An Overview of Commercial Aircraft

2017 - 2018

DVB Bank SE
Aviation Research (AR)

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Introduction

For an asset-based financier, the characteristics of assets used as loan collateral are of great importance. An in-depth understanding of the asset is essential to be able to assess the viability of financing opportunities. **DVB Bank SE** is a **leading financial specialist in international transport finance.** DVB's Aviation division uses this expertise to act as a highly specialised aircraft lender.

In this booklet, **DVB Aviation Research ('AR')** presents an overview of commercial airliners. The aircraft types that are included are the main western-built types that are currently in operation or that have been launched. Some new aircraft developments out of Russia, China and Japan are also considered as modern and therefore these have been included as well. Also included are two turboprop aircraft; the ATR 72-500/600 and Bombardier Dash-8 Q400, which the Bank considers suitable for asset based financing. Older types that are deemed to be less relevant for the Bank's day-to-day business (such as the DC-9, B707, B727, BAe146, MD-11Pax etc.) have been omitted. This publication is intended to be used for reference purposes only.

For each aircraft type, key data includes:

Class: Short description of size and/or range category to which the aircraft belongs.

First Flight: Acts as a guide to the age of the technology employed in the aircraft model.

First Conversion: For cargo aircraft, this indicates the year in which the first (cargo) conversion into the subject aircraft type/variant has taken place.

Standard Seating: Refers to the type's passenger seat count for the most commonly employed number of seat classes as used in the manufacturer's marketing material.

Max. Payload: In case of a freighter aircraft, the maximum gross payload includes the weight for containers and/or pallets and is restricted by the Maximum Zero Fuel Weight (MZFW).

Range: Indicates the range of the aircraft in nautical miles with the specific passenger payload identified. Airlines categorise aircraft by size. Aircraft in a given size-category but with less range than their peers often suffer from reduced market acceptance.

Engine Options: Indicates the various engine types installed or to be installed on the total fleet (in service + on order + in storage) of the subject aircraft type. The fragmentation of the various engine types is expressed as a percentage of the total fleet. Engine types which were offered but never produced/ordered for the subject aircraft type are not included. A fleet fragmented by engine type may have more limited remarketing prospects.

In Service: Number of aircraft in service for passenger and/or freight operations of commercial operators (September 2016).

On Order: Number of aircraft ordered by commercial operators for passenger and/or freight operations (September 2016).

In Storage: Number of stored aircraft for passenger and/or freight operations of commercial operators (September 2016).

Operators: The number of commercial operators which have the subject aircraft type in service, on (firm) order or in storage (September 2016). The number of operators generally gives an indication of remarketing prospects but, the quality of the operator base is not expressed. A large number of weaker operators may also confer a higher likelihood of bankruptcy-driven surplus (especially for older types) in the event of a downturn.

Last Delivery: Indicates the month and year in which the last aircraft of the specific type was delivered. In case the type is still in production, N/A (Not Applicable) has been assigned. In case the end of production of the type has been announced, the estimated (est.) delivery month of the last aircraft is expressed.

The **aircraft description section** generally contains the background of the subject aircraft type, some technical and/or operational characteristics complemented with market information and possibly information on the market potential for freighters (both production and converted freighters). Any qualitative statements should be regarded as AR's current opinion of the type, which is not necessarily the official opinion of DVB Bank SE.

In addition to the individual aircraft overview, AR has included **diagrams** which give an overview of the various **seat-range characteristics** of the individual aircraft types within a specific category (regional, narrowbody, widebody and freighter jet aircraft).

AR has decided not to include any value references as such information could be confusing and/or easily misinterpreted as it requires a broad explanation of definitions and assumptions. For a view on the various values of the aircraft types, AR can always be contacted directly.

AR hopes that this booklet proves to be a useful instrument for a better and broader understanding of the assets that the Aviation division is concerned with. For specific questions or suggestions for improvement, please contact the AR team.

DVB Aviation Research
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AIRBUS

Airbus A318-100

Class:	Small Narrowbody
First Flight:	15 January 2002
Standard Seating:	107 (2 class), 132 (1 class)
Range:	1,500 - 3,100 nm
Engine Options:	PW6000A (14%), CFM56-5B (86%)
In Service:	41
On Order:	0
In Storage:	8
Operators:	5
Last Delivery:	April 2015

As the smallest member of the A320 family, the A318 is a niche market aircraft designed for A320 family operators who have a (small) requirement for 100-seat aircraft and prioritize fleet commonality over lower operating cost. Because the A318 is a ''double shrink'' from the baseline A320 model it is relatively heavy and is therefore unable to compete with purpose-built 100-seaters such as the Embraer 190/195 and the Bombardier CS100. As a result it has a small operator base and order book. In June 2007 it was certified by the European Aviation Safety Agency for steep approach operations, making it the largest commercial aircraft to operate at airports such as London City. Next to the CFM56-5B that can be used on all members of the A320 (ceo) family) Airbus offered PW6000 engines, which may have operational advantages but undermine the commonality with other A320-family aircraft, the A318's strongest selling argument. In addition the PW6000 suffered serious technical setbacks which lead to the cancellation of many A318 orders, leaving AVIANCA Brazil as the only operator of the PW6000. Only 15 P&W powered A318s have been built. In 2010, the first A318 (2004 built, CFM engines) was parted out. 11 (all ex Frontier CFM powered aircraft) A318s have already been scrapped. The A318 has a high commonality with the other A320 family models, making an A318 more valuable today in parts than as a "flyer".

Airbus A319-100

Class:	Moderate Size Narrowbody
First Flight:	29 August 1995
Standard Seating:	124 (2 class), 156 (1 class)
Range:	1,900 - 3,700 nm
Engine Options:	CFM56-5A (10%) -5B (56%), IAE V2500-A5 (33%) TBD (1%)
In Service:	1,321
On Order:	15
In Storage:	24
Operators:	119
Last Delivery:	N/A

The A319 is a simple shrink of the baseline A320. Like its main competitor, the 737-700, it is used by a wide range of operators. The increased MTOW options combined with up to two additional fuel tanks give the A319 a relatively long range by single aisle standards. Since 2013 "Sharklets" have been available for the A319s resulting in 4.0% fuel burn improvement and 500kg more payload. Airbus launched a Sharklet retrofit programme-replacing the original wingtip fences for in-service A320 Family aircraft (MSN 1200 and above) late October 2013. Also, Airbus developed cabin enhancements to raise the A320 Family's seating capacity through changes to cabin monuments (new rear galley configuration and lavatory design) and the use of slim-line seats. In 2014 the Aviation Authorities reassessed the A320 family exit limit to increase the A320 exit capability, which allowed a higher seating capacity on the A320 Family aircraft. For the A319 with the single over-wing exit, all these initiatives improved the seat count by up to fifteen additional seats, resulting in lower operating cost per seat. Airbus developed a second over-wing emergency exit option, initially for easyJet, allowing an increase from 145 to 156 passengers. This version proved to be popular in the used equipment market, but with the reassessed and authorized exit limit using wider escape slides, this double over-wing exit is no longer an advantage, except for reasons of fleet commonality. The A319 is also offered in a low density long range version for (high) premium services and as an intercontinental corporate jet version with up to 6 additional fuel tanks. There are 67 A319s in service as corporate/private jet/VIP/Head of State aircraft (called the ACJ319, 2 on order and 6 stored on order for a total of 51 customers).

For a long time the A319 was the second most popular member of the A320-family, but it has lost this position as the second most popular version to the A321 based on the current trend in orders. With just 15 A319s on order and only 21 orders placed in the last two years, A319 sales have been lagging behind the larger A320 and A321 which have lower seat mile costs due to their larger seating capacity. The outlook for the A319 is a bit diffuse. Biggest operator Easyjet has started to gradually phase out the A319, but on the other hand low cost carriers as Allegiant and Volotea are looking for second hand A319s in a transitioning process from a MD-80 / Boeing 717 fleet to an Airbus narrowbody fleet. The small narrowbody segment will see some new entrants in the near future. Bombardier steps in with the all new design CS300 capable of 160 seats and Embraer offers the re-designed and re-engined E195-E2, which will be a 10-seat stretched compared to the old E195 and now offers ~135 seats. Arch-rival Boeing offers the Boeing 737-700 in the same capacity class as well as the re-engined and slightly stretched "MAX" version, dubbed 737-7. Also the new Russian MC21-200 falls in this market. But Airbus itself is offering the A319neo, a re-engined A319-100 and approximately a 15% more efficient successor. The A319neo will be available as from mid-2017. Given its small fuselage, a freighter conversion for the A319-100 is very unlikely.

Airbus A319-100neo

Class:	Moderate Size Narrowbody
First Flight:	est. 2017
Standard Seating:	140 (2 class), 160 (1 class)
Range:	2,100 - 3,750 nm
Engine Options:	CFM LEAP-1A (64%), PW1100G-JM (0%), TBD (36%)
In Service:	0
On Order:	55
In Storage:	0
Operators:	3
Last Delivery:	N/A

In December 2010, Airbus launched the 'New Engine Option' (or "neo") for the A320 family. The base-line A320neo entered service in 2016 and the shorter A319neo probably will follow one year later. Like the A320neo, the A319neo will be powered by either Pratt & Whitney's PW1000G ('Geared Turbo Fan') engines or CFM's new LEAP 1A engines. These larger (higher bypass ratio) and slightly heavier engines reportedly will offer a 15% fuel burn advantage over today's engines. Together with some aerodynamic and structural adjustments and new winglets ('Sharklets'), the anticipated net efficiency gain is expected to be 10-15% for the A319neo vs. the A319. Under "the Increased Cabin Efficiency" name, Airbus offers new slime-line seats and a change of cabin monuments (Space flex / Smart Lavatories) which raised the A319neo's seating capacity to 140 or 160 seats, so improving further the seat-mile economics of the A319 design.

Apart from competing with the 737 MAX 7, the A319neo is also aimed to fence off competition from Bombardier's CS300 and a possible "CS500" stretch of that type. With only 55 A319neo aircraft on order, it is the slowest selling variant of the new A320neo family. It has attracted less orders than its main competitor, the equally slow selling Boeing 737 MAX 7. With new entries in the 120-140 class segment (CS300, E195-E2, MS-21) and dwindling sale figures of the B737-700NG and current A319, the A319neo will enter a tough market. The EIS of the A319neo is scheduled for mid-2017.

Early 2014 P&W announced that it is developing an upgrade (improved blade profiles and component contours) for the PW1100G geared turbofan engine that should reduce fuel consumption by 4%, bringing the total benefit to 19%). The upgrade will be introduced in 2019 and the new components will not become available for retrofit on existing PW1100G engines, but only be included in new-build engines. As observed after engine upgrades in the past, the introduction of such upgraded P&W GTF engines (if not retrofittable) may have an impact on the values of the first A320neo family aircraft, equipped with the older and less efficient P&W GTF engines. Airbus also offers a Corporate Jet version of the A319neo.

Airbus A320-200

Class:	Medium Narrowbody
First Flight:	27 June 1988
Standard Seating:	150 (2 class), 180 (1 class), 189 (high density)
Range:	2,650 - 3,300 nm
Engine Options:	CFM56-5A (5%) -5B (54%), IAE V2500-A1 (1%) -A5 (39%), TBD (1%)
In Service:	3,892
On Order:	468
In Storage:	61
Operators:	263
Last Delivery:	N/A

The A320-200 is the baseline aircraft of the Airbus narrowbody family. One of the most successful jets in history with respect to sales volume. The A320 was initially developed in two different payload/ range variants. The A320-100 was the first variant and only 21 were delivered. The second variant is the longer range A320-200, featuring wingtip fences and increased fuel capacity. The selection of the A320 by JetBlue in 1999 highlighted the successful entrance of the A320-family in the low cost market and was followed by more low-cost (start-up) orders, particularly from Asia. Unlike the Boeing 737 "Next Generation" family, the A320 family has the option to be equipped with either CFM56 or IAE V2500 (PW6000 instead of V2500 on the A318) engines. Although this choice is an advantage for operators during purchase negotiations, in theory two sub-fleets could limit remarketing options. In case of the A320 the two subfleets each have enough critical mass to ensure market liquidity. Early A320s that are powered by the older V2500-A1 or CFM56-5A engines are sometimes referred to as A320'Classics'. The V2500-A1 engines, despite a "Phoenix" upgrade kit, need substantially more maintenance which makes them much less attractive. As from late 2012, so called 'Sharklets' (Airbus marketing name for winglets) have been available for new A320s resulting in approximately 4.0% fuel burn improvement which further enhances operational flexibility (500kg more payload or 150nm additional range). Airbus launched a Sharklet retrofit programme for in-service A320 Family aircraft (MSN 1200 and above) late October 2013. Also, Airbus has developed cabin enhancements to raise the A320 Family's seating capacity through changes to cabin monuments (new rear galley configuration and lavatory design) and the use of slim-line seats. In 2014 the Aviation Authorities reassessed the A320 family exit limit to increase the A320 exit capability, which also contributes to a higher seating capacity on the A320 family aircraft. For the A320, all these initiatives improved the seat count by up to nine additional seats, resulting in a lower fuel burn per seat on average.

In December 2010 Airbus launched the A320neo as 15% more efficient successor aircraft for the A320-200. The first A320neo was delivered to Lufthansa in January 2016. Despite the launch of the A320neo and the trend in recent years of swapping orders to the larger A321, sales of the current A320 aircraft have remained high. Mid-2016 there was still a backlog of ~ 450 Airbus A320-200s. Allegiant Air-normally acquiring used A320s-surprised the industry by placing an order for 12new Airbus A320-200s of the current generation with deliveries scheduled for 2017 and 2018. Allegiant was probably offered attractive conditions to take these "last-of-the-line" A320-200s, as Airbus ramps up sales for the A320neo. Given the large order backlog for all A320 family aircraft (CEO and especially NEO), the production rate for the A320 family will be increased from the current level of 42 aircraft a month to 50 a month in Q1 2017 and finally to 60 aircraft a month by mid-2019 with a new line in Hamburg. From 2018 all production aircraft will be neo variants. The New Final Assembly Line (FAL) in Mobile (Alabama, USA) will produce

about three / four aircraft per month by 2018. Together with its current facilities in Hamburg, Toulouse, and Tianjin-Airbus now has a global FAL network to serve customers from different continents. The introduction of the A320neo is likely to impact values of current generation narrow-bodied aircraft, but the degree will depend on the price of fuel.

In 2007 Airbus launched a Passenger-to-Freighter (P2F) programme for the A320, together with EFW and Russian companies IRKUT and United Aircraft Corporation (UAC). But only three years later Airbus and its partners announced a decision "to stop and freeze "the programme and dissolve the partnership. PacAvi subsequently announced an independent P2F conversion for the A320 (and A321) in 2014 and has inducted an A320-200 for conversion in a facility at Hahn airport and conversion on this aircraft began in January 2015. PacAvi aims to get the A320P2F supplemental certificate (STC) in due course and will be joined in this programme by AeroTribune. Conversions will be done at Goodyear (Arizona, USA). Today PacAvi says it has some 47 orders for this conversion programme. Airbus/EFW, now together with ST Aerospace re-launched a P2F programme for the A320 and A321 in June 2015, with the first deliveries scheduled to take place in 2019 (A321) and 2020 (A320). There will be four facilities for this conversion programme in Dresden, Singapore, Mobile and Guangzhou.

Airbus A320-200neo

Class:	Medium Narrowbody
First Flight:	25 September 2014
Standard Seating:	165 (2 class), 189 (1 class)
Range:	3,150 - 3,500 nm
Engine Options:	CFM LEAP-1A (35%),PW1100G-JM (26%), TBD (39%)
In Service:	16
On Order:	3,415
In Storage:	0
Operators:	63
Last Delivery:	NA

In December 2010, Airbus launched the 'New Engine Option' for the A320. A320neo's customers have the choice between either the Pratt & Whitney's PW1100G-JM ('Geared Turbo Fan') engines or CFM's new Leap-1A engines. The larger (higher bypass ratio) and slightly heavier engines reportedly will offer a 15% fuel burn advantage over today's engines. Together with some aerodynamic and structural adjustments and new winglets ('Sharklets'), the anticipated efficiency gain is expected to be 10-15% for the whole aircraft when compared to today's A320 production standard. In terms of payload/range, this should result in approximately 2 tonne higher useful payload capability over a typical A320 mission or a 500nm increase in range. Per September 2016 more than 3400 A320neo's have been ordered, making it the fastest selling aircraft ever.

On 20 January 2016 the first delivery of an A320neo took place. The first A320neo was delivered to Lufthansa. With a backlog of more than 4.000 A320neo family aircraft, this was a historical event. But being the first delivery of one of the bestselling aircraft in history, was not the only historical fact of this event, it marked also the first delivery of a commercial jet aircraft equipped with engines featuring the Geared Turbofan technology. While an innovative and promising technology, it was this new engine that delayed the first delivery of an A320neo. Late 2015, launch customer Qatar Airways refused to take delivery due to concerns about the engine. The new P&W GTF engines reportedly suffered from rotor bow, or thermal bowing, due to asymmetrical cooling after shut down. This phenomenon is caused by differences in temperature across the shaft section supporting the rotor. If the engine is allowed to cool down after a flight, it cannot be re-started again too soon. A cold restarted engine has to run idle for three minutes before moving to full throttle. This gives a start delay of 3 minutes or 6 minutes for a dual-engine start (much longer than the industry standard of 1 minute). Pratt&Whitney will fix this start up delay issue with software and hardware fixes (additional coatings and strengthening of the 3rd and 4th shaft bearings). Aircraft already delivered will be retrofitted. Although this sounds as a minor problem, it caused Qatar Airways to refuse taking delivery of their aircraft. Lufthansa became the first airline to receive the A320neo and used the new A320neo in its first months of service especially on domestic routes in Germany, close to their maintenance bases. Flying to other destinations in their network will take place when all the engine issues are solved. The first A320neo equipped with LEAP engines was delivered to Turkey's Pegasus Airlines in July 2016.

The market between the GTF and LEAP is fiercely competitive. The majority of A320neo engine choices is still "undecided" (39%). CFM so far has taken the lead with 35%, probably based on the excellent reliability reputation of the "old" CFM56. After years of absence, except as partner in the IAE-consortium, P&W has to fight for market share, which is currently still a minority with 26%. With a high percentage of

undecided the battle is by no means over. Early 2014 P&W announced that it is developing an upgrade (improved blade profiles and component contours) for the PW1100G geared turbofan that should reduce fuel consumption by 5% after 2019 (bringing the total benefit to 20%). The upgrade package will be introduced in 2019 and the new components will not become available for retrofit on existing PW1100G engines, but only be included in new-build engines. As observed after engine upgrades in the past, the introduction of such upgraded P&W GTF engines (if not retrofittable) may have an impact on the values of the first A320neo family aircraft, equipped with the older and less efficient P&W GTF engines.

Airbus A321-100

Class:	Large Narrowbody
First Flight:	11 March 1993
Standard Seating:	185 (2 class), 220 (1 class)
Range:	2,300 - 2,400 nm
Engine Options:	CFM56-5B (52%), IAE V2500-A5 (48%)
In Service:	56
On Order:	0
In Storage:	2
Operators:	13
Last Delivery:	June 2001

The A321 is the largest member of the A320 family and was designed as a stretched A320 with an improved wing, increased weights and higher thrust engines. The aircraft was offered in two versions; the basic-100 and the longer-range-200 variant. The-100 was optimized for relatively short range compared to the A320 and an extra fuel tank was not added to the initial design to compensate for the extra weight. The A321-100 was especially favoured by airlines in Europe but lacks the range for North American coast-to-coast operations. A321-100s with msn >633 are often certified for low MTOW operations but are built according to the A320-200 standard with a structural MTOW of 89t (196k lb) and could be upgraded to higher weights by a relatively easy 'paper change', that usually require some "monetary compensation" to the OEM, though. For increased range capability, an additional centre (fuel) tank (ACT) would be needed. More than half of the 56 A321-100s currently in service are flying with just two (Lufthansa and Alitalia) of its 13 operators. 12 A321-100s have been scrapped in the past 2 years.

