bought by individuals," says Hatton. "The majority of freight going long distance, and being carried by large aircraft, are commodities, such as electronics, fashion goods and high end agricultural products. Many shipments now require volume capacity, rather than weight capacity."

Major 747 operators have experienced the benefits of a sharp improvement in market conditions leading to a rise in aircraft utilisation. Cargolux is one example. "Our revenues have grown at about 18% per year in the past five years," says Heiner Wilkens, president of Cargolux. "This has doubled the size of the airline, and has changed the economics of the operation. Load factors now average 90-92% per year, which means we need more capacity. This will help us improve unit costs. Like most other freight carriers, we feel the effects of yield erosion and need to improve efficiency."

The past two years have seen a sudden increase in demand and orders for the 747-400F. This has also slowed down conversions of 747-100s and -200s. Virtually all major 747F operators acquiring aircraft in the past two years have ordered the 747-400F, many of them for the first time.

Cargolux is one carrier that has

increased its 747-400 fleet in the past two years, while also disposing of all its older 747-200s.

Several other major freight carriers have experienced the same rise in freight traffic and responded to it by ordering the 747-400. Until 1999 the 747-400F had secured 75 orders, eight sales per year. In 2000 this doubled to 16. Sales have been concentrated with Asiana, Cathay Pacific, Cargolux, Korean and Atlas Air.

Fleet profile

Although freight traffic is expected to increase by a factor of 2.7, the global fleet is forecast to increase by a factor of 1.9. This less than proportionate increase in the fleet is explained by higher predicted load factors, and a switch to larger types.

The current freight fleet of 1,700 aircraft is dominated by narrowbodies. In 20 years narrowbodies are expected to account for about 1,300 aircraft, or 40% of the total fleet. The larger freighter category is forecast to almost treble in size from 320 aircraft to 890. The two other categories will make up the balance of the fleet.

Besides international trade and traffic growth, another factor is that the packing density of all freight is declining. When packing densities were higher, structural payload and maximum packing densities were the most important features of aircraft. With falling densities, the emphasis has shifted to volume, and this stimulates demand for capacity and larger types.

The current fleet of 320 large freight

The large freighter category is expected to grow from 320 to 890 aircraft over the next 20 years. Retirements over the same period means 770 aircraft will have to be added. Estimates vary, but 410 of these will be converted and 360 new factory-built aircraft. Of the conversions, about 300 will be 747s. Increasing competition from the 747-400 will reduce the number of -200s and -300s converted.

types includes DC-10s, MD-11s and 747s. This is forecast to increase to 890 by 2020, a net increase of 570. Over the same period 120 of the current fleet are forecast to retire, meaning 770 aircraft will have to be added. These will be a combination of converted MD-11s, 747-200/-300s and 747-400s; and new 747-400Fs, 747-XFs and A380Fs.

Boeing's forecast is that, of the 770 additions to the large freighter fleet, 410 (53%) will be converted aircraft. The remaining 360 will be new aircraft. The market for new aircraft will be divided between the 747 family and A380F, but there will be a market on average for only about 18 factory-built freighters per year between Airbus and Boeing.

The split between the number of MD-11 and 747 conversions can be easily forecast. There are more than 150 MD-11s still in passenger operation. About 40 aircraft from American, Swissair and Japan Airlines are committed to conversion. The majority of MD-11s will probably be converted to freighters, meaning a total of about 150 aircraft.

The MD-11 will satisfy the lower end of the large freighter category. The MD-11 has a net payload in the region of 190,000lbs and a range performance which makes it capable of operating trans-Atlantic routes. Converted 747s will serve similar route lengths with higher capacity requirements.

About 300 remaining aircraft of the 410 that are forecast to be converted will be 747-200s, -300s and -400s. This is a market for about 15 conversions per year. There are about 270 candidate -200 and -300 combi and passenger aircraft available. The combi and higher gross weight -200s and -300s are the only ones likely to be considered for conversion, making about 180 aircraft.

747 market

The recent increase in sales of 747-400Fs means the market for 747-200/-300 conversions is continually being revised down. Boeing Services aims to launch the conversion of the 747-400 in the 2003-2004 period, which will weaken the economic case for converting the older and less capable -200 and -300.