Airbus A321-200

Class:	Large Narrowbody
First Flight:	15 March 1997
Standard Seating:	185 (2 class), 220 (1 class), 230 (High Density)
Range:	2,700 - 3,200 nm
Engine Options:	CFM56-5B (37%), IAE V2500-A5 (57%), TBD (6%)
In Service:	1,242
On Order:	364
In Storage:	23
Operators:	113
Last Delivery:	N/A

The A321-200 is the same size as the A321-100 but features structural reinforcements, a higher weight schedule and a provision for two ACTs which gives it its 3,000+ nm range. The 89t (196k lb) A320-200 version with reinforced structure became the A321 production standard from 1997 while further weight upgrades eventually resulted in a maximum MTOW of 93.5t (206k lb). From mid-2013 'Sharklets' have been available for new A321s resulting in c.4.0% fuel burn improvement and 2,550kg more payload which further enhances operational flexibility. Airbus launched a Sharklet retrofit programme for in-service A320 Family aircraft (MSN1200 and above) late October 2013. Also, Airbus has developed cabin enhancements to raise the A320 Family's seating capacity through changes to cabin monuments (new rear galley configuration and lavatory design) and the use of slim-line seats. In 2014 the Aviation Authorities reassessed the A320 family exit limit to increase the A320 exit capability, which also contribute to a higher seating capacity on the A320 family aircraft. For the A321, all these initiatives improved the seat count by up to almost twenty additional seats, resulting in a much lower fuel burn per seat.

The A321-200 was the first direct competitor to the Boeing 757-200. While not as range-capable as the Boeing 757-200, the A321-200, especially the higher MTOW version, became a strong competitor on medium routes, such as US coast-to-coast. With the A321 (and later Boeing 737-900ER) taking over the US domestic routes, the 757 was marginalised to fly only long haul single aisle routes. In recent years, sales figures of the A321-200 have been rising and since 2010 it has outsold the A319, making it the second most popular aircraft in the A320 family. In the last two years the A321 has even outsold the A320 (157 orders/Type swaps versus 110 orders/type swaps for the A320). Sales of the A321-200 have especially been strong in the US for use on coast- to-coast routes. In recent years, the A321-200 has become popular among low-cost carriers. Frontier, Vueling, WizzAir and VietJet took delivery of their first A321-200s in 2015 and 2016. The December 2010 launch of the A321neo marked the introduction of a c.15% more efficient replacement, available as from late 2016. The freighter conversion programmes by Airbus / EFW / ST Aerospace and PacAvi/ Aerotribune will may extend the life of the A321 in the freight market, although generally only the first feedstock aircraft for cargo conversion trade at a premium over the part-out value.

Airbus A321-200neo

Class:	Large Narrowbody
First Flight:	9 February 2016
Standard Seating:	206 (2 class), 240 (1 class)
Range:	3,000 - 3,700 nm 3,300 - 4,050 nm (LR version)
Engine Options:	CFM LEAP-1A (30%), PW1100G-JM (46%),TBD (24%)
In Service:	0
On Order:	1,190
In Storage:	0
Operators:	48
Last Delivery:	N/A

In December 2010, Airbus launched the 'New Engine Option' (or "neo") for the A320 family. The base-line A320neo entered service in 2016 and the longer A321neo probably will follow late 2016. Like the A320neo, the A321neo will either have Pratt & Whitney's PW1100G-JM ('Geared Turbo Fan') engines or CFM's new LEAP-1A engines. The larger (higher bypass ratio) and slightly heavier engines reportedly will offer c.15% fuel burn advantage over today's engines. Together with some aerodynamic and structural adjustments and new winglets ('Sharklets'), the anticipated efficiency gain is expected to be 10-15% vs. the predecessor aircraft. Airbus also announced a new two door arrangement (Airbus Cabin Flex (ACF)-concept) for the A321neo, which will result in 16 more seats, bringing the total of passengers on a A321neo to 240(single class).This will make the A321neo an even stronger competitor to the 737-900ER and together with the increased range vs. the A321ceo, enhances its appeal as a potential 757 replacement. Early 2014 P&W announced that it is developing an upgrade (improved blade profiles and component contours) for the PW1100G geared turbofan that should reduce fuel consumption by 3% after 2019 (bringing the total benefit to 18%). The upgrade will be introduced in 2019 and the new components will not become available for retrofit on existing PW1100G engines, but only be included in new-build engines. As observed after engine upgrades in the past, the introduction of such upgraded P&W GTF engines (if not retrofittable) may have an impact on the values of the first A320neo family aircraft, equipped with the older and less efficient P&W GTF engines.

In October 2014, Airbus unveiled a new long range variant of the A321neo. The A321neo LR as it is called by Airbus is clearly aimed at the "middle-of-the-market "(757-200 replacement) market. It will have a range of 4.050 nm-200nm more than the Boeing 757-200 (some of which are used on long-range trans-Atlantic routes) and 400nm more than the standard A321neo. To achieve the extra payload/range performance, this new A321neo variant will have a 97 tonne MTOW and three auxiliary fuel tanks instead of two. The A321neoLR product study considers an aircraft with a three-class cabin of 114 economy seats, 30 economy plus and 20 lie-flat business seats. The A321neo LR will have a slightly lower cabin capacity than the 757-200 but comparable range. Intended markets are North America to Europe, Europe to Africa, North America to South America and S.E. Asia to Australia. With newer engines and a more modern design, the A321neo LR will have 27% lower fuel burn than the 757-200. Due to technical differences, no retrofit will be available to modify the standard A321neo to the standard of the new A321neo LR, but an aircraft built as an A321neo LR can be operated as a typical A321neo, because it is possible to remove (and re-install) the extra auxiliary tank and lower the MTOW. This offers maximum flexibility for airlines. The A321neo LR was officially launched by Airbus in January 2015 when it secured its first commitment from US lessor Air Lease Corporation (ALC), which signed a MoU for 26 A321neo LR aircraft in January 2015. In the summer of 2015 it was

announced that ALC has signed a contract with Air Astana for a lease of four of these A321neo LR aircraft to replace the 757s in Air Astana's fleet. During the Farnborough Air Show of 2016, Norwegian announced that it converted 30 of its previously ordered 100 A320neo aircraft to the A321neo LR. Norwegian intends to use these A321neo LR on transatlantic routes. The A321neo LR will be available from 2019.

Airbus A300-600(R)

Class:	Medium Widebody
First Flight:	9 December 1987
Standard Seating:	266 (2 class), 298 (1 class)
Range:	4,050 - 4,150 nm
Engine Options:	GE CF6 (87%), PW4000 (13%)
In Service:	23
On Order:	0
In Storage:	17
Operators:	9
Last Delivery:	September 2002

In the early seventies, Airbus entered the commercial aviation industry with the A300 as the first member of the A300/A310 family of regional twin aisle aircraft. After the A300B, which sold 250 aircraft by 1984, the A310 arrived, which offered a two-crew electronic flight deck, increased use of composite materials and a redesigned rear fuselage. These advances were written back into the A300 design and eventually led to the A300-600 and the longer-range A300-600R. Both variants primarily competed with Boeing's 767-300ER but suffered from inferior economics and fell short of the long-range market requirement that most airlines sought to fulfil at the time. The 767-300ER got the majority share of annual demand until Airbus offered the A300-600R's growth replacement-the A330-200. The last A300-600 passenger aircraft was produced in 2002 although, production of the A300-600 freighter continued until 2007. The freighter conversion programme took off in 2001 and helped for some time to control the oversupply of redundant passenger A300-600(R)s thanks to FedEx and European Air Transport / DHL. The amount of A300-600(R) in passenger service is dwindling and part-outs are now a common method to extract the last remaining value. Currently, the only 23 Airbus A300-600(R) aircraft in active service are operated by Iranian Airlines.

Airbus A310-200/300

Class:	Small Widebody
First Flight:	3 April 1982 (-200), 8 July 1985 (-300)
Standard Seating:	218 (3 class), 240 (2 class), 280 (1 class)
Range:	3,670 - 4,350 nm
Engine Options:	GE CF6 (65%), PW JT9D (2%), PW4000 (33%)
In Service:	35
On Order:	0
In Storage:	14
Operators:	15
Last Delivery:	June 1998

The A310 was developed as a shrink version of the A300 to complement the Airbus product line and better meet the needs of the short-mid range market's capacity requirements. Unfortunately, the market for such aircraft was smaller than envisaged, had to be shared with Boeing and wanted longer range. Originally developed as the medium range-200, the A310 was later also offered in the longer-range-300 version with an additional tail tank and more powerful engines. The-300 also introduced wingtip fences to improve aerodynamic efficiency, a feature that has since been retrofitted to some –200s. Both A310 variants have the same external dimensions. Compared to the earlier A300B models the A310 incorporates a new wing design, a redesigned rear fuselage, a two-crew "glass" cockpit and increased use of composite materials but, both models lack FADEC engines. In the passenger market the A310 lost out against the Boeing 767, which offers significantly better payload/range capabilities. The last A310 was produced in 1998. From the original (-200) variant, 85 aircraft were built of which none aircraft is in passenger service today. Some 48-200s were converted to freighter, but none of them are in service anymore today. From the A310-300, 170 aircraft were built, of which 35 aircraft are still in passenger service. Largest operators are Air Transat from Canada with 9 aircraft and Mahan Air from Iran, who also has a fleet of 9 A310-300s in active service. 38 A310-300s have been converted to freighter, of which 12 are still in service. 4 A310-300s remain in service as corporate/VIP/government aircraft, while 17 A310-300s found a role in the military as a tanker or multi role transport aircraft. With zero demand for A310 freighter-conversions, part out seems the logical end of life solution as long as there is value in the engines from which parts can be used for a rapidly shrinking fleet of other older generation twin aisles.

Airbus A330-200

Class:	Medium Widebody
First Flight:	13 August 1997
Standard Seating:	235 (3 class), 247 (2 class), 380 (1 class)
Range:	6,450 - 7,250nm
Engine Options:	GE CF6 (28%), PW4000 (20%), RR Trent 700 (50%), TBD (2%)
In Service:	501
On Order:	42
In Storage:	37
Operators:	91
Last Delivery:	N/A

The A330-200 is the longer range, shorter fuselage development of the A330-300. Airbus positioned the A330-200 as an efficient, more capable and more comfortable alternative to the Boeing 767-300ER. Due to the initial sales success of the A330-200, supported by significant interest from leasing companies, Boeing decided to launch the stretched 767-400ER in 1997. The A330-200s newer technology, superior range capability and crew commonality with the A320 and A340 families made the A330-200 the preferred choice in its category. The coinciding demise of the 767 drove Boeing to the development of the (failed) Sonic Cruiser and later the 787 (originally 7E7) which initially claimed performance should be 20-30% more efficient (787-8) than the A330-200. However, the 787's troublesome entry into service (delays) caused strong (interim) demand for the A330 which was granted 240min ETOPS certification in 2009 and is now also offered at an upgraded 242t MTOW for more payload/range to better compete with the 787. All A330s produced after MSN 1627 are 242t MTOW capable. Iberia and Aerolíneas Argentinas are the first operators of 242t MTOW A330-200s. The 242t MTOW option makes the A330-200 an interesting aircraft for airlines who need the extra performance for hot-and-high operations or who need a suitable aircraft for long range, relatively low demand routes.

The continuous improvement to the A330 programme and especially the A330-300 means that the A330-300 has now almost the same range to offer as the A330-200 with far more passenger load. This makes the A330-300 a more efficient aircraft. Since 2009 annual sales of the A330-200 have been less than the A330-300 and by 2013 the A330-200 was finally outsold by the A330-300. The A330-200 backlog is currently ~40 aircraft, including 15 aircraft for Kingfisher and it is highly unlikely, that these Kingfisher aircraft will ever be delivered. In recent years more and more A330-200s have been phased out (Emirates & EVA Air) and a large portion of the stored fleet is unplaced, although there are airlines picking up used A330-200s. Among these airlines are existing A330-200 operators who want to top up their fleet (Turkish Airlines, Air Transat, TAP Portugal), but also airlines who will use the A330-200 to start new long haul routes or replace older equipment (Eurowings, AZUL, SATA, Shaheen, Onur Air). Part-outs of A330-200 have started, but are still very low (~10 so far). The values extracted from the A330 airframe are still relatively low, as there is enough supply on the market from the large number of A340s which have been parted out so far (A340 and A330 airframes have high commonality). In December 2014, Egypt Air signed an agreement with EFW to convert two of the carrier's A330-200 passenger aircraft to freighter, making Egypt Air the launch customer for the A330 P-to-F conversion programme. The launch of an A330 conversion programme opens an aftermarket for older A330s. Derived from the A330-200 is the dedicated A330-200 Freighter, the military A330 Multi Role Tanker Transport aircraft and the corporate ACJ330. In 2014 Airbus introduced the A330-200's successor, the A330-800neo.

Airbus A330-800neo

Class:	Medium Widebody
First Flight:	est. EIS 2H2018
Standard Seating:	257 (2 class), 406 (1 class)
Range:	7,500 nm
Engine Options:	RR Trent 7000
In Service:	0
On Order:	10
In Storage:	0
Operators:	2
Last Delivery:	N/A

After months of speculation, Airbus launched the A330neo (new engine option) at the Farnborough Air show in July 2014. In fact this concept is strikingly similar to the first design of the Airbus A350 launched in 2004. This first A350 design was based on an A330 fuselage with new aerodynamics and engines. However this design was rejected by many customers and Airbus went back to the drawing board to design a complete new A350 and renamed it the A350 XWB. In first instance, the smallest version of the A350 XWB, the A350-800 was aimed at the market segment of the A330-200/300. However, as this was a shrink from the baseline A350-900, the A350-800 was a suboptimal design. With the same size wings as the bigger A350-900 and with new efficient engines it was a relatively heavy aircraft with a long range that was not optimal for most of the current A330 users. Airbus studied hard to introduce a new version of the A330. The current A330 was still its best-selling wide body airliner as it was a relatively inexpensive widebody positioned in the lower half of the widebody market; it was very well positioned to serve high density routes in the market segment below 4.000 nm. A final reason to be hesitant about a new A330 design was that a more efficient A330neo might easily steal orders from the A350 XWB. Current A330 customers such as Delta and AirAsiaX kept pushing Airbus to develop a more efficient version of the A330. The fact was that developing a new version of the A330 would be relatively cheap as Airbus could use the same principles employed to develop the A320neo and benefit from engine technology developed for the A350 XWB, therefore Airbus decided to introduce the A330neo.

Central to the new A330 concept are the new RR Trent 7000 engines. Contrary to the A330ceo (current engine option), the A330neo will only have one engine manufacturer. The new RR Trent 7000 will have a 112inch diameter fan with a 10:1 bypass ratio developing a thrust of 300-322KN. Besides these new engines the A330neo also features new larger winglets, an increased wingspan (+3.7m) and some aerodynamic improvements to the wings and fuselage. The cabin design is also optimised and includes new-design lavatories and crew rests. These increased cabin efficiencies will result in up to ten seats more than in the current A330. All new techniques and improvements contribute to 11% lower trip costs and (thanks to 10 extra seats) 14% lower fuel burn per seat. The A330neo has a > 95% spare parts commonality with the current generation A330s and both generations have the same type rating. This minimises the entry in service costs for airlines that already operated the A330, as they would not need to spend money on new spares or additional flight crew training. The A330neo comes in two sizes, the A330-800neo and A330-900neo. The A330-800neo is the smaller of the two and will be the successor of the A330-200. As of summer 2016 Airbus has received only ten firm orders from 2 operators (Hawaiian Airlines and TransAsia Airways) for the A330-800neo. The first order was for 6 aircraft from Hawaiian Airlines, which was in fact an order swap as this commitment replaces a previous order placed by Hawaiian for six A350-800s. Given the limited order book. It is far from certain that the A330-800neo will ever be built.

Airbus A330-300

Class:	Large Widebody
First Flight:	2 November 1992
Standard Seating:	277 (3 class), 300 (2 class), 440 (1 class)
Range:	4,500 - 6,100 nm
Engine Options:	GE CF6 (17%), PW4000 (17%), RR Trent 700 (58%), TBD (8%)
In Service:	619
On Order:	99
In Storage:	26
Operators:	71
Last Delivery:	N/A

The A330-300 is the twin-engined, medium-range sister of the long-range A340-300, with the same fuselage, wing and cockpit. The Airbus A330-300 entered commercial service in 1994 and was optimized for medium range high-density markets, but continuous improvement on the A330-300 means that it has developed into a very capable and efficient medium to long haul aircraft. The initial production standard of the A330-300 had a maximum take-off of 212t and range of only around 4,500nm with 295 passengers in a three class lay-out. After the A330-200 introduction in 1997, an A330-300 with a MTOW of 230t and an optional 233t MTOW was introduced. Subsequently Airbus added a further 235t MTOW option which entered service in 2013 increasing its range to 5,650nm. A 240t MTOW version was announced in mid-2012 and in November 2012, Airbus announced a 242t MTOW option with centre wing fuel tanks activated for the first time on the A330-300, giving it a range of 6,100nm. The first 242t version was delivered to Delta Air Lines in May 2015. All A330s produced after MSN 1627 are 242t MTOW capable. Besides Delta, also SAS and Air China have opted for the 242t A330-300. The 233t MTOW (or more) versions are preferred by most airlines for their route flexibility, but the 242t gives the airlines more range and payload. Like the 777-200 (its initial competitor), it can be equipped with engines from all three major engine manufacturers. Because of its lower structural weight (i.e. higher efficiency) and greater range capability it enjoys considerably more success than the 777-200. As with the A330-200, the-300 received 240min ETOPS certification in 2009. The A330-300 seems to be somewhat less threatened than the-200 by the range-optimized 787. As the A350-800/900 will have much higher capital cost and will also be optimized for longer range operations, the A330-300 is expected to remain a very efficient competitor with an ideal mix of medium-to-long-haul range capabilities.

The launch of an A330 freighter conversion programme in 2012 opened an aftermarket for older A330-300s. At the Farnborough Air Show 2016. DHL Express signed an order to become the launch customer for the A330-300 P2F, with an order of for 4 aircraft. The first aircraft will be re-delivered to DHL after conversion at Dresden late 2017.

With 20 year's production and the introduction of new generation competitors as the A350XWB and 787, Airbus has been studying ways to extend the life of the A330. In 2013 Airbus launched a new regional version of the A330-300 with a lower 199t MTOW, de-rated engines, a cockpit optimized for high cycle operations and a high density cabin tailored for shorter ranges (less galleys and crew rest rooms). This makes the A330-300 a relatively low-priced short-haul wide bodied people mover. This version is primarily aimed at markets with large populations and fast growing, concentrated air traffic flows (so mainly SO-Asia and China), and is in fact a kind of a return to the originally A330-300 design and intended role. The first A330-300 Regional was delivered to Saudi Arabian Airlines in August 2016.

At the Farnborough Air Show 2014 Airbus introduced a re-engined version of the A330, called the A330neo. Although the successor aircraft has already been announced, Airbus increased the monthly production rate for the A330 from (the earlier reduced) 6 to 7 aircraft per month. With a backlog of 100 aircraft the A330-300 is still popular. 40% of the outstanding orders are placed by Chinese operators. In June 2015 China Aviation Supplies Holding (the Chinese authority acting as buyer for Chinese airlines) ordered 40 Airbus A330s and took an option for 30 more. The aircraft attractiveness to Chinese (and Asian) operators was an impetus to build an A330 completion centre in Tianjin. The first A330 will be completed in Tianjin in March 2017.

Airbus A330-900neo

Class:	Large Widebody
First Flight:	est. EIS 2018
Standard Seating:	287 (2 class), 440 (1 class)
Range:	6,550 nm
Engine Options:	RR Trent 7000
In Service:	0
On Order:	176
In Storage:	0
Operators:	8
Last Delivery:	N/A

After months of speculation, Airbus launched the A330neo (new engine option) at the Farnborough Air show in July 2014. In fact this concept is strikingly similar to the first design of the Airbus A350 launched in 2004. This first A350 design was based on an A330 fuselage with new aerodynamics and engines. However this design was rejected by many customers and Airbus went back to the drawing board to design a complete new A350 and renamed it the A350 XWB. In first instance, the smallest version of the A350 XWB, the A350-800 was aimed at the market segment of the A330-200/300. However, as this was a shrink from the baseline A350-900, the A350-800 was a suboptimal design. With the same size wings as the bigger A350-900 and with new efficient engines it was a relatively heavy aircraft with a long range that was not useful for most of the current A330 users. Airbus studied hard to introduce a new version of the A330. The current A330 was still its best-selling wide body airliner as it was a relatively inexpensive widebody positioned in the lower half of the widebody market; it was very well positioned to serve high density routes in the market segment below 4.000 nm. A final reason to be hesitant about a new A330 design was that a more efficient A330neo might easily steal orders from the A350 XWB. Current A330 customers such as Delta and AirAsiaX kept pushing Airbus to develop a more efficient version of the A330. The fact was that developing a new version of the A330 would be relatively cheap as Airbus could use the same principles employed to develop the A320neo and benefit from engine technology developed for the A350 XWB, therefore Airbus decided to introduce the A330neo.

Central to the new A330 concept are the new RR Trent 7000 engines. Contrary to the A330ceo (current engine option), the A330neo will only have one engine manufacturer. The new RR Trent 7000 will have a 112inch diameter fan with a 10:1 bypass ratio developing a thrust of 300-322KN. Besides these new engines the A330neo also features new larger winglets, an increased wingspan (+3.7m) and some aerodynamic improvements to the wings and fuselage. The cabin design is also optimised and includes new-design lavatories and crew rests. These increased cabin efficiencies will result in up to ten seats more than in the current A330. All new techniques and improvements contribute to 11% lower trip costs and (thanks to 10 extra seats) 14% lower fuel burn per seat. The A330neo has a > 95% spare parts commonality with the current generation A330s and both generations have the same type rating. This minimises the entry in service costs for airlines that already operated the A330, as they would not need to spend money on new spares or additional flight crew training.

The A330neo comes in two sizes, the A330-800neo and A330-900neo. The A330-900neo is the larger of the two and will be the successor of the A330-300. With a backlog of 176, the A330-900neo is far more popular than the A330-800neo, so the main focus of the A330neo programme will be on the-900neo variant. The A330-900neo is capable of transporting ~287 passengers in a two class cabin lay out over a

distance of 6,500nm. These are 10 passengers more over a 400 nm larger distance than the current A330-300. The larger A330-900neo is much more popular than the A330-800neo. As of summer 2016 Airbus has received 176 firm orders and 20 commitments for the A350. The first orders and commitments were placed by AirAisaX and lease companies Air Lease Corporation, Avolon and CIT. The A330-900neo got a big impetus from the December 2015 Delta Air Lines order for 25 A350-900neo. Delta will use these aircraft for North Atlantic Markets and claims that the A330-900neo is an aircraft with relatively affordable ownership costs that can operate these missions as they don't require the range offered by more modern but more expensive aircraft as the A350 XWB or Boeing 787. The A330-900neo will make its first flight in 2017 with certification and following delivery to launch customer TAP Portugal late 2017. Airbus is studying to introduce a 245t MTOW version of the A330neo.

Airbus A340-200

Class:	Medium Widebody
First Flight:	1 April 1992
Standard Seating:	261 (3 class), 300 (2 class)
Range:	6,500 - 8,000 nm
Engine Options:	CFM56-5C
In Service:	2
On Order:	0
In Storage:	5
Operators:	3
Last Delivery:	November 1998

The A340-200 basically is a four-engined A330-200 with the same capacity but a higher MTOW and significantly more range. Fuselage, wing and cockpit design are the same. The A340s four-engine design freed it from restrictions that limited twin-engined aircraft have to operate within a certified timeframe (on one engine) from the nearest suitable airport. However, increased engine reliability has led to less stringent rules for certification for 180 minutes Extended Twin-engine Operations (ETOPS) of the competing Boeing 777 family. The A340-200 is the shorter fuselage, long range version of the A340-300 which was launched simultaneously. When the stretched A340-500 and-600 were launched several years later, the-200 lost appeal as the stretched versions resulted in lower seat mile costs and could accommodate higher specific passenger payloads. In total, only 28-200s were built. Only two of them are currently in service with Egypt's Leisure Air. The remainder is stored; scrapped or is in use as Corporate / VIP aircraft. One aircraft has been written-off.

Airbus A340-300

Class:	Large Widebody
First Flight:	25 October 1991
Standard Seating:	295 (3 class), 335 (2 class), 440 (1 class)
Range:	6,500 - 7,400 nm
Engine Options:	CFM56-5C
In Service:	120
On Order:	0
In Storage:	27
Operators:	33
Last Delivery:	October 2008

The A340-300 basically is a four engined A330-300 with the same capacity but a higher MTOW and significantly more range. Fuselage, wing and cockpit design are the same. The A340s four-engine design freed it from restrictions that limited twin-engined aircraft have to operate within a certified timeframe (on one engine) from the nearest suitable airport. However, increased engine reliability has led to less stringent rules for 180 minutes Extended Twin-engine Operations (ETOPS) of the competing Boeing 777 family. The A340-300's main rival, the twin-engined Boeing 777-200ER was favoured by the industry, outselling the A340-300 by an average rate of 2:1. The MD11 was a relevant competitor as well. In a marginally successful attempt to revive the A340s fortunes, a high gross weight version became available in 1996 featuring a reinforced structure with became production standard as from msn 117. In 2003, Airbus introduced further enhancements like an LCD flightdeck, a fly-by-wire rudder and improved CFM56-5C/P engines though this didn't have a strong impact as new clients preferred the Rolls-Royce powered A340-600 and, later on, the 777-300ER. It nevertheless is the most widespread A340 which increasingly, is operated by airlines with a view to disposal/retirement as soon as a replacement can be secured. In an increasing fuel price environment, several operators were keen to replace the A340-300 with more efficient (twin engine) equipment. Many airlines have already replaced the A340-300, or are in the process of replacing them, with new enhanced versions of the A330-300 (or even with the competing Boeing 777-300ER), making the A340-300 an aircraft operated increasingly by second tier airlines. The massive drop in fuel costs in the last two years, should benefit the four-engined A340-300, but phase-outs (Cathay, China Airlines, SriLankan, Emirates, Finnair) have continued in the last years. Around 60 A340-300s have been permanently withdrawn from use and most of them have been scrapped, which in turn has led to a big reduction in part-out values. Especially the early built aircraft with the lower MTOW and lower thrust engines have been phased out. The A340-300 relatively small and less powerful CFM56 engines make that the engine maintenance costs are relatively low and are comparable to those of the A320 and 737NG (x2). This in combination with the low capital costs of the A340-300 make it an attractive aircraft for second and third tier airlines with a poor credit status and without an ETOPS status who need long haul equipment.

Airbus itself does not offer a cargo conversion programme for the A340-300, but LCF Conversions has developed a freighter conversion which uses the standard lower fuselage freight doors and install a pair of internal cargo lifts, forward and aft, to transfer the payload between the lower and main deck, avoiding the high cost expenditure normally associated with large-door conversion and need to strengthen the main deck. Today this programme is still not officially launched and certified and market interest appears muted. If a cargo conversion programme is launched, part-out scenarios for the A340-300 would no longer be the only alternative.

Airbus A340-500

Class:	Ultra Long Range Large Widebody
First Flight:	11 February 2002
Standard Seating:	313 (3 class), 359 (2 class), 375 (1 class)
Range:	9,000 nm
Engine Options:	RR Trent 500
In Service:	5
On Order:	0
In Storage:	19
Operators:	8
Last Delivery:	January 2013

The A340-500 is a slightly stretched (10.5 ft) ultra-long-range development of the A340-300. The A340-500 was developed in conjunction with the 34.8 ft stretched-600. Both aircraft have a new 20% larger wing and are equipped with RR Trent 500 engines. The A340-500's 9,000nm range allows it to fly non-stop routes such as Singapore-New York, Toronto-Hong Kong and Dubai-Sydney. However, considering the very limited number of substantial ultra-long range routes and especially the high cost involved in such operations, the-500 remains a niche aircraft which competes with the more efficient, twin-engined 777-200LR. To fly such ultra-long routes the Airbus A340-500 has large tanks and structural reinforcements to its frame to deal with this large amount of fuel on board the aircraft. However with the high fuel prices seen in the recent past it became almost impossible to make money flying the A340-500 with a full load of fuel. The load factor must be far above the 100% to make such routes profitable. Due to its relatively heavy structure, the-500 cannot compete with the lighter A340-300 and 777-200ER on routes within the range of these competitors. In 2013 Singapore Airlines stopped flying its non-stop routes between Singapore and New York/Newark and between Singapore and Los Angeles for which it had a dedicated fleet of five A340-500s. All Singapore Airlines' A340-500s were subsequently phased out and returned to Airbus. Emirates operated a fleet of 10 Airbus A340-500s, but the last one was returned to Airbus in March 2016. With only 5 aircraft currently in commercial passenger service and 20 aircraft stored, interest in commercial operation of this aircraft is very limited and it seems VIP/Government service (currently five service) is the most likely (but very small) aftermarket.

Airbus A340-600

Class:	Large Widebody
First Flight:	23 April 2001
Standard Seating:	380 (3 class), 419 (2 class), 475 (1 class)
Range:	7,500 - 7,900 nm
Engine Options:	RR Trent 500
In Service:	72
On Order:	0
In Storage:	16
Operators:	10
Last Delivery:	July 2010

The A340-600 is a 34, 8 ft. (85 seat) stretch of the A340-300 which at over 246 feet, makes it the longest passenger aircraft in operation. The aircraft is equipped with more powerful RR Trent 500 engines, a new wing, enlarged stabilizers and strengthened landing gears. Like its competitor, the much more successful Boeing 777-300ER, the A340-600 was developed to replace the 747-100/200/300 and, although somewhat smaller, to supplement or replace the 747-400. Shortly after its introduction Airbus developed a higher gross weight variant at the request of its prospective customers, leaving early production models at risk of becoming oddball aircraft due to structural differences. The high gross weight version features airframe, landing gear and engine pylon reinforcements, which have become production standard after the aircraft's introduction in mid-2006. The improvement in MTOW allows for 350nm additional range or 12,000 lbs of payload on a 6,000nm flight.

Apart from mainly European legacy carriers, the A340-600 failed to impress the market. The A340-600 is Iberia's and South African Airways' main long haul type and forms part of the Lufthansa long haul fleet as well. Middle Eastern carriers as Qatar Airways and Etihad are using the type to operate on higher yielding routes, offsetting higher fuel costs. The aircraft has a payload advantage over the B777-300ER operating from hot and high airports such as Madrid or Johannesburg. Especially in an increasing fuel price environment, several operators are keen to replace the A340s with more efficient (twin engine) equipment. With the A350-1000 (EIS earliest 2017), Airbus already has a twin engined replacement aircraft under development. Although not impossible, a freight conversion is unlikely, due to a mix of technical reasons (length of the aircraft and constraints on bending under heavy load with high density cargo) and the relatively small fleet acting as feedstock (same for A340-500) combined with the high costs involved in such a conversion and likely unappealing FTK costs compared to other large freighters.

Although no longer in production, Airbus started a marketing offensive in the summer of 2013, as a reaction to the rapidly declining market values of used A340 aircraft. Airbus stressed that all versions of the A340 still have excellent performance (especially in hot-and-high circumstances due to its four engines) and long range capabilities and with its four engines it is free from ETOPS constraints, making more direct routes and fuel and time savings possible. Airbus also plans to re-certify the A340-600 to carry up to 475 passengers, by introducing 35 seats instead of a forward toilet and mid-cabin galley. Together with Rolls Royce Airbus is working to improve the engine efficiency and maintenance costs. All these improvements should make the A340-600 a more competitive aircraft, unfortunately only at low price levels or reduced lease rates. However this new marketing campaign did not change much in the market perception of the A340-600. Most airlines who bought the A340-600 new from the factory are in the process of phasing out the aircraft (Virgin, Thai) or will phase them out in the near future as new equipment (Iberia, Lufthansa) will enter the fleet. Only new operator who operates used A340-600s is Mahan Air from Iran, who added-through a rather obscure purchase process involving Maltese and Iraqi airlines-6 ex Virgin aircraft to its fleet in the summer of 2015. In 2016 Lufthansa-the largest operator of the A340-600-put four aircraft in storage. These four aircraft will return into service as replacement for the four oldest A340-600 in their fleet, which are currently offered for sale and will probably leave the fleet in the nearby future. Lufthansa is intended to fly the remainder of the A340-600 fleet into the 2020s, until they have taken delivery of enough A350-900s and 777-Xs.

Airbus A350-800

Class:	Medium Widebody
First Flight:	est. 2019
Standard Seating:	280 (3 class), 312 (2 class)
Range:	8,200 nm
Engine Options:	RR Trent XWB
In Service:	0
On Order:	16
In Storage:	0
Operators:	2
Last Delivery:	N/A

The A350 family could be seen as Airbus' answer to the slightly smaller Boeing 787 family but effectively also competes with the slightly larger Boeing 777 family. After its first launch in 2004, some A350s were ordered but the design failed to impress the market and was criticized for being nothing more but an upgraded A330 which couldn't compete with the Boeing 787. Airbus responded with the redesigned A350 dubbed 'XWB' for eXtra Wide Body which featured a 12 in. wider fuselage, a new (composite) wing, upgraded A380 based systems and an advanced technology cockpit with 6 large LCD screens. Although launched as an "optimized' design, the A350-800 will now be a simple shrink of the base line A350-900 which already entered service early 2015. As the smallest member of the A350 family, it will in terms of payload and range, be closest to the 787-9. Because it will be slightly larger than the 787-8, it could probably be competitive to that type as well in terms of seat-mile economics. Airbus claims the A350-800 could well co-exist with the A330 family as the latter is optimized for much less range, but on the longer run the A350 is considered to be the future twin-engine replacement of the A330/A340 family which is already reflected in the existing order book. The anticipated efficiency gains of an A350-800 over an A330-200 on a 4,000nm trip are expected to exceed 20%.

The A350-800 is the least popular version of the A350XWB. Many airlines who placed original A350-800 orders transferred their orders to other A350 variants, making the order book for the A350-800 shrink from c.150 to 16 aircraft. With very little market appeal and capable alternative versions of the A350, legitimate doubts are raised if Airbus will continue with the development of the A350-800 version in its current configuration. Airbus itself seems not very supportive of the current A350-800 and is moving slowly away from it. With the introduction of the A330-800neo, it has become highly unlikely that Airbus will ever produce the A350-800. Hawaiian Air which was one of the few customers of the type swapped its six strong A350-800 order to the A330-800neo. Although the A350-800 is still on offer on Airbus website, the A350-800 is not promoted anymore in Airbus marketing presentations on various business conferences. With just 16 orders in the book for 2 operators (Aeroflot and Asiana Airlines) it seems increasingly unlikely that the A350-800 will exist beyond the drawing board.

Airbus A350-900

Class:	Large Widebody
First Flight:	14 June 2013
Standard Seating:	325 (3 class), 366 (2 class)
Range:	7,590 - 8,100 - 9.700 nm (ULR version)
Engine Options:	RR Trent XWB
In Service:	36
On Order:	564
In Storage:	0
Operators:	39
Last Delivery:	N/A

The A350 family could be seen as Airbus' answer to the slightly smaller Boeing 787 family and effectively also competes with the slightly larger Boeing 777 family. It is considered to be the future twin-engine replacement of the A330/A340 family as well. After its first launch in 2004, some A350s were ordered but the design failed to impress the market and was criticized for being nothing more but an upgraded A330 which couldn't compete with the Boeing 787. Airbus responded with the redesigned A350 'XWB' (eXtra Wide Body) which featured a 12 in. wider fuselage, a new (composite) wing, upgraded A380 based systems and an advanced technology cockpit with 6 large LCD screens. The A350-900 is the first and base line A350 model and entered service with Qatar Airways in January 2015. It features a fuselage which is c.21 ft longer than the A350-800 to accommodate approximately 40 more passengers. In terms of payload-range, the A350-900 is positioned closest to the 777-200ER which has 400nm less range and a slightly lower seat capacity. The slightly smaller 787-9 and stretched 787-10 are competitors as well. Airbus claims the A350-900 could well co-exist with the A330 family as the latter is optimized for much less range but the A350's (anticipated) efficiency gains could well accelerate A330 replacement, certainly in a high fuel price environment.

The A350-900 made its first flight on 14 June 2013. The test programme proceeded without any hiccups and the first A350-900 was delivered to its launch customer Qatar Airways on 22 December 2014. Currently around 35 A350-900s have been delivered to various customers and most airlines note that the reliability of the A350 is "over and beyond" expectations. So the entry into service of this new design seems to be without any teething problems. Something which cannot be said from its production process. Problems in the supply chain of especially the seats led to a very slow pace of deliveries. However mid 2016 it seem these problems have been solved, as the stream of new A350-900 deliveries finally got momentum. With ~35 aircraft in service and 564 A350-900 on order, it is by far the most popular variant of the A350 family.

In October 2015 Airbus introduced a new long range version of the A350-900. The A350-900ULR (Ultra Long Range) will feature a higher 278/280t MTOW, a 17% higher usable fuel capacity as well as aerodynamic tweaks to stretch its range to 9.700nm. Launch customer of the A350-900ULR variant is Singapore Airlines, which will use this version for non-stop flights between Singapore and the US. First delivery of these long range variants will be in 2018. Airbus has declared that it will be possible to re-configure an A350-900ULR back to standard A350-900 specifications.

In March 2016, Airbus announced that it will enhance the standard version of the A350-900 to provide an optional weight increase to 280t MTOW. Together with an aerodynamic clean-up and powerplant improvements this enhanced A350-900 version will have a 2% lower fuel burn, which gives the aircraft a 500nm longer range of up to 8.100nm. The A350-900 has previously been available with MTOWs of 276t, 272t or 275t. The enhanced version will be available from 2020. With 280t MTOW this enhanced version has the same MTOW as the A350-900ULR, but Airbus says that a combination of larger fuel capacity and transporting fewer passengers (the A350-900ULR will according to Airbus be equipped with an extended premium class cabin, which will give the aircraft a seat count of roughly half of the standard A350-900 cabin), the A350-900ULR will still have more range.

Airbus A350-1000

Class:	Large Widebody
First Flight:	est. 2017
Standard Seating:	366 (3 class), 440 (2 class)
Range:	7,950 nm
Engine Options:	RR Trent XWB
In Service:	0
On Order:	193
In Storage:	0
Operators:	11
Last Delivery:	N/A

The A350 family could be seen as Airbus' answer to the slightly smaller Boeing 787 family and effectively also competes with the slightly larger Boeing 777 family. It is considered to be the future twin-engine A330/A340 replacement as well. After its first launch in 2004, the A350 failed to impress the market and was criticised for being nothing more but an upgraded A330 which couldn't compete with the 787. Airbus responded with the redesigned A350'XWB' (eXtra Wide Body) which featured a 12 in. wider fuselage, a new (composite) wing, upgraded A380 based systems and an advanced technology cockpit with 6 large LCD screens. The A350-1000 will have a 23ft stretch of the base line-900 to accommodate 40 more seats. This largest member of the A350 XWB family is planned to enter service in 2017. In terms of payload-range, the A350-1000 is expected to be a competitor to the 777-300ER which has the same range and 15 more seats. If the Rolls-Royce Trent XWB engines are indeed as efficient and as powerful as planned and the airframe will not be too heavy, the A350-1000 might turn out to be considerably more efficient and a strong contender of the very successful 777-300ER. GE refused to offer GEnx engines for the A350 family as the type poses a threat to exclusively GE powered 777-300ERs.

So far 193 A350-1000s have been ordered of which 58 were former A350-800 and A350-900 orders. Boeing's new 777-8 and-9 are Seattle's answers to the A350-1000 and will put this programme under pressure. Early 2016 Airbus has revealed that it is studying an extended version (~45 more seats), dubbed the A350-2000. According to Airbus, it is technically not a big issue to stretch the A350-1000, but it wonders if the market for 400 (3 classes) seat twin-engined aircraft is big enough to make a profitable business case for the A350-2000.

Airbus A380-800

Class:	Very Large Widebody
First Flight:	27 April 2005
Standard Seating:	544 (3 class), 644 (2 class), 853 (1 class)
Range:	8,200 nm
Engine Options:	EA GP7200 (42%), RR Trent 900 (49%), TBD (9%)
In Service:	195
On Order:	124
In Storage:	2
Operators:	19
Last Delivery:	N/A

The double deck A380-800 has been the largest passenger aircraft in production, since it made its first flight in April 2005. According to Airbus, the A380 offers 49% more cabin floor space which results in 26% more seat space than the Boeing 747-400. Also, the A380 is quieter and is claimed to have 800nm more range and 17% better operating economics. The A380's main competitor is the 747-8I which still will accommodate c.58 less seats than A380 (3 class) but certainly closes in on range and operating economics. It however failed to impress the market so far. As from the first commercial A380 delivery to Emirates (msn 011) in July 2008, several (weight) improvements were achieved and more are expected. As from msn 026, the aircraft will have improved wiring, vertical tail, composite-crossbeams and door structures (weight saving approximately 0.7t). Further weight saving measures were implemented as from msn 60 (c.1.0t), msn 80 (c.0.3t). Msn 95, BA's first A380 delivered in July 2013, was the first with a strengthened structure and optimised fly-by-wire control laws resulting in a 4t higher MTOW, providing 100nm additional range. Although these 'steps' in weight are not enormous, the early production aircraft could become odd-balls because of worse performance. Potentially up to 120 of the earliest A380s suffered a wing-rib bracket cracking problem. A retrofit solution, involving localised reinforcement and thicker rib brackets on the type is in place. A380s delivered from 2014 onwards will feature a new rib design. In 2015 Airbus presented cabin improvements. New cabin configurations (11 abreast) and improvements (among others, side stowage removal and combined crew rest) increases the effective cabin area with 20m² and will give the A380 better seat-mile economics. Airbus has the opportunity to stretch the current design into an A380-900 to obtain an even larger aircraft with better seat-mile economics, though such stretch seems unlikely in the foreseeable future.