The -400F's superior payload-range performance compared to the -200SF

Demand for factory-built 747-400Fs has been bolstered by high traffic flows in and out of the Asia Pacific. Traffic growth, higher yields, longer routes and easier aircraft financing terms have allowed several key freight operators to justify the cost of acquiring new aircraft.

means that, although the two have similar volumetric payloads, the -400F can carry the same payload further. The -400F is also able to operate many routes non-stop with an economic payload. Boeing Services estimates an Asian carrier operating the -400F is able to pick up an entire extra return flight per week between the Asia Pacific region and either Europe or the US because of its higher productivity.

“There is still a good demand for MD-11s and converted 747s, but it depends on the price of the aircraft. Used aircraft values have to fall low enough to enter the zone where it becomes economic to convert them,” says Hatton. “The utilisation and yields required to justify a new 747-400F are high enough for there to still be demand for quite a large number of 747-200 conversions. The utilisation break point between a converted and new 747 is about 400 flight hours (FH) per month”.

While Boeing estimates half of the additions to the large freighter fleet will be factory-built aircraft, Hatton expects new types will account for only about a quarter, and conversions will still dominate.

The difference in unit operating costs of fuel, maintenance, flight crew and aircraft finance for the 747-200SF and 747-400F will be influenced most by aircraft utilisation. The 747-200SF has traditionally operated at about 3,500FH per year. At this rate of utilisation, the -200SF and -400F have close ton-mile costs although the -200SF is the more economic option. This is, however, only when the 747-400F has a lease rate of \$950,000 per month. This is only possible if the operator is able to get a substantial discount on list price, as well as a low lease-rate factor. Both have become easier to obtain in recent years, and lease rate factors have dropped to below 1% of purchase price per month because of more recent financing techniques. This low finance charge has put downward pressure on -200SF lease rates.

In the past the ratio of the -400F's and -200SF's finance charges was higher. This, combined, with lower traffic volumes and yields favoured the -200SF.

At a higher rate of utilisation of about 4,500FH per year for the -200SF and 5,000FH for the -400F, the ton-mile costs



for the -400F are about 15% lower than for the -200SF. The -400F will get a slightly higher rate of utilisation because of its longer range.

Comparison of unit costs at these two levels of utilisation illustrate the cross-over between the 747-200SF and -400F. The markets for these two aircraft have become clearly separated, and the -200SF will continue to serve the shorter and less busy routes with lower traffic volumes and yields. The -400F is more suited to serving longer distance markets, with no technical stops and operating for airlines which can generate high utilisations.

Some airlines are able to generate even higher rates of utilisation with the 747-400. “Our aircraft achieve about 5,500FH per year,” says Wilkens. “This is necessary since they are extremely expensive. The high rates of utilisation means the 747-400 is the right aircraft compared to the -200, the last of which we sold in 1999.”

While Cargolux has opted for an all new fleet of -400Fs, other major 747 operators operate a mixed fleet. “Because Atlas Air operates wet lease contracts for other airlines we are dependent on their requirements, and also have to offer the cheapest unit cost,” explains Rick

Shuyler, executive vice president at Atlas Air. “Also, our growth and expansion are dependent on the contracts we get, rather than freight traffic growth. We now operate 37 747-200SFs and -400Fs, but could have a fleet of 100 aircraft in 5-10 years if we continue to expand at the same rate. The choice between -200SF and -400F is dependent on route distance, the density of the material, payload carried and aircraft utilisation that we could generate. If we can get a higher aircraft utilisation we can then justify the -400F. Until the 747-X and A380 become available in 2008 we will continue to consider both the -200SF and -400F.”

747-400 conversions

The economic case for converting the 747-400 to a freighter is based on the resulting lease rate of the aircraft. To offer the right economics compared to the -200SF and factory built -400F, a converted -400 would need a lease rate in the region of \$750,000 per month. Lease rate factors of aircraft with a 15-year remaining life are in the order of 1.2%, meaning the build cost for a converted 747-400 would have to be in the region of \$65 million.