The Airbus A380 is offered with a two engine choice. The GP7200 of Engine Alliance and the RR Trent 900. With a market share of 42% for the GP2700 and 49% for the RR Trent, it seems that there is some equilibrium between the two engine manufacturers. Emirates (who is by far the biggest operator of the A380) has selected the EA engine for its initial batch of ninety A380 aircraft. 12 out of the 19 A380 operators have chosen the RR Trent for the A380. For its second batch of additional 52 A380 aircraft Emirates have also chosen the RR Trent engine, so the RR engine is now clearly becoming the most popular powerplant for the A380.

A380 sales got a highly needed boost in 2013 by the order of lessor Amadeo (formerly known as Doric) of 20 A380s and an Emirates' order for an additional 50 aircraft. Since 2013 the order intake of the A380 has again been slow, with only Emirates ordering two additional aircraft (in fact these were orders for two 2014 built planes, originally intended for Skymark) and a small but important order for three aircraft by Japan's ANA Airlines. After the softening of the sanctions against Iran, Iran Airlines signed a letter of intent for 12 Airbus A380s. Besides this slow order intake, the A380 is also plagued by deferrals. QANTAS deferred it last A380s on order, Air France cancelled its last two aircraft on order, and it seems very unlikely that Virgin Atlantic will ever take delivery of its A380s on order. Also the four A380s ordered by Transaero (ceased operations) will probably never been built. IAG / BA has stated that BA will probably not convert its nine A380 options into orders, because they are "too expensive". And as of today, Amedeo still has not named any customers for the majority of their 20 A380s on order. With this shrinking backlog, Airbus has decided to cut the production from the A380 from 27 aircraft per year to 12 from 2018.

In 2017 the first five A380s of Singapore will be ten years old and with five new aircraft entering the Singapore fleet in 2017, it will be very likely that the earliest five Singapore A380s will come to the market. In September 2016 Singapore announced that it will not extend the lease on its first A380 after its expiry in October 2017. This will make this aircraft the first A380 on the second hand market. By mid-October 2016, Singapore has not made a decision whether to renew the leases of the other four 10 year old A380s in its fleet. Malaysia reportedly will dispose its six A380s in 2017/2018. Former IAG (BA) CEO Willie Walsh has shown interest in "five or six" second hand A380s for IAG Spanish subsidiary Iberia as well as BA, but time will tell how the second hand market for the A380 will develop.

As the most airlines have chosen the 777-300ER as successor of their 747-400 aircraft, only 19 different operators have ordered the A380, and its fleet is mainly concentrated with one airline. 44 % of all A380 (in service and on order) are operated or will be operated by Emirates. As largest customer of the A380, Emirates has been pushing Airbus to make some improvements to the A380 including a re-engine of the superjumbo. Airbus says a re-engining of its A380 superjumbo is something it plans to look at in the longer term, but its main priority is to ensure that the development schedules of the A350 and A320neo remain on-track. Since the very slow order intake for the A380 and some awkward announcements from an Airbus official in 2014 about a possible end of production for the A380 due to the difficulty of turning a profit from the programme, the future of the A380 has been intensely discussed. Also the market introduction of the Boeing 777-9 will be a serious threat for the A380. The seat-mile cost of the 777-9 will be superior to those of the A380. A stretch and re-engine of the A380 (an A380neo), can improve the competiveness of the A380 in the 2020s. Engine Alliance has indicated that the market size in which the A380 competes is too small to develop a more powerful engine for the A380neo on an economic viable basis, which leaves only Rolls Royce as potential engine supplier for a possible A380neo. For a long time Airbus has been reluctant to be specific about the A380neo, but at the Farnborough Air Show 2016 Airbus said that there will be an A380neo "when the time is right", without mentioning any time schedule. Emirates CEO Tim Clark is a strong advocate for the A38neo and has declared several times that Emirates would buy an additional 100 aircraft if Airbus would launch an A380neo.

Boeing 717-200

Class:	Small Narrowbody
First Flight:	2 September 1998
Standard Seating:	106 (2 class), 117 (1 class)
Range:	1,010 - 1,615 nm
Engine Options:	BR700-715
In Service:	154
On Order:	0
In Storage:	1
Operators:	5
Last Delivery:	May 2006

The Boeing 717 was originally developed by McDonnell Douglas as the MD-95, a 100-seat off-shoot of the MD-90. Development started in 1991 and was targeted at the Northwest Airlines requirement for a DC-9-30 replacement. The MD-95 was the only former McDonnell-Douglas Corporation commercial passenger aircraft programme retained by Boeing after its take-over of MDC and was subsequently renamed the Boeing 717-200. As such it shared no commonality with other aircraft in production, although Boeing considered both shrink and stretched versions. As a stand-alone aircraft it didn't have a lot of commercial success and only attracted AirTran Airways as large customer. Production was ceased in 2006. Southwest Airlines which acquired AirTran, has sub-leased its inherited 88 strong 717 fleet to Delta Airlines and the first 717 was delivered to Delta in October 2013. By early 2016 the entire AirTran fleet had been transitioned to Delta Air Lines. Delta has also acquired some 717s from other operators and with a current fleet of 91 Boeing 717s in service (58.7% of the current fleet), Delta is by far the biggest operator of the type. The majority of the 717 fleet (101 aircraft) is controlled by the Boeing Capital Corporation. With currently only five airlines operating the Boeing 717, the operator base is very small. Finish airline Blue1 phased out its nine strong fleet of 717 in 2014 and 2015. The former ex Blue1 717s found new employment with Delta, QANTASlink and Spanish low cost airline Volotea. However despite the fact that Volotea added some additional ex Blue1 717s to its fleet (19 currently in service) in 2015, the airline has already announced that it will phase-out the type and replace it with Airbus A319 aircraft in the near future. Also Turkmenistan Airlines is planning to replace their Boeing 717 with other equipment, leaving only Delta, QANTASLink and Hawaiian as operators of the type.

Boeing 737-300

Class:	Moderate Size Narrowbody
First Flight:	24 February 1984
Standard Seating:	126 (2 class), 144 (1 class)
Range:	1,330 - 2,190 nm
Engine Options:	CFM56-3
In Service:	298
On Order:	0
In Storage:	102
Operators:	115
Last Delivery:	December 1999

The 737-300 was the first version of the 737-'Classic' Family and was derived from the 737-200 as a growth replacement. It would become the most successful of the three-version family with over 1,000 delivered from 1984 to 1999. Early built 737 Classics were still equipped with analogue cockpit displays. Digital CRT displays became standard in 1988. The 737-'Classic' is preferred above its MD-80 competitors, mostly due to the cleaner, more economical CFM56 engine above the older PW JT8D-200. Compared with its modern competitors (737-700 and A319), the 737-300 is more expensive to maintain, less fuel efficient and offers much less range. With low fuel prices, the 737-300 could still be attractive as its capital costs are minimal and modifications like winglets (c.140 modified, mainly Southwest Airlines) could improve performance. Nevertheless, many 737-300s were parked during the last economic crisis and only a few coming back when markets recovered, almost all with second tier airlines. More and more phase outs and part outs illustrate the nearing end of life for the type. New competing products and age related import restrictions in secondary markets could accelerate this. Highly cycled aircraft will face structural issues and increased maintenance/inspection costs with repairs which could shorten the economic life as well. Cargo conversion programmes are offered for the 737-300 which may extend the operating lives of some suitable 737-300s. As of summer 2016, more than 100 operators still fly with the 737-300. Most of them have very small fleets and only five airlines have a fleet of ten aircraft or more. Southwest Airlines is the exception and is with a fleet of 107 737-300 aircraft by far the biggest operator. However, with the introduction of the 737 Max in its fleet, Southwest will accelerate the retirement of its 737-300s and all aircraft will be phased out by late 2017. The flood of more than 100 ex Southwest 737-300s on the market will have a negative impact on the already low market value and part-out value of the 737-300.

Boeing 737-400

Class:	Medium Narrowbody
First Flight:	23 February 1988
Standard Seating:	147 (2 class), 162 (1 class)
Range:	1,580 - 1,995 nm
Engine Options:	CFM56-3
In Service:	156
On Order:	0
In Storage:	104
Operators:	90
Last Delivery:	February 2000

This 120 in. stretched version of the 737-300 was Boeing's pretty successful attempt to keep Airbus from having the 150-seat market to itself. The 737-400 enjoyed a good sales performance, especially considering the short 11-year production cycle. However, it was never to become as successful as the smaller 737-300 and suffered from the simultaneous introduction of the more advanced Airbus A320. Boeing also developed a higher gross weight 737-400 for enhanced payload/range (up to 360nm), with structural reinforcement of the aircraft. When compared with its modern technology competitors (737-800 and A320), the 737-400 lacks range, is more expensive to maintain and is much less fuel efficient. Although not as massively parked as the 737-300 during the last economic crisis the-400 is being phased out by many operators as well. New competing products and age related import restrictions in secondary markets could accelerate this. At low/moderate fuel prices, a 737-400 can be economically viable if purchased at a low price. For highly cycled aircraft structural issues will lead to increased maintenance/inspection costs with repairs possibly shortening the economic life. The 737-400 is still popular with small cash-strapped airlines who are specialized in ad-hoc charters and wet-lease operations to provide additional capacity during peak season for mainline and first tier airlines. The low capital cost for the 737-400 allow a low utilization to still generate a profit. Like for the smaller-300, cargo conversion programmes are available. As a freighter the 737-400 has become far more popular than its smaller sibling the 737-300 freighter. As of today ~100 737-400 have been converted, mainly driven by the availability of affordable feedstock aircraft. The introduction of the A320 and Boeing 737-800 passenger-to-freighter conversion programme, with the first aircraft to be converted around 2017-2018 probably signals the end to the 737-400 conversion market. The 737-400 is the only variant of the classic 737 range for which there is no winglet modification available. The 737-400's is the heaviest of the 737 classics but, has the same wing. As a result, the wing has not enough residual strength to support the winglets.

Boeing 737-500

Class:	Small Narrowbody
First Flight:	30 June 1989
Standard Seating:	110 (2 class), 128 (1 class)
Range:	1,130 - 2,320 nm
Engine Options:	CFM56-3
In Service:	164
On Order:	0
In Storage:	55
Operators:	68
Last Delivery:	July 1999

The-500 is the smallest member of the 737-Classic family with the longest range. It replaced the similar sized 737-200. Competitors included the MD-87, the largest members of the BAE Systems/Avro product lines and the lighter more efficient but narrower Fokker 100. Commonality with the-300 and-400 and the large US domestic market gave the-500 the upper hand. Later competition came from the less successful A318 and 737-600. In the secondary market, the 737-500 isn't widely accepted as it is relatively heavy and has comparatively high seat-mile costs. Especially newer competitors like E190/195 and CSeries are much more efficient. In 2015 and 2016 main operators Southwest (25 aircraft) and Lufthansa (33 aircraft) phased out the type. Biggest current operator UTAir (32 aircraft) has already announced that it will phase out the fleet in the near future and the first 10 aircraft will leave the fleet by 2018. The secondary market is further limited by age related import restrictions in more and more countries. Because of its long range the type has been popular in Russia and as of today Russia is still the biggest operator country for the 737-500 with 52 aircraft flying for 9 different commercial operators. Additional winglets can improve the aircraft performance. So far c.60 737-500 have been retrofitted with winglets. For high cycled aircraft structural issues will lead to increased maintenance/inspection costs with repairs possibly further shortening the economic life. Given its small size, there is very little interest in conversion to freighter, so there are no conversion programmes for the 737-500.

Boeing 737-600

Class:	Small Narrowbody
First Flight:	26 January 1998
Standard Seating:	110 (2 class), 128 (1 class)
Range:	940 - 2,840 nm
Engine Options:	CFM56-7B
In Service:	54
On Order:	0
In Storage:	1
Operators:	5
Last Delivery:	September 2006

The 737-600 is the 100-seat member of 737-'Next-Generation' family, offering the same cabin dimensions as it predecessor, the 737-500. The 737-'NG' family main new features when compared to the 'Classics' are a new engine and a new wing with greater fuel capacity and optional winglets. The 737-600 has a 10,300 lb higher empty operating weight then the 737-500, which was already considered overweight for its size. The 737-600 has been a commercial failure collecting only 69 orders, representing just 0.8% of the 737-NG Family total. Since 2010, already twelve 737-600s have been scrapped. The 737-600 is the only variant of the 737NG for which there are no winglets available.

Boeing 737-700

Class:	Moderate Size Narrowbody
First Flight:	9 February 1997
Standard Seating:	126 (2 class), 144 (1 class)
Range:	1,160 - 3,010 nm
Engine Options:	CFM56-7B
In Service:	1,045
On Order:	71
In Storage:	21
Operators:	82
Delivery:	N/A

The 737-700 replaces the 737-300, offering the improvements of the 737-'NG' features, combined with the fuselage of the 737-300. It enjoyed significant commercial success, resulting in a broad operator base with a large fleet albeit somewhat concentrated at large North American carriers (Southwest, United, WestJet). Its main competitor, the Airbus A319, is similarly popular and both aircraft seem to have perfectly split the 130-seat market for years. Over the last years, order intake dwindled which illustrates a (planned) shift to slightly larger equipment by many operators including Southwest Airlines. Also new competitors with significantly more efficient engines were launched (CS300, A319neo). Boeing reacted to these new competitors by introducing the 737 MAX 7. Early 2016, United placed an order for 40 Boeing 737-700s at, according to industry rumours, very attractive prices as a result of the intense competition between Boeing (737-700) and Bombardier (CSeries). Southwest Airlines is the biggest operator of the 737-700, with a fleet of 490 aircraft (43.9%. of the current fleet). Although it converted its remaining orders for new 737-700s to the 737-800 variant early 2016, Southwest is still adding 737-700 aircraft to its fleet. In recent years, Southwest has added more than 50 737-700s previously operated by other operators to its fleet and 22 more used 737-700s are due to enter the Southwest fleet in the near future.

The 737-700 could remain competitive with performance upgrades like the CFM56-7BE 'Evolution' engines, aerodynamic refinements, weight schedule improvements, the new Sky Interior and/or aggressive pricing. Blended Winglets (3-5% fuel burn improvement) are becoming more prevalent (71 on order, 914 in service), can be retrofitted and are standard on the 737-700 based Boeing Business Jet 1 ('BBJ1').

In January 2013 Aviation Partners Boeing (APB) introduced a new type of winglet called the Split Scimitar Winglets. By replacing an aluminium winglet tip cap of a blended winglet with a new aerodynamically shaped "Scimitar " TM winglet tip cap and by adding a new Scimitar tipped Ventral Strake savings up to 45,000 gallons of jet fuel per aircraft per year are possible according to APB. APB received FAA Certification for the Split Scimitar Winglets in February 2014. Since the launch of the programme, Scimitar winglets have been ordered by United Airlines, TUI, COPA Airlines, Alaska Airlines, Southwest Airlines and AeroMexico. The BBJ, of which 109 are built and 1 still on order, combines the-700 fuselage with the-800 wing. Derived from the BBJ1 is the 737-700ER which is basically a commercial airline variant of the BBJ1 with nine auxiliary tanks below the main deck giving it a maximum range of 5,510 nm. Only two 737-700ER have been built and delivered to Japanese airline ANA in 2007. Both 737-700ER were withdrawn from use by ANA sin March 2016. Other variants of the 737-700 include the 737-700C (convertible) which has a 3.4 x 2.1m side cargo door, and the 737-700QC (Quick Change) which has pallet mounted seats for conversion from passenger to freighter configuration and vice-versa, a process which can be taken in less than one hour. So far the 700C/QC

has been unpopular with just 19 aircraft in service (15 with US Navy, 2 with Saudi ARAMCO, 1 with TAAG Angola Airlines, and 1 Air Algerie). There is also the 737-700AEW&C variant, which is a military /naval surveillance aircraft. A cargo conversion is also available for the 737-700. IAI Bedek launched a conversion programme together with Alaska Airlines and also PEMCO is planning to launch a Freighter conversion programme, as well as a conversion to Combi or QC variant.

Boeing 737-7

Class:	Moderate Size Narrowbody
First Flight:	est. 2018 / EIS2Q2019
Standard Seating:	138 (2 class), 170 (1 class)
Range:	est. 1,700 - 4,200 nm
Engine Options:	CFM LEAP-1B
In Service:	0
On Order:	60
In Storage:	0
Operators:	3
Last Delivery:	N/A

With the successful introduction of the A320neo family, Boeing had to respond. For several years, Boeing was investigating the replacement of the 737 with an all new "clean sheet" design. But the introduction of the A320neo with its efficient specifications and sky high sales figures put pressure on Boeing to come far earlier with a more modern and efficient 737NG successor. So in August 2011 Boeing presented the 737 MAX Family. The first 737 MAX will be delivered in 2017. Most important new feature of the 737 MAX is the introduction of the new CFM International LEAP-1B engine. With a fan diameter of 69.4 inches (176 cm) it is an increase of 7.6 inches (19.3cm) from the CFM56-7B engine on the 737NG. To maintain a 16.9 inches (42.9cm) ground clearance beneath the engine, Boeing had to increase the height of the nose gear by 8 inches (20cm), which drove a re-design of the forward electronics equipment bay in the nose section. The engine is also moved more forward and up relative to the 737NG. The new larger fan diameter improves the fuel burn by a claimed 12-14%.The new engine also has external nacelle chevrons similar to those on the 787 and 747-8, which reduces the engine's noise. The new Leap-1B engine is smaller than the Leap-1A and PW1100G engine option on the new A320neo family. Fuel efficiency is improved by some aerodynamic modifications on the fuselage (a new tail cone) and the introduction of a new winglet design, called the AT-Advanced Technology-winglet. In term of range the 737 MAX has an improved range of 400-540nm. Inside, Boeing offers the Sky Interiors as standard and offers some minor modifications to the aircraft systems. This includes a flight deck with 4 new large displays but with the same look and feel as the 737NG flightdeck to preserve commonality with training across the 737 Family.

Boeing froze the definitive design of the 737 MAX in the summer of 2013.The first flight of a 737 MAX (a 737-8) took place on 29 January 2016 and the first 737 MAX is scheduled to enter commercial service in mid-2017.The designation MAX is only used as a marketing term and to name the whole family. The official designations of the three MAX models will be 737-7, 737-8 and 737-9. Initially Boeing did not change the fuselage length and door configurations of the 737 MAX so the 737-7, 737-8 and 737-9 designations compare to the-700,-800 and 900ER designations of the 737NG. The 737 MAX will likely put negative pressure on the values of current generation narrow bodied aircraft.

The 737-7 is proposed as the successor of the 737-700. It will compete with the new A319neo and the stretched Bombardier CS300. However, interest in the smallest MAX variant seems minimal. In 2013 it saw its first orders for 30 737-7s for Southwest and 25 737-7s for Westjet. Canadian start-up Jetlines ordered five 737-7s in December 2014, making a total order backlog of 60 Aircraft for just three operators. As there has been no further order activity since December 2014, Boeing decided to change the initial 737-7 design. At the Farnborough Air Show 2016, Boeing presented a re-design of the 737-7 by stretching the fuselage and adding some design elements from the larger 737-8. This modified

737-7 is a 1.93 meter stretch of the original design, so the aircraft can carry two more seat rows. Besides this stretch, the new 737-7 also has the higher-gauge aluminium wing from the 737-8 which allows the aircraft to carry more fuel in the wing and give the aircraft more range. Also a second over-wing emergency exit is added to increase certified maximum seating and finally the new 737-7 will get the strengthened landing gear from the 737-8 to accommodate higher weights as the MTOW will be increased from 70.4t to 80.4t. The new design reportedly is mainly driven by the demands from the two largest customers of the 737-7, Southwest and Westjet. The re-design is also triggered by the development of the Boeing 737 BBJ Max. Just as the BBJ 1 is a derivative of the 737-700, the 737 BBJ Max will be a derivative of the 737-7. With the design tweeks of the re-desigend 737-7, the 737 BBJ Max will have enough range to be competitive to the Gulfstream 650ER. Besides the 60 orders for the 737-7, there are 402 orders for which the choice between a 737-7, 737-8 and 737-9 is still open.

Boeing 737-800

Class:	Medium Narrowbody
First Flight:	31 July 1997
Standard Seating:	162 (2 class), 184 (1 class)
Range:	1,560 - 2,935 nm
Engine Options:	CFM56-7B
In Service:	4,088
On Order:	872
In Storage:	34
Operators:	191
Last Delivery:	N/A

The 737-800 is considered the optimum 737-'NG' model and has a slightly longer fuselage than its 737-400 predecessor, increasing seat capacity from 146 to 160. More importantly, it also has room for two more seat-rows than the A320 giving it a potential revenue advantage and lower seat-mile costs. The 737-800 and its main rival the A320-200 are considered commercially very successful. With more than 4.000 aircraft in active service, more than 800 on order backlog, almost 200 operators and the fact that there is only one engine choice (no engine split as in the A320 market), the Boeing 737-800 is seen as the most liquid aircraft on the market today. Nevertheless, Airbus rocked the boat by launching the A320neo which is expected to be 10-15% more efficient. Boeing reacted by launching the B737-8 with a new engine, a new winglet and other improvements to reach the same percentage of savings as the A320neo. To stimulate sales in the run-up to the introduction of the 737 MAX, Boeing offered performance upgrades like the CFM56-7BE 'Evolution' engines, aerodynamic refinements, weight schedule improvements, the new Sky Interior, longer maintenance intervals, new space-saving lavatories and/or aggressive pricing. Winglets (3-5% fuel burn improvement) have become more or less standard on new deliveries (96.9% of in service fleet and zero Non-winglets 737-800 on order) and can be retrofitted. In January 2013 Aviation Partners Boeing (APB) introduced a new type of winglet called the Split Scimitar Winglets. By replacing an aluminium winglet tip cap of a blended winglet with a new aerodynamically shaped "Scimitar " TM winglet tip cap and by adding a new Scimitar tipped Ventral Strake savings up to 45,000 gallons of jet fuel per aircraft per year are possible according to APB. APB received FAA Certification for the Split Scimitar Winglets in February 2014. Since the launch of the programme, Scimitar winglets have been ordered by 25 airlines. United Airlines made the first commercial flight with a 737-800 equipped with Scimitar Winglets on 19 February 2014.

With a backlog of more than 800 aircraft and the nearby introduction of the 737 MAX, Boeing will ramp up the production of the 737 from 44 aircraft per month to 57 aircraft per month in 2019. As a VIP/ corporate shuttle version, the 737-800 based Boeing Business Jet 2 ('BBJ2') attracted a total of 23 orders of which 21 have been delivered so far. Freight conversions are now offered by Boeing and Aeronautical Engineers (AEI). AEI launched its 737-800SF (special Freighter) program on 4 March 2014. Boeing's 737-800BCF (Boeing Converted Freighter) program was launched on 24 February 2016. Converted aircraft carry up to 23.9t of Cargo in up to 6.50 cubic feet (includes 11 standard pallets and one half-pallet) on routes of up to 2,000nm. It features a main deck cargo door (86" x 140") for AAA pallets and unit load devices. The cost for a conversion will approximately be ~ $3.5mln. AEI also offers a Combi- conversion for the 737-800 and besides Boeing and AEI also IAI Bedek from Israel is considering to step into the 737-800 conversion market. However, the NG is still considered too young and expensive for conversion. Given the presence of conversions for 737 'classics' this might change when values permit.

Boeing 737-8

Class:	Medium Narrowbody
First Flight:	29 January 2016
Standard Seating:	162 (2 class), 184 (1 class)
Range:	1,650 - 3,515 nm
Engine Options:	CFM LEAP-1B
In Service:	0
On Order:	1,898
In Storage:	0
Operators:	47
Last Delivery:	N/A

With the successful introduction of the A320neo family, Boeing had to respond. For several years, Boeing was investigating the replacement of the 737 with an all new "clean sheet" design. But the introduction of the A320neo with its efficient specifications and sky high sales figures put pressure on Boeing to come far earlier with a more modern and efficient 737NG successor. So in August 2011 Boeing presented the 737 MAX Family. The first 737 MAX will be delivered in 2017. Most important new feature of the 737 MAX is the introduction of the new CFM International LEAP-1B engine. With a fan diameter of 69.4 inches (176 cm) it is an increase of 7.6 inches (19.3cm) from the CFM56-7B engine on the 737NG. To maintain a 16.9 inches (42.9cm) ground clearance beneath the engine, Boeing had to increase the height of nose gear by 8 inches (20cm), which drove a re-design of the forward electronics equipment bay in the nose section that encloses the nose gear. The engine is also moved more forward and up relative to the 737NG. The new larger fan diameter improves the fuel burn by a claimed 12-14%. The new engine also has external nacelle chevrons similar to those on the 787 and 747-8, which reduces the engine's noise. The New Leap-1B engine is smaller than the Leap-1A and PW1100G engine option on the new A320neo family. Fuel efficiency is improved by some aerodynamic modifications on the fuselage (a new tail cone) and the introduction of a new winglet design, called the AT-Advanced Technology-Winglet. In term of range the 737 MAX has an improved range of 400-540nm. Inside, Boeing offers the Sky Interiors as standard and offers some minor modifications to the aircraft systems. This includes a flight deck with 4 new large displays but with the same look and feel as the 737NG flightdeck to preserve commonality with training across the 737 Family.

Boeing froze the definitive design of the 737 MAX in the summer of 2013. The first flight of a 737 MAX (a 737-8) took place on 29 January 2016 and the first 737 MAX is scheduled to enter commercial service in mid-2017. The designation MAX is only used as a marketing term and to name the family. The official designations of the three MAX models will be 737-7, 737-8 and 737-9. Initially Boeing did not change the fuselage length and door configurations of the 737 MAX so the 737-7, 737-8 and 737-9 designations compare to the-700,-800 and 900ER designations of the 737NG. The 737 MAX will likely put negative pressure on the values of current generation narrow bodied aircraft.

The 737-8 will be targeted against its arch rival the A320neo. So far 1,898 orders have been placed for the 737-8 variant, making it the most popular 737 MAX variant. There are 402 orders for which the choice between a 737-7,737-8 and 737-9 is still open and there are 487 orders for which the customer has not decided for a 737-8 or 737-9.

Boeing 737-8-200

Class:	Medium Narrowbody
First Flight:	2019
Standard Seating:	200 (1 class)
Range:	830 - 2.700 nm
Engine Options:	CFM LEAP-1B
In Service:	0
On Order:	200
In Storage:	0
Operators:	2
Last Delivery:	N/A

With the successful introduction of the A320neo family, Boeing had to respond. For several years, Boeing was investigating the replacement of the 737 with an all new "clean sheet" design. But the introduction of the A320neo with its efficient specifications and sky high sales figures put pressure on Boeing to come far earlier with a more modern and efficient 737NG successor. So in August 2011 Boeing presented the 737 MAX Family. The first 737 MAX will be delivered in 2017. Most important new feature of the 737 MAX is the introduction of the new CFM International LEAP-1B engine. With a fan diameter of 69.4 inches (176 cm) it is an increase of 7.6 inches (19.3cm) from the CFM56-7B engine on the 737NG. To maintain a 16.9 inches (42.9cm) ground clearance beneath the engine, Boeing had to increase the height of nose gear by 8 inches (20cm), which drove a re-design of the forward electronics equipment bay in the nose section that encloses the nose gear. The engine is also moved more forward and up relative to the 737NG. The new larger fan diameter improves the fuel burn by a claimed 12-14%.The new engine also has external nacelle chevrons similar to those on the 787 and 747-8, which reduces the engine's noise. The new Leap-1B engine is smaller than the Leap-1A and PW1100G engine option on the new A320neo family. Fuel efficiency is improved by some aerodynamic modifications on the fuselage (a new tail cone) and the introduction of a new winglet design, called the AT-Advanced Technology-Winglet. In term of range the 737 MAX has an improved range of 400-540nm. Inside, Boeing offers the Sky Interiors as standard and offers some minor modifications to the aircraft systems. This includes a flight deck with 4 new large displays but with the same look and feel as the 737NG flightdeck to preserve commonality with training across the 737 Family.

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In September 2014 Boeing introduced a new high density variant of the 737 MAX Family, called the 737-8-200. The 737-8-200 is based on the 737-8 airframe. Modifications to the cabin such as smaller front and rear alleys and two mid-rear fuselage escapes doors to meet the FAA evacuation regulations has made it possible to accommodate up to 200 passengers. The 737-8-200 will have the same MTOW as the 737-8 and will therefore have a shorter range of 2.700nm. The 737-8-200 is especially designed for low cost carriers, as Boeing expects that the low cost sector will account for 35% of the single-aisle airline capacity by 2033. With 200 seats, a 737-8-200 will have five percent lower operating

costs than the 737-8-200. Launch customer of the 737-8-200 is Ryanair which ordered 100 aircraft and took options for a 100 more in November 2014. In May 2016 Vietnamese low-cost carrier VietJet Air ordered 100 737-8-200s. A remarkable order as VietJet Air is an all Airbus operator with currently a fleet of 37 Airbus A320/320ceo aircraft in service and 63 A320/A321neo aircraft on order.

Boeing 737-900

Class:	Large Narrowbody
First Flight:	3 August 2000
Standard Seating:	175 (2 class), 189 (1 class)
Range:	1,630 - 2,340 nm
Engine Options:	CFM56-7B
In Service:	52
On Order:	0
In Storage:	0
Operators:	6
Last Delivery:	August 2005

The 737-900 is a 7-feet 8-inch stretch of the 737-800, seating 14 additional passengers in a two-class configuration. However, due to the lack of an additional emergency exit, the maximum seating capacity of the 737-900 is limited to the same 189 passengers as on the-800. This makes the aircraft uninteresting for the charter and low-cost sector. It also lacks the payload/range capability of its Airbus A321-200 competitor. These factors made the 737-900 an even bigger commercial failure then the 737-600, causing a large 737-800 operator like SAS to opt for the A321 instead of the 737-900. Winglets can be retrofitted which reduces fuel consumption and consequently extends the range slightly but hasn't improved the 737-900s commercial prospects.
The development of the 737-900ER consigned the-900 into the ranks of the least popular single-aisle aircraft. Production of the 737-900 ended in 2005. Only 56 737-900 were built and are still in service today-50% of them are fitted with winglets. In January 2013 Aviation Partners Boeing (APB) introduced a new type of winglet called the Split Scimitar Winglets. By replacing an aluminium winglet tip cap of a blended winglet with a new aerodynamically shaped "Scimitar " TM winglet tip cap and by adding a new Scimitar tipped Ventral Strake savings up to 45,000 gallons of jet fuel per aircraft per year are possible according to APB. APB received FAA Certification for the Split Scimitar Winglets in February 2014. Since the launch of the programme, Scimitar winglets have been ordered by 25 Airlines. In October 2013 Alaska Airlines ordered Split Scimitar winglets for its complete 737NG fleet, including its 737-900s, but until today none of their 737-900 haven been retrofitted with Scimitars. Only United Airlines operates 6 737-900 equipped with Scimitar winglets.

Boeing 737-900ER

Class:	Large Narrowbody
First Flight:	5 September 2006
Standard Seating:	178 (2 class), 204 (1 class)
Range:	1,455 - 2,950 nm
Engine Options:	CFM56-7B
In Service:	396
On Order:	108
In Storage:	0
Operators:	20
Last Delivery:	N/A

As the 737-900 was not able to compete effectively with the A321, Boeing developed the 737-900ER which offers longer range and more seats. Technically, the-900ER, features a flat rear pressure bulkhead which enlarges the usable cabin space, a pair of additional exit doors to increase the maximum seat capacity to 215 and structural and aerodynamic changes and 2 optional additional fuel tanks which increase the range to enable it to fly 'coast-to-coast' in the US Domestic market. The 737-900ER entered service in 2007 with Lion Air and has become the production standard. In the first years of service, the 737-900ER fleet was highly concentrated with Lion Air and this somehow contributed to its stigma as a not very liquid, difficult to finance asset. However since 2011 things have improved especially thanks to big orders from United and Delta Air Lines, who see the aircraft as a replacement for their domestic 757-200s. Today United is with 135 aircraft (130 in service & 5 on order) the biggest operator of the type, followed by Delta and Lion Air who both have a fleet of 120 aircraft (Delta: 64 aircraft in service and 56 on order; Lion Air including its subsidiaries Batik Air, Malindo Air and Thai Lion Air 98 aircraft in service and 22 on order). Alaska Airlines is also a large operator of the type with 65 aircraft (49 in Service and 16 on order). These four airlines have together a market share of 87.3% which make the fleet still highly concentrated. Besides these four airlines, all other operators of the type have relatively small fleets with only Turkish Airlines operating a sizeable fleet of 15 aircraft. The Turkish Airlines 737-900ER are equipped with extra tanks and operate mainly on the airline's African network.

With only 20 operators and its high fleet concentration in North America and Indonesia, it is clear that the 737-900ER does not have the market appeal of its largest competitor the A321-200. On paper, the 737-900ER matches some of the A321-200 key capabilities but, a combination of (a) late introduction compared to the rest of the 737NG Family and; (b) poor field performance in hot/high take-off conditions; meant that the aircraft so far probably failed to reach the manufacturer's aspirations for sales volume and particularly growth of the operator base. With the introduction of the improved A321neo on the horizon Boeing had to improve its offer. Boeing reacted by launching the 737 MAX 9 with a new engine, a new winglet and other improvements which will make the aircraft 10-15% more efficient.

As a VIP/corporate shuttle version, the 737-900 based Boeing Business Jet3 ('BBJ3') attracted a total of 7 orders of which 6 have been delivered so far. In January 2013 Aviation Partners Boeing (APB) introduced a new type of winglet called the Split Scimitar Winglets. By replacing an aluminium winglet tip cap of a blended winglet with a new aerodynamically shaped "Scimitar " TM winglet tip cap and by adding a new Scimitar tipped Ventral Strake savings up to 45,000 gallons of jet fuel per aircraft per year are possible according to APB. APB received FAA Certification for the Split Scimitar Winglets in February 2014.

Since the launch of the programme, Scimitar winglets for the 737-900ER only have been ordered by the North American operators of the type, United Airlines, Delta Air Lines and Alaska Airlines. Currently there are no cargo conversion programmes for the 737-900 and 737-900ER, but Boeing is looking at a 737-900BCF.

Boeing 737-9

Class:	Large Narrowbody
First Flight:	est. 2016/EIS4Q2017
Standard Seating:	178 (2 class), 204 (1 class)
Range:	1,560 - 3,515 nm
Engine Options:	CFM LEAP-1B
In Service:	0
On Order:	222
In Storage:	0
Operators:	11
Last Delivery:	N/A

With the successful introduction of the A320neo family, Boeing had to respond. For several years, Boeing was investigating the replacement of the 737 with an all new "clean sheet" design. But the introduction of the A320neo with its efficient specifications and sky high sales figures put pressure on Boeing to come far earlier with a more modern and efficient 737NG successor. So in August 2011 Boeing presented the 737 MAX Family. The first 737 MAX will be delivered in 2017. Most important new feature of the 737 MAX is the introduction of the new CFM International LEAP-1B engine. With a fan diameter of 69.4 inches (176 cm) it is an increase of 7.6 inches (19.3cm) from the CFM56-7B engine on the 737NG. To maintain a 16.9 inches (42.9cm) ground clearance beneath the engine, Boeing had to increase the height of the nose gear by 8 inches (20cm), which drove a re-design of the forward electronics equipment bay in the nose section. The engine is also moved more forward and up relative to the 737NG. The new larger fan diameter improves the fuel burn by a claimed 12-14%.The new engine also has external nacelle chevrons similar to those on the 787 and 747-8, which reduces the engine's noise. The New LEAP-1B engine is smaller than the LEAP-1A and PW1100G engine option on the new A320neo family. Fuel efficiency is improved by some aerodynamic modifications on the fuselage (a new tail cone) and the introduction of a new winglet design, called the AT-Advanced Technology-Winglet Technology. In term of range the 737 MAX has an improved range of 400-540nm. Inside, Boeing offers the Sky Interiors as standard and offers some minor modifications to the aircraft system. This includes a flight deck with 4 new large displays but with the same look and feel as the 737NG flightdeck to preserve commonality with training across the 737 Family.

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The 737-9 competes with the A321neo for orders. Both aircraft are especially seen as the successor for the 757-200, although with less range. To offer more range Airbus has announced a long range version of the A321neo. Compared with the ~1.200 orders for the Airbus A321neo, sales of the 737-9 have been very disappointing. So far 222 737-9s have been ordered (100 of them for United) and there has been very little order-activity. No new orders for the 737-9 have been announced since September 2014. There are 402 orders for which the choice between a 737-7, 737-8 and 737-9 is still open and there are 487 orders for which the customer has not decided for a 737-8 or 737-9. To grasp the 757 successor market Boeing has been talking about a new middle-of-the-market aircraft. An all new clean-sheet aircraft offering the range and seating capacity in the range of the old 767-200 and the operating economics of the 737 MAX. But it will take some time before this aircraft-if it is ever launched-will be available so Boeing is also considering options to improve the current 737-9 design, to offer a more competitive aircraft to the A321neo. A possible stretch (a 737-10?) and re-engining of the current 737-9 with a larger fan engine (which requires also a longer, re-designed landing gear) is one of the options Boeing has, to repair the five-to-one ratio, by which the 737-9 is currently being outsold by the Airbus A321neo. It has to be taken into account, for a significant number of MAX' orders the version has not been decided and possibly some-9 orders are hidden in this group.

Boeing 757-200

Class:	Large Narrowbody
First Flight:	19 February 1982
Standard Seating:	196 - 200 (2 class), 221 - 228 (1 class)
Range:	2,130 - 3,995 nm
Engine Options:	PW2000 (46%), RR RB211-535 (54%)
In Service:	357
On Order:	0
In Storage:	152
Operators:	63
Last Delivery:	April 2005

The 757-200 was developed in conjunction with the wide bodied 767 programme. As a result the 757-200 shares c.50% of the components with the 767 and has a common crew rating. The 757 was designed for trans-continental markets that had outgrown the then-available 727. In 1986, a 757-200 with a higher certified MTOW entered service. ETOPS certification further improved the 757's operational flexibility. The 757 attracted many orders from the major carriers and charter airlines. Nevertheless, for the higher frequency mainline operations, legacy carriers and especially low cost airlines selected A320 family or 737NG aircraft. The 757's transcontinental range, which made the aircraft heavy, became less attractive as a differentiator as the range of the more modern A320 family and 737NG had increased. The competing, newer A321-200 was lighter, more fuel efficient and also able to fly US coast-to-coast routes. When retrofitted with winglets (51,3% of pax fleet), the 757-200 could get 4-5% more efficient which even opened up a new role in low density medium haul (transatlantic) operations.

Boeing decided to end the 757 production in 2004. Although the part-out phase already started for older 757s, large fleets of younger 757s have remained in passenger service, particularly at some US majors. However American Airlines, Delta Airlines and United Airlines have already ordered large quantities of 737-900ER, 737-9, A321-200 and A321neo aircraft to replace their ageing 757-200 fleet and in recent years especially United and American have sent many 757 aircraft to the storage fields in the desert. About 30% of the 757-200 fleet is stored. Some of them will be converted to freighter, but many will not return to the skies again. With the introduction of even more efficient aircraft with the same seating, payload and range specifications as the 757-200, in the form of the A321neo and 737-9, the days of the 757-200 as transcontinental workhorse of the US majors are numbered. The disposal of large quantities of 757-200s will have impact on its values. It may still be an attractive aircraft for some airlines looking for a relatively cheap and medium range aircraft, available in the short term. A large number of 757-200s have an extended operational future with e.g. DHL and Fedex (no winglets) as strongly committed customers for freighter conversions. As corporate/VIP /Head of State aircraft, 22 757-200s are operated by 16 operators.