A380, 747X-STRETCH & 747-400F PAYLOAD DATA

Aircraft type	A380F	747X-Stretch	747-400F
MTOW lbs	1,285,000	1,043,000	875,000
MZFW lbs	879,000	760,000	610,000
OEW lbs	548,000	446,600	361,000
Maximum structural payload lbs	331,000	313,400	249,000
Upper deck			
Container type	Pallet	N/A	N/A
Number	17		
Total volume cu ft	9,095		
Main deck			
Container type	Pallet	Pallet	Pallet
Number	28	36	30
Total volume cu ft	17,640	25,817	21,347
Lower deck			
Container type	LD-3	LD-1	LD-1
Number	36	42	37
Total volume cu ft	5,256	7,350	5,600
Total capacity			
Total volume	31,991	33,167	26,947
Volumetric payload @ 6.5 lbs per cu ft	207,941	215,585	175,155

Conversion and maintenance to prepare for service will account for about \$20 million of this cost. Current market value of the passenger aircraft would then need to be about \$40 million.

Avitas puts the current market value of 1989-built -400s at \$65 million, and does not forecast base values to drop to \$40 million until around 2011. That is, the value of the aircraft based on economic ability. Current market values, determined by market demand, will be lower than base values. Considering that freight conversion is the only secondary market option for 747-400, they may reach \$40 million several years before 2011.

If major passenger operators need to re-structure their fleets to accept the 747-X or A380, or increase frequency and opt for the 777 or A340, 747-400 retirements may push their values down to \$40 million fast enough for the first conversions to happen in the 2004-2006 timeframe.

747-X & A380

The predicted market for new freighters is 360-380 aircraft. This includes the 747-400F, 747-X and A380.

This limits sales of new aircraft to less than 20 per year, meaning competition for orders will be fierce. This could work to airlines' advantage through securing generous purchase discounts.

The new aircraft market is divided in two. The first is the 747-400F, which has a structural payload of 249,000lbs.

The larger 747-X Stretch freighter and A380F have similar structural payloads of 313,400lbs and 331,000lbs.

Major freight carriers which have ordered the 747-400F in recent years are likely to continue acquiring more aircraft. This includes Atlas Air, Cargolux, Cathay Pacific, Air France, Korean and Polar Air Cargo.

Some of these airlines may require the 747-X or A380 by the time they become available in 2008. Others, such as FedEx

and UPS, seem more likely to bypass the 747-400F. FedEx has already selected the A380F. UPS is considering the A380 and 747-X, and there is also the possibility of Airbus launching a freighter version of the A340-600.

The launch of the A340-600 as a freighter would crowd an already limited market for new aircraft, but would challenge the -200SF. Until the 747-X and A380 become available, airlines will opt between converted 747s and new -400Fs. Airlines which have ordered the 747-400F will be the main 747-X and A380 customers.

The competition between the 747-X and A380 will be interesting, since the two aircraft have similar payload capabilities.

The A380F's maximum structural payload is only 17,600lbs more than the 747-X Stretch (see table, this page). The A380 is heavier than the 747-X Stretch in all respects, in that it has a higher operational empty weight, maximum zero fuel weight and take-off weight.

The A380, however, has three decks compared to the 747's two, including its unique upper deck, which provides more volume. The A380's landing gear wells mean its lower deck has less space for containers than the 747-X Stretch. The A380's fuselage is also shorter than the 747-X's, and so the A380's main deck has less volume than the 747-X. The A380 therefore has to make up for this with the upper deck, but it still has 1,100 cubic feet less volume than the 747-X Stretch.

With packing densities now falling to the region of 6.5 lbs per cubic foot, the A380's volumetric payload will be lower than the 747-X Stretch's, at 207,900lbs. This compares to 215,600lbs for the 747-X Stretch (see table, this page).

The similarity in payloads will have the largest influence on airline fleet selections. The configuration of an upper deck on the A380 will also pose an additional consideration in aircraft selection. "The A380 and 747-X Stretch have similar payloads, but the 747 can take tall payloads if these have to be carried," says Wilkens. "The A380 has the advantage of being young and at the start of its life cycle, while the 747 is now at the end of its development cycle. This has an implication on aircraft residual values, since the A380 will be around for many years after the 747."

The similarity of payloads in comparison to the difference in list prices could make the 747-X Stretch more competitive than the A380. Special loading considerations also have to be made for the A380. The A380F, however, has the same fuselage as the -100 passenger model. The freighter version of the A380-200 should increase freight capacity, meaning airlines could favour the A380 as a longer-term solution. **AC**