Early 2014 Boeing confirmed that it is in the early phase of a market study for a 757 successor. Since then, the possible introduction of a "middle-of-the-market" (MoM) aircraft has been a hot topic at aviation conferences and in the on-line and printed aviation media. These new MoM aircraft should fit between the current single aisle aircraft (the 737 Max) and the smallest twin-aisle aircraft (787-8). The MoM aircraft should be capable to fly 210-250 passengers in a 2 class configuration over distances of 4.500- 5.000nm. Especially the successful introduction of the long range version of the Airbus A321neo put some pressure on Boeing to come with a competitive aircraft in this MoM segment. Boeing have various options. A further stretch of the 737-9 (a 737-10) with new wing and larger LEAP engines would be a relative cheap and quick solution. The development of a new clean sheet design, the other option, will be a much higher investment and it would be unlikely that this new clean sheet aircraft will be available before 2023-2025. Doubts about the size of this market segment makes that Boeing is still investigating if there will be enough interest from airlines to justify the investment.

Boeing 757-300

Class:	Large Narrowbody
First Flight:	2 August 1998
Standard Seating:	234 (2 class), 280 (1 class)
Range:	1,855 - 3,490 nm
Engine Options:	PW2000 (29%), RR RB211-535 (71%)
In Service:	55
On Order:	0
In Storage:	0
Operators:	6
Last Delivery:	April 2004

The 757-300 was a last-minute and essentially unsuccessful attempt to revitalize the 757 market by introducing a stretched version. After offering only one version for almost two decades, this 23ft longer version (c.44 more pax in single class) was offered as well. However by the end of the 1990s the 20 year old technology of the 757 was considered outdated and the trend in the narrow bodied aircraft market was towards smaller aircraft used with high frequency instead of larger. As a result the 757-300 never got of the ground commercially and production was ended only five years after it first entered into service. United, Delta (both US airlines inherited the type after a takeover of another airline) and Condor are the most important 757-300 operators (21, 16 and 13 a/c in service respectively). There is no cargo conversion program for the 757-300.

Boeing 767-200/200ER

Class:	Small Widebody
First Flight:	26 September 1991
Standard Seating:	181 (3 class), 224 (2 class), 255 (1 class)
Range:	4,530 - 6,385 nm
Engine Options:	GE CF6-80 (57%), PW JT9D (32%), PW 4000 (11%)
In Service:	19
On Order:	0
In Storage:	28
Operators:	23
Last Delivery:	March 2003

The 767 variants make up a family of small and medium wide bodied aircraft for medium to long-range operations. The 767-200 is the smallest of the three variants and is offered in a basic and a high gross weight (-200ER extended range) version and some "hybrid" versions (-200EM;-200ERM). The aircraft was designed to fit in between the larger DC-10 and L1011 wide bodies and the narrow bodied 727s. It would replace the 707 and DC-8s and competed directly with the slightly earlier introduced A310. Both aircraft ended up splitting a rather limited 220-seat wide bodied aircraft market. Many passenger 767-200/200ER aircraft have already been dismantled and with 67.3% of the current fleet stored, the type has a very high storage percentage.

Although the 767 production line is still open (for freighters and the 767 Tanker order from the USAF), there has been no 767-200(ER) delivery since March 2003 and it is not likely that any new ones will be ordered. The operator base is very fragmented and consists of just second tier operators with very small fleets (3 or less). An additional eight 767-200s serve as corporate/VIP/Head of State aircraft. Twelve 767-200s were built as tanker, military transport aircraft or military reconnaissance aircraft for the Japanese and Italian Air Force and one 767-200 was converted from passenger aircraft to tanker / transport aircraft for the Colombian Air Force. After a long an intense procurement process the USAF ordered 175 767 Tankers which will be a derivative of the 767-200. For older-200(ER)s, a (package) freighter conversion programme is available (60 conversions so far for primarily ABX Air and Star Air). However, looking forward, the 767-300(ER) is the preferred conversion candidate because of the larger volume and higher take-off weights.

Boeing 767-300/300ER

Class:	Medium Widebody
First Flight:	30 January 1986
Standard Seating:	218 (3 class), 236 (2 class), 350 (1 class)
Range:	4,415 - 5,500 nm
Engine Options:	GE CF6-80 (65%), PW JT9D (1%), PW4000 (30%), RR RB211-524 (4%)
In Service:	481
On Order:	0
In Storage:	74
Operators:	84
Last Delivery:	June 2014

The basic 767-300 is essentially a 45 seat stretch of the 767-200, and is mostly used in the North American and transatlantic market as well as the Asian domestic (Japan) and regional markets. Boeing almost simultaneously developed the higher gross weight 767-300ER which has up to 2,000 nm of additional range, a standard lower deck large cargo door and is mostly used on inter-continental routes. The 767-300ER is the most successful member of the 767 family, selling over 500. However like the 757, the 767 is technically outdated, a problem that became obvious after the introduction of the A330-200 which is more efficient and more capable. Many airlines therefore replaced their 767-300ER with the new Airbus products (among others KLM, Air Europa, SAS, and Air France). Although still on offer by Boeing, sales of the 767-300ER have dried up and in the summer of 2014, the-for the time being-last passenger 767-300ER was delivered to Air Astana. The A330-200 still records moderate sales, so in the meantime it has already outsold the 767-300ER. It is possible to upgrade the 767-300ER with winglets (est. 4-5% fuel burn improvement) which has been done to 270 aircraft, mostly by the US majors which still operate the majority of the 767-300(ER) fleet. Boeing's 787 will replace a large part of all 767s in the near future.

Despite the low backlog, the 767 production line remained open because of the USAF tanker aircraft order which was granted in 2011 to Boeing's 767 platform (with 787 updates) and for 767 freighters, ordered by Fedex. For first tier airlines, used 767-300ERs are no longer attractive aircraft as they can afford more modern and fuel efficient alternatives. However, thanks to its low capital costs and long haul capabilities, a 767-300ER can be a very good aircraft for new start-up airlines, ACMI operators and new long haul low-cost/leisure initiatives. For example in Canada Air Canada Rouge and WestJet started long haul low cost operations aimed at the leisure market with 767-300ERs in 2013 and 2015. Many former passenger 767-300ERs, excluding low MTOW aircraft with structurally weaker wings, will find a second life as a converted freighter as soon as feedstock values have become cheap enough. It certainly beats converted A300 or A310 freighters on payload/range capability although it has a narrower fuselage (less optimal container configurations) than these Airbus competitors. Demand for medium widebody freighters is rising in mainly China and the USA as e-commerce companies like Alibaba and Amazon intend to start their own air express operations to become more independent from companies like UPS, DHL and Fedex. Converted 767-300 freighters are an ideal platform for these new start up initiatives. In 2016 more than 20 767-300/ERs had been converted. As corporate/VIP aircraft, an additional eight 767-300(ER)s are in service.

Boeing 767-400ER

Class:	Medium Widebody
First Flight:	9 October 1999
Standard Seating:	245 (3 class), 267 (2 class), 375 (1 class)
Range:	3,720 - 5,365 nm
Engine Options:	GE CF6-80 (100%), PW4000 (0%)
In Service:	37
On Order:	0
In Storage:	0
Operators:	2
Last Delivery:	May 2002

Like the 757-300, the 767-400ER was a failed attempt by Boeing to revive a 20-year-old programme. It was launched to create a better competitor to the successful A330-200. The 767-400ER is a 45 seat (21 feet) stretch of the (already stretched) 767-300 fuselage and also features an extended wing by the addition of 7 feet and 8 inch raked wingtips. Market acceptance of the 767-400ER was-with only two airlines buying the aircraft-awful as it largely featured 20 year-old technology. Today Delta Airlines (21) and United Airlines (16) which inherited the aircraft from the Continental take over, operate the 767-400ER. Although still being offered by Boeing, it is unlikely that the 767-400ER will receive any additional commercial orders. Fedex expressed some interest in a (factory built) 767-400 freighter some years ago, but ordered the-300 freighter version of the 767. One 767-400ER is built as VIP aircraft for the Government of Bahrain.

Boeing 787-8

Class:	Medium Widebody
First Flight:	15 December 2009
Standard Seating:	242 (2 class), 291 (1 class)
Range:	7,355 nm
Engine Options:	GE GEnx-1B (56%), RR Trent 1000 (36%),TBD (8%)
In Service:	304
On Order:	115
In Storage:	2
Operators:	41
Last Delivery:	N/A

The 787 family is initially designed to replace the 757- and 767-products and is the most successful widebody aircraft design ever in terms of aircraft ordered prior to its entry into service. The 787 family features many new technologies like a full composite structure including wing and barrel shaped fuselage sections (accommodates 9 abreast seating), new up to 15-20% more efficient and relatively quiet engines, improved aerodynamics and many new electric systems instead of pneumatics/ hydraulics. The 787-8 is the 'baseline model' and is optimized for the long-range medium-density markets and would serve as such as a replacement for the 767-300ER and be a new threat to the successful A330-200. Furthermore, its ultra-long-range capability enables it as well to develop new point-to-point routes, as airlines may use it as "pathfinder" to develop routes between city-pairs at long range that have insufficient traffic density to (yet) justify the larger long range aircraft types. Design and production difficulties lead to multiple serious delays of the first delivery. Eventually the first Dreamliner was delivered to ANA in September 2011 and first commercial service of a 787 took place later that year on 26 October.

After a successful first year in service and 50 Dreamliners delivered to various airlines, the 787 programme got a major setback. In January 2013 after "battery events" on board a Japan Airlines 787-8 and on board an ANA 787-8, the global fleet of all 787-8s in service was grounded by the aviation authorities. The damage to the battery and surrounding area led to loss of battery function on both airplanes and in both cases was caused by the lithium-ion batteries that Boeing installs in the forward and aft electronic equipment bays of each 787. This type of battery is necessary for the 787's performance, because of the battery type's ability to offer peak performance in very short notice and because each battery is relatively light and small. After more than 200,000 engineers' hours spent, Boeing presented an improved battery design with a three-layer protection method preventing initiation or propagation of a battery event and then additionally preventing any impact to the safe operation of the airplane. The US FAA approved the new battery design and lifted the grounding order on 21 April 2013. Boeing exercised a programme of battery system retrofits to the in service and undelivered new 787s and airlines subsequently resumed operations with their 787 fleets. Besides these battery problems, teething problems continued to haunt the 787, which caused major operational problems for many operators. One of the most high-profile incidents was a fire (again) on board a parked, unoccupied and unpowered Ethiopian Airlines 787 at London Heathrow on 12 July 2013. Although this fire was not caused by its main batteries, but by a overheated Emergency Locator (ELT), which contains Lithium-Manganese Dioxide Batteries, it did not help to improve the 787 already tainted (media) reputation. All these 2013 incidents did not result in any cancellation of orders. Several operators still indicate that while the 787 is a very advanced design, it is a bit of a "prima donna" as its systems are complex and sensitive causing headaches to the airlines' operational organisations.

As of summer 2016, more than 300 787-8s have been built and delivered to more than 40 operators. Boeing decided it will deliver none of the six flight test aircraft to customers. The first batch of customer production models (line # 7-22, nicknamed "Terrible Teenagers") suffered from structural overweight and performance issues and didn't meet Boeing's performance guarantees provided to the original customers, who subsequently rejected these aircraft. Also, Boeing encountered serious quality and design issues in the construction of major components such as empennage, side-of-body wing joint and horizontal tail plane stabilizers. This meant that the aircraft had to be re-engineered to meet target delivery specifications. The "teenager" aircraft feature a lower-than-standard MTOW, severely compromising its payload/range capability. The "teenager" 787-8 aircraft were stored at Everett and Boeing tried hard to sell these "teenagers" with a huge discount to other airlines. However the "teenager" stigma made it very difficult to find customers for these aircraft. In 2015 Boeing sold six of these "teenagers" to Ethiopian and two to Air Austral. These eight "teenagers" will have to undergo a probably costly modification programme, before being suitable for delivery to their new customers. Two more teenagers were sold to the Mexican and Korean government for use as a VIP aircraft.

For various reasons (delays, expected 787-8 underperformance, more value, etc), a significant numbers of 787-8 orders have been swapped to the 787-9 variant and there have also been very few new orders since 2010, as airlines prefer the better economics of its larger siblings, the 787-9 and 787-10. Since its first commercial flight in October 2011, Boeing only booked 34 new orders for the 787-8 and they placed 12 of the old 787-8 "teenagers" in the market at discounted price levels. The last new order for a new 787-8 dates back to 2013. The current backlog has shrunk to 115 aircraft and as long as no orders are placed, the last 787-8 aircraft from the current order book are scheduled for delivery around 2020.

Unfortunately Boeing didn't bother incorporating a number of the structural improvements of the-9 design into the-8, so it seems Boeing is commercially more focused on the-9. Boeing selected General Electric (GE) and Rolls-Royce (RR) to supply engines for the 787 program. The initial versions of these engines missed aircraft fuel burn targets by around 3-to-4 percent. Incremental improvements to the engines' hardware and software resulted in enhanced engine performance that better matched the aircraft fuel burn target. The PIP II package for the GEnx-1B engines and the package TEN (e.i.s. 2017) for the RR Trent 1000 engines are expected to achieve (or exceed) the original fuel burn targets for the 787. This still leaves a number of early production aircraft with GEnx-1B PIP I and Trent 1000 Package B and C engines. GE has indicated that during future shop-visits all PIP I engines may be upgraded to PIP II level. RR has not made any similar indications regarding the upgrade of Package B and C engines to the Package TEN

hardware standard. This means that RR "B" and "C"powered 787's are at risk of becoming marginalised in the future. In addition, PIP II and Package TEN engines are more desirable (76K+ thrust level) engines as they can be applied to the 787-8 and 787-9, as well as the 787-10. Different airframe OEW's and engine standards require an individual evaluation of early 787-8's. It is deemed likely that the weights and payload-range performance of the 787-8 will gradually improve as further deliveries take place but will not meet the initial specs as set by Boeing for the time being. Line number 21 was the first 787-8 with a higher MTOW (502.5k lb) for long range operations.

Boeing has sold five 787-8 BBJs (Boeing Business Jets) for VIP/ Head-Of-State operations. Besides these five BBJs five more 787-8 (including 3 "teenagers") operate in a similar role, bringing the total of 787-8 VIP aircraft to ten. None of these VIP 787-8s is currently in service and all are currently being outfitted with a luxurious VIP interior.

Boeing 787-9

Class:	Medium Widebody
First Flight:	17 September 2013
Standard Seating:	290 (2 class)
Range:	7,155 - 7,635 nm
Engine Options:	GE GEnx-1B (48%), RR Trent 1000 (41%), TBA (11%)
In Service:	141
On Order:	432
In Storage:	0
Operators:	41
Last Delivery:	N/A

The 787 family is initially designed to replace the 757- and 767-products but the 787-9 variant is closer to the 777-200ER in terms of payload-range. Compared to the baseline 787-8, the 787-9 has more powerful engines and a stretched fuselage (20 ft) which should enable it to carry some 40 more passengers (up to 290 passengers) over an additional 300nm range (7,600nm). The A350-800 is expected to be a close competitor but the slightly larger A350-900 could offer competing seat-mile economics as well. Versus the larger 777-200ER, the 787-9 is expected to bring a 20% relative trip cost improvement which is a 10% improvement in seat mile cost. In general, the 787 family features many new technologies like a full composite structure including wing and barrel shaped fuselage sections (accommodates 9 abreast seating), new up to 15-20% more efficient and relatively quiet engines, improved aerodynamics and many new electric systems instead of pneumatics/ hydraulics.

Design and production difficulties of the 787 programme have lead to serious delays, but on 17 September 2013 the 787-9 finally made its first flight. After a successful test programme, the first 787-9 was delivered to Air New Zealand on 10 July 2014. It is not yet clear whether the aircraft will meet the weight and payload-range specs as set by Boeing. Some order swapping from the 787-8 to the-9 already indicates that customers increasingly see the-9 as a popular variant with probably less teething problems than the-8. As of summer 2016, with 141 787-9s in active service and 432 787-9s on order, the 787-9 has clearly outsold the 787-8. The 787-9 did not suffer from a difficult entry-into-service with operational reliability problems for the airlines as the 787-8 did. Boeing claims for 787 reliability are now comparable to other aircraft. On the production side, the problems seemed to be solved as Boeing is producing the 787 with a rate of 10 aircraft a month, which will increase to 12 aircraft per month (+20%) later in 2016 and to 14 per month in 2020. The 787 is built at two production lines; in Everett (WA) and Charleston (SC). 2 787-9 have been ordered as a BBJ variant.

Boeing 787-10

Class:	Large Widebody
First Flight:	est. 2017 EIS 2018
Standard Seating:	330 (2 class)
Range:	5.630 - 6.430 nm
Engine Options:	GE GEnx 1B (71%), RR Trent 000 (29%)
In Service:	0
On Order:	153
In Storage:	0
Operators:	9
Last Delivery:	N/A

The 787 family was initially conceived as a two-size family of aircraft compromising three models besides the already mentioned 787-8 and 787-9 Boeing also developed a 787-3. This version was initially developed for regional operations and featured the same fuselage dimensions as the 787-8. The 787-3 has been dropped by Boeing due to lack of market interest. In 2006 Boeing introduced the idea of a further stretch of the 787-9 to provide more payload capability and initially, called it the 787-10. After a few silent years, Boeing revealed a new rendering of a larger variant of the 787, now designated 787-10X. The-10X appears to be shorter than the original "2006" 787-10. At the Paris Air Show in June 2013, Boeing launched the new Aircraft model (now called 787-10 again). The "new" 787-10 is marketed with seating for ~330 passengers in a two class layout and a range of ~6,400nm. It has the same wingspan and engines as the 787-9, which indicates that the 787-10 would probably be targeted for thick, medium-long routes such as transpacific or transatlantic. As such, it would be a strong competitor to today's very successful Airbus A330-300 (having slightly more pax and ~1,000nm more range) as well as to the Airbus A330-800/900neo and Airbus A350-800 and-900 which probably will be heavier but probably beat the-10 on range. In general, the 787 family features many new technologies like a full composite structure including wing and barrel shaped fuselage sections (accommodates 9 abreast seating), new up to 15-20% more efficient and relatively quiet engines, improved aerodynamics and many new electric systems instead of pneumatics/ hydraulics. A clear advantage for the 787-10 would be that it could benefit from the design, production and operational experience gained with the 787-8 and-9.

The service entry of the 787-10 is targeted for the second half of 2018. Initially the 787-10 was very well received in the market and in the first half year after its introduction at the Paris Air Show 2013, more than 120 aircraft had been ordered. Since then, the new order intake has been slow with only 21 new 787-10 orders, which in combination with a few order swaps from the 787-9 to 787-10 makes for a total backlog of 153 aircraft. If history is to repeat itself, a 787-10ER (extend range) might be introduced in the near future to give the 787-10 the extra range to compete against the new Airbus offerings in the segment. M.E. carriers would probably welcome a bit more range. Boeing however has not announced any plans in this direction and indicates that the-10 combines optimal seat-mile cost with adequate range for the majority of missions.

Boeing 777-200

Class:	Large Widebody
First Flight:	12 June 1994
Standard Seating:	312 (3 class), 355 (2 class), 440 (1 class)
Range:	3,125 - 4,240 nm
Engine Options:	GE90 (9%), PW4000 (74%), RR Trent 800 (17%)
In Service:	70
On Order:	0
In Storage:	6
Operators:	10
Last Delivery:	May 2007

The Boeing 777-family was developed to fill the capacity gap between the 767 and 747-400 and to replace older wide bodies as DC-10-10 and L-1011 Tristar. Compared to previous aircraft generations, the 777's largely computerized design featured improved, more reliable engines, a higher percentage of composites in the structure, digital fly-by-wire and a modern LCD cockpit. The 777-200, initially referred to as the 777A with a maximum range of 4,240 nm primarily aimed at the US high-density, trans-continental and intra-Asia market. The increasing high frequency competition from low-cost carriers in the US domestic market and strong competition from the more efficient and slightly longer range A330-300 limited the market acceptance and commercial success of the 777-200. Nine different-200 customers have taken delivery of 88 aircraft. The last few years, phase-outs of the 777-200 have accelerated. Eleven 777-200s have already been broken up; nine of them in the last two years. As the 777-200 is less capable compared to the 777-200ER and doesn't offer the low seat mile cost of the A330-300, the 777-200 is less attractive for new operators. The reason that they are still flying is fleet commonality as all eight operators have also other variants of the 777 in their fleet (Operator # 9 and # 10 are Russian lease companies with both one stored ex Transaero 777-200 in their inventory). Most 777-200s are used on medium-haul high density routes. Largest operator of the type United Airlines (19 aircraft) has announced that it will move 10 777-200 from their transatlantic network, to their domestic network. One 777-200 is in use as VIP / Head of State aircraft for the Government of Gabon.

Because Fedex showed some interest in a conversion programme, a second life as converted (regional) freighter is a very remote possibility. Even the usually less cycled 777-200ER doesn't seem to be a popular feedstock plane. Only a converted 777-200LR could offer payload/range capabilities close to a factory freighter. Conversion won't be cheap (slightly under $30 mln) anyhow, because of the significant composite content in the structure and the complex (cockpit) technology. Although the 777 assembly line is still open, there has not been any 777--200 delivery since May 2007 (except-200LRF freighters) and it is not likely that any new 777-200s passenger planes will be ordered.

Boeing 777-200ER

Class:	Large Widebody
First Flight:	7 October 1996
Standard Seating:	313 (2 class)
Range:	5,130 - 7,065 nm
Engine Options:	GE90 (38%), PW4000 (23%), RR Trent 800 (39%)
In Service:	363
On Order:	0
In Storage:	40
Operators:	49
Last Delivery:	July 2013

The Boeing 777-family was developed to fill the capacity gap between the 767 and 747-400 and to replace older wide bodies as DC-10 and L-1011 Tristar. The 777-200ER, also referred to as the 777-200IGW (increased gross weight) or 777B, was developed to replace the DC-10 and L1011 tri-jets on long-haul routes and compete with the four-engine A340-300 and the MD-11 tri-jet. The 777-200ER was optimized on markets such as Europe to the US West Coast and offered some 2,500 nm range over the 777-200. Some airlines even managed to get the 180 minutes ETOPS certification increased to 207 minutes in 2000 which enabled the 777-200ER to fly trans-pacific routes efficiently and compete on thin 747 routes. The 777-200ER is however offered in six different gross weight variants. The lower gross weight versions are not always simply upgradeable and this would in any case be a very expensive exercise. Its payload/range performance combined with the efficiency of twin-engines made the 777-200ER the fastest selling widebody until the 787 was launched. In recent years sales of the 777-200ER have dried up and although the aircraft is still offered by Boeing there are no 777-200ERs on backlog. The last 777-200ER which came off the production line in Everett was delivered to Asiana Airlines in July 2013. Many airlines favour the A330-300 especially the new 240t and 242T MTOW variants or go for the larger 777-300ER variant, which has become the most popular model within the 777-family. In 2013, the 777-200ER was overtaken by the 777-300ER in terms of the number of aircraft produced. It seems that Airbus finally will threaten the 777-200ER's market dominance with the A350-900 design. For operators that don't need the range, the more efficient high gross weight A330-300 is more attractive.

The 777-200ER has long been one of the most popular wide bodied aircraft in the market. But with a new generation aircraft entering service in the coming years and the fact the 777-200ER design is starting to age, many aircraft will be phased out in the coming years. Phase-outs have already started with Singapore Airlines, China Southern, Kenya Airways, Emirates and Malaysia Airlines. The number of stored 777-200ERs grew from around 7 early 2015 to 40 in the summer of 2016. Given the known difficulties of remarketing large wide boded aircraft, these developments will have a negative impact on its market values. Most 777-200ER are still in service operated by their original operator. Mostly first tier network airlines like for example British Airways, American Airlines, United Airlines and Air France. With the new replacement types as the 787-9 and A350-900 now entering service and their deliveries finally getting momentum, it is not expected that market values for 777-200ER aircraft will recover. Relief can come from a 777 conversion programme. If Boeing launches a 777 conversion programme (based on Fedex interest), the 777-200ER seems to be the preferred feedstock candidate based on payload-range and load distribution capabilities as well as the potential availability of suitable and affordable feedstock aircraft. Performance wise a converted 777-200ER will be far away from the 777 factory freighter and will effectively be a large regional freighter. Conversion probably will be costly (~ $30 mln) because of the significant composite content in the structure and the complex (cockpit) technology. 3 777-200ER are in use as Corporate Jet or as presidential aircraft.

Boeing 777-200LR

Class:	Ultra Long Range Large Widebody
First Flight:	8 March 2005
Standard Seating:	312 (3 class), 317 (2 class)
Range:	7,835 - 8,555 nm
Engine Options:	GE90
In Service:	55
On Order:	0
In Storage:	1
Operators:	12
Last Delivery:	December 2014

The 777-200LR is an ultra-long-range derivative of the 777-200ER and was designed to counter the A340-500. Boeing named it "the Worldliner", because it could connect almost every city pair on the globe. Compared to the-200ER it has a strengthened structure and landing gear, a larger wing with additional fuel capacity, raked wingtips (likewise the 777-300ER) and three optional auxiliary fuel tanks in the rear cargo hold. Together with the powerful GE engines, these changes made it the longest-range aircraft in the world.

Like its Airbus counterpart it is designed for a small market niche and is unlikely to ever become a significant commercial success due to the limited number of routes requiring such ultra-long-range capability. So far 59 777-200LRs have been built with 13 operators. There are no 777-200LRs on order backlog and the last 777-200LR was delivered to CEIBA Intercontinental in December 2014. For a niche aircraft the operator base is quite diverse with Delta Airlines and Air Canada from North America, Qatar Airways and Emirates from the booming Middle East, Air-India and Pakistan International Airlines from the sub-Indian continent and Ethiopian Airlines from Africa. But also some more exotic airlines like Turkmenistan Airlines and CEIBA Intercontinental fly with the 777-200LR. In 2014, Air-India, one of the largest operators of the type, sold 5 of its 8 strong fleet to Etihad Airways, which will use the long range aircraft for flights to the US West coast. Air Austral from the French Indian Ocean Territory of Reunion Island used to fly one 777-200LR, but they sold this aircraft late 2015 to Crystal Luxury Air, a US leisure airline who will use the aircraft for luxurious around- the-world tours with seating for 88 passengers with full reclining flatbed seats.

Boeing's attempts to reposition the-200LR as a 200ER with extra belly cargo capacity met with little enthusiasm. Higher direct operating and capital costs make the 777-200LR sub-optimal on shorter routes that can be served more efficiently with other types. The much lighter 787-9 and the A350-900 will probably combine lower trip and seat-mile costs in the not-too-distant future on many of the 777-200LR's routes.

Given its structural strength and the fact that it is powered by the same engines as the Boeing factory freighter version of the 777, the 777F, the-200LR could become the most popular 777 for cargo conversion, as its performance should be close to the factory freighter. However the large amount of composite material in airframe and floor of the 777-200LR will make a conversion very costly. Given the small fleet size and the high costs involved, there might not be a profitable business case for a 777-200LR conversion. Three 777-200LRs are in use (two in service / one stored) as VIP / Head-of-State aircraft.

Boeing 777-300

Class:	Large Widebody
First Flight:	16 October 1997
Standard Seating:	388 (3 class), 425 (2 class), 550 (1 class)
Range:	3,120 - 5,045 nm
Engine Options:	GE90 (0%), PW4000(27%), RR Trent 800 (73%)
In Service:	53
On Order:	3
In Storage:	0
Operators:	10
Last Delivery:	July 2006

The 777-300 is designed to operate on mid-to-long range high density routes and is currently almost exclusively used within Asia (Emirates also has a fleet) by the large network carriers. Compared to the-200, it has a 33ft stretched fuselage. For most airlines, there are insufficient city-pairs with mid-to-long range distances to deploy the-300 efficiently and it lacks the range to appeal to the long-range market. With the introduction of the more flexible long-range 777-300ER in 2003, the 777-300 has been driven in a short-range high capacity role, which is a very small market with virtually no secondary operators. Remarketability (if any) is further split by the choice of engine manufacturers. Although the 777 production line is still open, there has been no delivery since July 2006 and it is not likely that any new-300s will be ordered. Russian airline Transaero Airlines took delivery of five ex-Singapore Airlines 777-300s between 2011- 2013 and became the first and still only non-Asian operator of the type. After Transaero's bankruptcy late 2015, all its five 777-300s were transferred to Rossiya. However by lack of any further remarketing options, an early part-out scenario is not deemed unlikely.

Boeing 777-300ER

Class:	Large Widebody
First Flight:	24 February 2003
Standard Seating:	386 (3 class), 396 (2 class)
Range:	5,715 - 7,370 nm
Engine Options:	GE90
In Service:	669
On Order:	126
In Storage:	1
Operators:	40
Last Delivery:	N/A

The 777-300ER is basically a combination of the stretched 777-300 fuselage with the larger, stronger wing of the 777-200LR. It provided Boeing with a true replacement for the 747-100/200/300 and even the 747-400, while also offering a growth supplement to the 777-200ER. Like the smaller 777-200LR and the-200LR Freighter, only GE90 engines are offered on the 777-300ER, which simplifies remarketing. The 777-300ER payload/range capability has improved somewhat since it entered service, allowing 500nm more range and a 25,000 lb higher take-off weight. Early production aircraft will be upgradeable to match this capability increase by strengthening the landing gear, although it remains to be seen how popular upgrades will be. Although 777-300ER sales were initially slow, the longer term 747 replacement market and limited competition from Airbus' much less efficient four-engined A340-600 almost gave the 777-300ER a monopoly in its market segment. Thanks to its large belly capacity, the 777-300ER could potentially generate significant additional cargo revenues. With 670 aircraft built and delivered and a backlog of ~ 127 aircraft, the 777-300ER has become one of the most successful Boeing widebody aircraft in history. However, the A350-1000, which is expected to enter service in 2017, will offer a very strong challenge.

Although somewhat confident on the 777-300ERs competitiveness based on the strong and 'Boeing exclusive' GE90 engines, Boeing had to improve the current 777-300ER to remain competitive and keep its leading position in its market segment. During the Dubai Air Show in 2013 Boeing therefore launched the 777X-program. This 777X (consisting of a 777-8 and 777-9) is a revamp of the current 777 generation including new engines, redesigned wings with folding wingtips and a range of other modifications and is scheduled to enter service around 2020.

With the coming introduction of the A350-1000 and the 777-9, sales of the 777-300ER have slowed down and its looks like its heydays are over. In the last two years the 777-300ER's backlog has shrunk to 126 aircraft. This has forced Boeing to cut production from 8,3 aircraft per month (100 per year) to 7 per month and to eventually 5.5 per month from late 2018. Despite this production rate reduction, there are still a lot of production slots for the 777-300ER open (estimated around 100), before the new 777X will enter production. To fill the open production slots, Boeing may consider to offer more attractive pricing for new 777-300ER buyers. Early 2015, Boeing introduced a set of upgrades for the current 777-300ER, to ensure the aircraft remains competitive in the long range market well after the 777X enters service. These upgrades include engine and aerodynamic improvements and interior adjustments. These will result in 2% fuel-burn savings and an increased seating capacity by up to 14 seats that will push the potential fuel-burn savings on a per-seat basis to as much as 5 % by late 2016. Most of the upgrades are retrofitable, and must help Boeing to keep the 777-300ER attractive and pursue new sales of the current-generation 777-300ER until the transition to the 777X at the end of this decade.

One 777-300ER is built as VIP aircraft for the Government of Abu Dhabi. Also the Japanese Government will take delivery of two new built 777-300ER "VIP" aircraft in the near future, which will replace the two 747-400 aircraft currently operating in this role. The 777-300ER's long fuselage and centre of gravity make cargo-conversions not a likely scenario.

Boeing 777-8

Class:	Ultra Long Range Large Widebody
First Flight:	est. 2020, EIS 2022
Standard Seating:	est. 355 (3 class)
Range:	est. 8,700 nm
Engine Options:	GE9X
In Service:	0
On Order:	53
In Storage:	0
Operators:	3
Last Delivery:	N/A

After years of studying, Boeing formally launched the new 777X family at the Dubai Air Show in November 2013 with orders from Emirates (150!), Etihad Airways and Qatar Airways, while Lufthansa already earlier ordered 20 777-9Xs in September 2013. These new revamped triple sevens are growth derivatives of the current 777 line up and are intended to compete with the new Airbus A350-900/1000. The new 777X aircraft will feature a new scale up version of the composite wings used for the smaller 787. At 233ft and nine inches the new wing is rumoured to be the largest span of any twin-engine Boeing aircraft type to date. It will be built using carbon-fibre reinforced plastic and will reportedly feature folding wingtips to allow the new wing 777X models to operate at airfields without the facilities to handle aircraft with longer ("code F") wing-spans. The extended wingspan is going to have a considerably better lift-to-drag ratio and is significantly lighter than the wings on the current models. Another novelty on the 777X is the advanced aluminium-lithium fuselage which is lighter. In the cabin, Boeing looks to remove 4inch from the 777X by carving the sidewall and frame shape, accommodating a more comfortable 10 abreast economy arrangement and nine-abreast premium economy offering while maintaining the same cross section. Core to the new variants will be a new General Electric GE9X engine, offering the latest generation engine technology. While Boeing made a request for proposal for a 100,000lb engine for the 777X to General Electric, Rolls-Royce and Pratt and Whitney, it announced in March 2013 that it had selected GE as its engine partner for the 777X. All these improvements will make the 777X 15-20% more efficient than the current 777 variants.

Initially two series of the new 777X were offered, the 777-8X and 777-9X. In November 2015 Boeing formally dropped the "X" suffix for the individual 777X variants, so the models are now called the 777-8 and 777-9. The combined family however will still be known as 777X. In the summer of 2016, Boeing acknowledged, that a stretch of the 777-9 is technically possible. If pursued, this new 777-10 derivative of the 777X family would have a seating of 450 passengers and would give Boeing a very capable two engine competitor to the Airbus A380. Boeing has said it will launch the 777-10 as there is enough customer interest. Boeing also announced a 777-8 freighter, details of which have yet to be confirmed. Smallest variant of the new 777X family will be the 777-8. The 777-8 (69,0 M) will be a 10 frame stretch of the 777-200ER (63.73M) and will have seating for about 355 passengers and a range of around 8,700nm. It will have a significantly de-rated 88,000lb version of the GE9X engine giving it a (provisional) MTOW of 315t. To date, the 777-8 is less popular than its big brother, the 777-9. Currently only the three usual suspects from the Middle East: Emirates, Qatar Airways and Etihad Airways, have placed orders for-combined-53 Aircraft. There are 10 orders for which the choice between a 777-8 and a 777-9 is still open. The 777-8 will be introduced after the 777-9 with a proposed service entry in 2022.

Boeing 777-9

Class:	Large Widebody
First Flight:	est 4Q2018; EIS 4Q2019
Standard Seating:	est. 406 (3 class)
Range:	est. 7,600 nm
Engine Options:	GE9X
In Service:	0
On Order:	243
In Storage:	0
Operators:	6
Last Delivery:	N/A

After years of studying, Boeing formally launched the new 777X family at the Dubai Air Show in November 2013 with orders from Emirates (150!), Etihad Airways and Qatar Airways, while Lufthansa already earlier ordered 20 777-9Xs in September 2013. These new revamped triple sevens are growth derivatives of the current 777 line up and are intended to compete with the new Airbus A350-900/1000. The new 777X aircraft will feature a new scale up version of the composite wings used for the smaller 787. At 233ft and nine inches the new wing is rumoured to be the largest span of any twin-engine Boeing aircraft type to date. It will be built using carbon-fibre reinforced plastic and will reportedly feature folding wingtips to allow the new wing 777 models to operate at airfields without the facilities to handle aircraft with longer ("code F") wing-spans. The extended wingspan is going to have a considerably better lift-to-drag ratio and is significantly lighter than the wings on the current models. Another novelty on the 777X is the advanced aluminium-lithium fuselage which is lighter. In the cabin, Boeing looks to remove 4inch from the 777X by carving the sidewall and frame shape, accommodating a more comfortable 10 abreast economy arrangement and nine-abreast premium economy offering while maintaining the same cross section. Core to the new variants will be a new General Electric GE9X engine, offering the latest generation engine technology. While Boeing made a request for proposal for a 100,000lb engine for the 777X to General Electric, Rolls-Royce and Pratt and Whitney, it announced in March 2013 that it had selected GE as its engine partner for the 777X. All these improvements will make the 777X 15-20% more efficient than the current 777 variants.

Initially two series of the new 777X were offered, the 777-8X and 777-9X. In November 2015 Boeing formally dropped the "X" suffix for the individual 777X variants, so the models are now referred to as the 777-8 and 777-9. The combined family however will still be known as 777X. In the summer of 2016, Boeing acknowledged, that a stretch of the 777-9 is technically possible. If pursued, this new 777-10 derivative of the 777X family would give Boeing a very capable two engine competitor to the Airbus A380. Boeing has said it will launch the 777-10 as there is enough customer interest. Boeing also announced a 777-8 freighter, details of which have yet to be confirmed. The 777-9 is the largest variant of the 777X family and has the program lead with service entry late 2019. It will have seating for about 400 passengers and a range of 8,200nm. It has a 3.6m stretched fuselage in comparison with the 777-300ER. It engines each provide 99,00Lb of thrust, giving it a (provisional) MTOW of 344t. As of summer 2016, a total of 243 777-9s were ordered by ANA, Cathay, Emirates, Etihad, Lufthansa and Qatar. However the last order (ANA for 20 aircraft) was placed in the summer of 2014, and since then no new orders have been placed. There are 10 orders for which the choice between a 777-8 and a 777-9 is still open.

Boeing 747-400(ER)

Class:	Large Widebody
First Flight:	29 April 1988
Standard Seating:	344 (3 class), 500 (2 class)
Range:	6,125 - 7,245 nm (-400) 7,495-7,635 nm (-400ER)
Engine Options:	GE CF6-80 (36%), PW4000 (41%), RR RB211-524 (23%)
In Service:	187
On Order:	0
In Storage:	59
Operators:	43
Last Delivery:	April 2005

The 747 was the first widebody in service and remained the largest passenger airliner until the A380 entered into service in 2007. The 747-400 was introduced into service in 1989 and enjoyed a monopoly in the 3-class over 400 seat capacity class for almost 20 years. The introduction of the A340-600 and 777-300ER as well as the A380 served to fragment market demand for the 747-400. Although none of these aircraft exactly matches the capacity of the 747-400, they do offer an alternative/replacement option and reduced the market for the new passenger 747-400s. Boeing unsuccessfully tried to re-start demand by offering the extended range 747-400ER which was only sold to Qantas (6). Boeing's 747-400's (growth) replacement product is the 747-8I which is the latest (and probably last) 747 derivative. Production of the 747-400 passenger aircraft ended in March 2005 followed by the last-400ERF freighter produced in October 2009. The 2008 economic crisis accelerated the phase out of the passenger 747-400s. For the right vintages, there have always been some demand for freighter conversion (both IAI-Bedek and Boeing offer a freighter conversion programme), but due to the stagnant cargo market, and the growing availability of used 747 factory freighters with nose loading capacity on the market, demand for 747 cargo conversions has dried up completely. By lack of a large secondary market, part out has already become a viable end-of-life solution for some vintages.

Once the Queen-of-the-Skies and the flagship of many top-notch airlines, the 747-400 has now the old-age-aircraft stigma and many airlines who once operated large fleets of 747-400s has phased them out or will phase them out in the very near future. Most 747-200s are / will be replaced by Airbus A380s, or Boeing 777-300ERs. Since 01 January 2015, 47 747-400 passenger aircraft have been retired. As the costs of operating a used 747-400 are very high, there is little appetite for used 747-400s. ACMI operators like Air Atlanta still add used 747-400 to their fleets and Rossiya from Russia took over some former Transaero 747-400s. Further there are a few airlines who buy these relatively cheap high capacity aircraft for (seasonal) demand (ao. Hajj charters). There are 14 747-400s in service as corporate/VIP/government aircraft.
One 747 been converted to water bomber.

Boeing 747-400M 'Combi'

Class:	Large Widebody
First Flight:	3 June 1989
Standard Seating:	264 (3 class) + 7 Palltes
Range:	6,650 - 7,214 nm
Engine Options:	GE CF6-80 (100%), PW4000 (0%)
In Service:	17
On Order:	0
In Storage:	3
Operators:	3
Last Delivery:	April 2002

The 747-400M, often indicated as 'Combi', is a 747-400 with a side cargo door at the aft main deck and a strengthened aft floor structure and cargo loading system. Compared to the-400, the Combi's main deck typically seats 110 less passengers but accommodates up to seven standard cargo pallets. The operator base is fairly small and KLM (15) is today actually the only airline with a substantial fleet of Combi's. Air France and Lufthansa used to operate Combi's in full pax configuration, but both have withdrawn these aircraft from use in recent years. When deployed in full main deck passenger mode (413 pax in 3-class), the extra weight puts it at a disadvantage vs. the 747-400 passenger variant. In general, Combi's were deployed on the thinner pax routes with sufficient cargo demand. However, with either growth of passenger or cargo demand on such route, more efficient full pax or full cargo alternatives become more attractive. The large belly cargo capacity of newer products such as the 777-300ER didn't contribute to the 747 Combi's success either. The 747-400 Combi was a more attractive feedstock candidate for cargo conversion than the passenger-400 provided conversion pricing adequately reflects the reduced work scope of the conversion process. However due to the stagnant cargo market the wider availability of second hand 747-400 factory freighters with nose-loading capacity, demand for converted 747-400 freighters has almost dried up.

Boeing 747-8I 'Intercontinental'

Class:	Very Large Widebody
First Flight:	20 March 2011
Standard Seating:	410 (3 class), 581 (2 class)
Range:	7,730 nm
Engine Options:	GEnx-2B
In Service:	32
On Order:	9
In Storage:	1
Operators:	5
Last Delivery:	N/A

The 747-8I 'Intercontinental' is Boeing's largest passenger airplane which is aimed at the capacity gap between the 777-300ER and A380. Its design parameters were intensively discussed with Lufthansa who is the largest (19) of the few airline customers so far. Technically, the design is a combination of the preceding 747-400 platform, some new 787 technology and an improved wing design with new (GEnx-) engines. Also, despite its long upper deck, it should be relatively easy to convert it 'into a freighter later' which would extend its operational life. It is claimed to be 11-12% more efficient than the 747-400 on a per seat mile basis but also quieter and has approximately 850 nm more range. Thanks to its 5.6m or 220in stretched metal 747-400 fuselage (160in stretch in front of the wing incl. upper deck and 60in aft) the 747-8I accommodates approximately 70 more seats than the 747-400.

The sales figures of the 747-8I are very disappointing. Airlines favour the Airbus A380 and even more the smaller, but more efficient 777-300ER. So far only Lufthansa (19), Air China (6), Korean Air (10), Transaero Airlines (4) and Arik Air (2) have ordered the 747-8I. The first 747-8I was delivered to Lufthansa in April 2012. With all Lufthansa and Air China 747-8Is delivered the back log is very small, as it is very unlikely that the Transaero Aircraft will ever be built as the airline defaulted in 2015. Also the Arik Air order is very uncertain. With the new 777-9, Boeing has a very capable and efficient aircraft in this market segment, so it is very unlikely that the 747-8I will get any new orders in the future. In 2016 it was announced that the production rate will go from 1.75 aircraft a month to 1 month in March 2016 and to 0.5 a month in September 2016 (freighter and passenger aircraft combined). In the summer of 2016 Boeing itself acknowledged that the production of the iconic 747 may come to an end. The two US Presidential VVIP 747-8s (the new Air Force One), may be the last 747s to leave the Everett Factory. The 747-8I is also offered as a Boeing Business Jet (BBJ). So far, nine 747-8I BBJs have been ordered from which 8 have been delivered.

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Aviation Investment Management

Established in 2001, DVB Aviation Investment Management ("AIM") is a fund management team advising the "Deucalion" funds which are the investment companies through which DVB and third-party institutional investors invest in aviation equity instruments.

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DVB AIM has invested over US$2.3 billion of equity in assets valued in excess of **US$7 billion.**

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Aviation Asset Management

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Aviation Financial Consultancy

DVB Aviation Financial Consultancy ("AFC") enables DVB Aviation to complete our financial product offerings for our global clients through arranging or advising on solutions that are outside of the bank's core lending activities.

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DVB AFC successfully advised the Marubeni Corporation on its share purchase in Aircastle. We also have a proven track record of arranging junior debt in the Korean market and have worked with several airlines on fleet selection, lease vs buy analysis and sourcing financing alternatives.

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DVB AFC has **successfully advised** the Marubeni Corporation on its share purchase in Aircastle and worked with several airlines on fleet selection, lease vs buy analysis and sourcing financing alternatives.

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Aviation Research

DVB Aviation Research ("AR") provides support to all of the DVB Aviation teams through industry and market research that is focused on aviation and aircraft assets.

Our DVB AR team is made up of highly experienced and knowledgeable asset experts with backgrounds from the appraisal, manufacturer, leasing, financial and airline communities.

This team acts as an independent group within DVB driven by actual market data and providing research that is geared towards investments and divestments.

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- Aircraft Types Analysis - research on each aircraft type, relative to its competitors and its positioning in the proposed fleet.
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DVB AR publishes an annual "Overview of Commercial Aircraft" book and, from time-to time, authors articles about the aerospace market.

A highly experienced and knowledgeable team of **asset experts** with backgrounds from the appraisal, manufacturer and financial communities.

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BOMBARDIER

Bombardier CRJ-100/200/440

Class:	Small Regional Jet
First Flight:	10 May 1991
Standard Seating:	50 (single class)
Range:	1,345 - 1,700 nm
Engine Options:	GE CF34
In Service:	555
On Order:	0
In Storage:	254
Operators:	84
Last Delivery:	March 2006

The CRJ100 is effectively a 20 ft. stretch of the Bombardier CL-601 Challenger corporate jet. In the nineties, the 'Canadair Regional Jet' replaced many more efficient but slower turboprops in the hub-spoke network but also supplemented narrowbody operations during off-peak hours and developed new thin point-to-point routes. Vis-a-vis Embraer's 50 seater jets (ERJs), the Bombardier products had a head start as they were available a couple of years earlier. US mainline pilot unions, who considered the regional jet a threat, forced limitations (via so-called scope clauses) on the number and size of regional jets to be operated by the US carriers via their regional partners. By virtually excluding the use of regional jets larger than 50 seats, the unions created a synthetic market for (sub-optimized) 50-seaters. A relaxation of those clauses led to an oversupply and many CRJ100/200 have been sent to the famous storage fields in the Southwest US deserts. The CRJ100/200s is quite successful as a (converted) Corporate/VIP-jets (88 in service / 11 stored), though huge concentration of the passenger fleet remains in the North American regional market (c.75%). Import restrictions/ requirements of possible secondary markets don't help either. The CRJ100 was sold in-ER (20% more range) and high gross weight-LR version (40% more range). The CRJ200 is basically a CRJ100 with improved engines and also exists in-ER and-LR version. The CRJ440 is basically a CRJ200 adjusted to fit the Northwest Airlines scope clause 44-seat maximum. In general, the 50 seater jet market is really soft with huge oversupply and competition from slower but more efficient turboprops. One third of the current fleet is stored and already a substantial number of CRJ100/200s have been parted-out at relatively young age just by lack of demand. In 2006, a conversion into a package freighter (no large door) was offered by Cascade Aerospace though only five aircraft have been converted so far. In February 2013 Aeronautical Engineers Inc. launched a CRJ200Special Freighter conversion programme, which entails cutting a large cargo door in the aircraft. AEI expects 100 CRJs to be converted. Mid 2016 AEI said it had firm orders for 34 conversions. A conversion will cost around $1.8 million.

Bombardier CRJ700 / CRJ700 NextGen

Class:	Medium Regional Jet
First Flight:	27 may 1999
Standard Seating:	70-78 (single class)
Range:	1,092 - 1,378 nm
Engine Options:	GE CF34
In Service:	301
On Order:	9
In Storage:	9
Operators:	19
Last Delivery:	N/A

The CRJ700 is a stretched CRJ200 which fits 20 more passengers. Other differences include more powerful engines, a larger wing and tail and a lowered floor and higher cabin windows which increases passenger comfort. The CRJ700 comes in three series: Series 700 for 68 passengers, Series 701 for 70 passengers and Series 702 for 78 passengers. All series are offered as basic or as a higher gross weight-ER and LR-variant for more range. Because of the regional jets' dependence on the US market, the success of the CRJ700 was mostly reliant on the relaxation of scope clauses which allowed them to replace (a limited number of) 50-seaters on markets that better fit the more efficient 70-seaters. However, further scope clause relaxation could turn the regional operators to the CRJ705/900/1000 and/or E190/195. Compared to its main Embraer 170 competitor, the CRJ700 benefits from its commonality with the large CRJ-fleet and from lower operating costs. However, the E170 has a larger and more comfortable passenger cabin and has a broader operator base that is much less concentrated to the North American market. In 2008 the CRJ700 was replaced by the CRJ700 NextGen with an upgraded cabin with larger bins and windows and slightly reduced weights for improved fuel burn.

The current order backlog is very limited with just 9 aircraft on order (6 for Felix Airways, an airline from Yemen. An order placed in 2008 making it highly unlikely that these aircraft will ever be built) and 3 for an unannounced commercial customer. Since 2013 Lufthansa CityLine has retired its original 20 strong CRJ700 fleet. 11 ex Lufthansa Cityline aircraft have found a new home and still operate in a passenger role, while the other 9 have been scrapped. United has announced early 2016, that it will phase out its CRJ700 fleet and will replace them with Embraer E175s. The fleet remains very concentrated in the North American market and faces some competition from the more efficient larger turboprops as the Dash8-Q400 and ATR72-600 (e.g. Horizon Air). 11 CRJ700 / CRJ700NextGen are in use as Corporate/VIP aircraft.

Bombardier CRJ900 / CRJ900 NextGen / CRJ705

Class:	Large Regional Jet
First Flight:	21 February 2001
Standard Seating:	75 (2 class), 90 (1 class)
Range:	1,070 - 1,553 nm
Engine Options:	GE CF34
In Service:	405
On Order:	33
In Storage:	4
Operators:	24
Last Delivery:	N/A

Almost twice the length of the original CL-601 Challenger, the CRJ900 is a further 12 feet 8 inch stretch of the already stretched CRJ700 with more powerful engines. The aircraft is offered in a standard and high gross weight-ER version, the latter offering 234 nm additional range. When launched, there was only very limited interest, though (in anticipation of) further relaxation of scope clauses, ordering eventually took off. The CRJ900 now also 'benefits' from scope clauses, limiting some operators to scale up to larger RJs or even narrowbodies on some routes. In the marketplace the CRJ900(ER) offers the same advantages of commonality with the existing fleet of CRJ's. The main competition for the CRJ900 comes from the smaller 78-seat Embraer 175 but primarily the slightly larger 98-seat Embraer 190. In general, the CRJ is slightly more efficient, though the E-Jets have a larger cabin cross-section which is appreciated by the passengers and airlines, especially on longer routes. Looking forward, Mitsubishi's all new MRJ90 could turn out to be a very efficient competitor as well. In 2007 Bombardier launched the CRJ900 NextGen, which features an upgraded cabin with larger bins and windows and slightly reduced weights which improves fuel burn. In April 2016 Bombardier introduced an improved cabin for the CRJ900, with-again-larger bins, larger forward toilet and bigger entrance area. These improvements are also available as retrofit for older CRJ900s. Bombardier's new and more efficient CS100 is slightly larger, some future cannibalization, especially on targeted growth routes, cannot be excluded. Late 2012 the CRJ900 NextGen got a major impetus with an order of 40 CRJ900s placed by Pinnacle Airlines (to be operated for Delta Air Lines) and one year later in December 2013 American Airlines placed an order for 30 CRJ900 NextGens, followed one year later in December 2014 with an additional 24, which will be operated by subsidiary PSA Airlines. Although not many, the CRJ900 still gets some orders. Since December 2014 46 CRJ900s NextGen have been ordered by China Express Airlines (10), Mesa Airlines (7) and Air Canada Jazz (5), lessor Falko (12) and 12 for an unannounced customers. 3 CRJ900 NextGen are in use as Corporate/VIP aircraft.

A special variant of the CRJ900 is the CRJ705. Although the name suggests otherwise, this is basically a 86-seat CRJ900 variant with the same 36.19m long fuselage as the CRJ900 but fitted with a 2-class 74-seat cabin in order to comply with seat limiting scope clauses. It has the same fuel capacity as the CRJ 700 but a heavier structure and higher MTOW. Thanks to the reduced passenger capacity the range is not compromised. The CRJ705 was originally launched by US Airways, but after the union objected the order was switched to the CRJ700. Since then, only Air Canada (Jazz) has taken delivery of 16 CRJ705s. In April 2016, Air Canada (Jazz) announced that as part of its fleet standardization plan, it will reconfigure its CRJ705s to CRJ900s by adding one seat.

Bombardier CRJ1000 NextGen

Class:	Large Regional Jet
First Flight:	3 September 2008
Standard Seating:	100 - 104 (1 class)
Range:	971 - 1,622 nm
Engine Options:	GE CF34
In Service:	47
On Order:	21
In Storage:	0
Operators:	4
Last Delivery:	N/A

Bombardier's CRJ1000 is a double stretch of the CRJ700 so a triple stretch from the CRJ200. It bridges the 'gap' between the CRJ900 and Cseries. Apart from a 9.8ft longer fuselage than the CRJ900, the CRJ1000 features a reinforced main landing gear, modified wing, fly-by-wire rudder, higher MTOW and slightly more powerful and efficient engines. Its cabin is conform Bombardier's new 'NextGen' standard with larger bins and windows. It will mainly compete with Embraer's E195 which is probably less efficient but has a spacier fuselage, giving it more the character of a mainline narrowbody aircraft which is generally appreciated by passengers. Also, competition from Mitsubishi's all new and very efficient MRJ and the cheaper SuperJet SSJ100 will be relevant. The CRJ1000 entered service with Brit Air (now rebranded as Hop!) and Air Nostrum at the end of 2010. So far only 47 aircraft have been delivered. With a limited backlog of 21 aircraft and a very small operator base (only Air Nostrum, Arik Air, Hop! and Garuda), the CRJ1000 is not a success story in terms of sales. Contrary to the other CRJ-models, the CRJ1000 has not attracted any orders in the US as the aircraft is too big to fit in the various scope clauses. A relaxation of these clauses can bring some success, but by that time the more modern competitors from other manufactures will also be available. The longevity of the CRJ production line probably allows Bombardier to discount the prices of CRJ aircraft. However Bombardier seems to be more focused on the CSeries, so it is not very likely the CRJ family will flourish again.

Bombardier CS100

Class:	Small Narrowbody
First Flight:	16 September 2013
Standard Seating:	108 (2 class), 135 (1 class)
Range:	1,500 - 3,100 nm
Engine Options:	PW1000G (GTF)
In Service:	2
On Order:	116
In Storage:	0
Operators:	6
Last Delivery:	N/A

Bombardier's CS100 is a brand new aircraft design which, together with the larger CS300, is specifically designed for the 100-149 seats market segment. It bridges the gap in aircraft sized between the largest regional jets and smaller 'mainline' aircraft like the A318/A319 and 737-600/700. The main technology improvement compared to these aircraft types is the engine technology. The CSeries' PW Geared Turbo Fan (GTF) engines are claimed to be up to 15% more fuel efficient, 50% less noisy and up to 40% cheaper to maintain than today's technology engines. Next to that, CSeries feature an aluminium-lithium fuselage and wing structure of new lightweight (composite) materials, fly-by-wire and a very modern LCD cockpit. A higher MTOW version for extended range (CS100ER) is being developed as well. The cabin accommodates 3+2 abreast seating in economy class and roll-aboard sized overhead bins. This all should make the CS100 at least 15% more efficient than today's competitors (E190/195) and an even larger improvement versus replacement targets such as the RJ100. It will be certified to operate from steep approach airports like London City. Anticipating a seat capacity up-scaling of today's regional jet fleet (scope clauses!), the CS100 seems also positioned to eventually replace the significant CRJ900 fleet. Future competition could well come from the re-engined E190-E2/E195-E2.

The prototype of the CS100 made its (delayed) first flight on 16 September 2013.The pace of the flight test programme had been very slow compared to the flight test programmes of new aircraft designs by Boeing and Airbus. So it was no surprise that in January 2014 Bombardier announced a CSeries programme delay, which slowed the rate of test flights, tests and spending while software and structural suppliers could catch up. As a result the delivery of the first CS100 to its launch customer was postponed to the second half of 2015, 9 months later than the latest schedule and 18 months behind the original plan. The CS100 launch customer was in first instance Malmo Aviation, but this airline deferred the delivery of its first CS100, so Bombardier had to look out for a new launch customer. Late February 2015, it was announced that Swiss would be the first airline to operate the CS100. By that time it was still expected that the first CSeries would be delivered late 2015. Bombardier would use the longer test period, to improve the maturity of the flight control software. The CS100 was Bombardier's first attempt at a full fly-by-wire aircraft and software problems had been the foremost reason cited for the programme's delays. In May 2014, the first CS100 flight test aircraft suffered an engine failure on the ground. The engine suffered from a "uncontained failure". Following this incident the CSeries test fleet of four aircraft was grounded for five weeks, but Bombardier assured to deliver the first aircraft-according to schedule-in the second half of 2015. However in Spring 2015, Bombardier already made public that certification would still be possible late 2015, but the first delivery would slip into 2016. Finally, after a 27 month flight test campaign, the Canadian Ministry of Transportation announced that the CSeries CS100 received type certification on 18 December 2015. Six months later in June 2016 the US Federal Aviation Authorities and the European Aviation Safety Agency certification was granted. On 28 June 2016, the first CS100 was delivered to its new launch customer Swiss. On 15 July 2016 the CSeries made its first revenue flight between Zurich and Paris.

A continuing concern for Bombardier during the test phase was the limited order backlog for the CSeries and CS100 in particular. Reportedly, many potential customers are a bit wary because of the reliability of the all new aircraft and engine architecture. Since the first commitments from Lufthansa/SWISS (30 a/c order, 30 LoI) market traction somewhat has stalled. Early 2015, things were not looking good for Bombardier; as it found itself in a painful, costly and difficult test phase for an aircraft which did not attract any additional orders. At that time the CS100/CS300 order backlog was only 58/180 aircraft. To get things back on track, some painful measures were taken. Some top executives were replaced, hundreds of jobs were axed and a new business jet programme (Learjet 85) was shelved. A cash injection of $1 Billion from the regional government of Quebec did also help. In February 2016 Air Canada announced an order for 45 CSeries aircraft (CS300). However this order seemed more like a "Canada Inc." political order. In that same month Bombardier lost a contest for a new 100-seat aircraft for United which placed an order for the (reportedly highly discounted) Boeing 737-700. In April 2016 things finally turned to the better as Bombardier received a big order from a US major as Delta ordered 75 CS100 (and 50 options) to replace the MD-83. Together with the festivities for the first delivery to Swiss in June, it finally looks like the CSeries is now gaining momentum.

Canadian regional airline Porter Airlines signed an LoI for 30 CS100s in September 2013, as the reduced low noise levels of the CS100 would make it an ideal jet aircraft to operate from Porter's main hub, Toronto's Billy Bishop Toronto City Airport. However the city council of Toronto has deferred the decision to open the airport for jet aircraft. Studies to extend the runway of the airport were halted after the Canadian government said no to amending the agreement which prohibits jet aircraft at Billy Bishop airport in 2016. Porter had ordered the CS100 under the condition it could operate them from Bishop Airport. However despite the fact that the chances that jet aircraft may operate at Bishop are very minimal after the Canadian government's decision, Porter has not yet cancelled the order and it is considering to use the aircraft on other airports.

Although not ordered in massive numbers either, the larger CS300 seems to be more popular. In 2011 Bombardier signed an agreement with COMAC which might lead to cooperation and alignment with the C919 product. This could bring the CSeries more traction in Asia. However until September 2016, the only order for CSeries jets from Asia is an order for 10 CS300 aircraft placed by Korean Air in July 2011. In 2015 COMAC closed a deal with Boeing to jointly operate a 737 completion centre in China. It is not clear how this cooperation with Boeing will influence COMAC's relation with Bombardier. COMAC can now obtain its much needed engineering experience and knowledge from Boeing, so it might lose its interest in working together with Bombardier.

Bombardier CS300

Class:	Moderate Size Narrowbody
First Flight:	27 February 2015
Standard Seating:	130 (2 class), 160 (1 class)
Range:	1,500 - 3,300 nm
Engine Options:	PW1000G (GTF)
In Service:	0
On Order:	235
In Storage:	0
Operators:	12
Last Delivery:	N/A

Bombardier's CS300 is a 10.6ft stretch of the CS100 design which together are specifically designed for the 100-149 seats market segment between the larger regional jets and the smaller narrowbodies. The CS300 will compete with the smaller mainliners like the A318/A319 and 737-600/700. The main technology improvement compared to these types is the engine technology, although this advantage was lost, when the Neo and MAX were introduced. The CSeries will be powered by two PW Geared Turbo Fan (GTF) engines which are claimed to be up to 15% more fuel efficient, 50% less noisy and up to 40% cheaper to maintain than today's technology engines. Next to that, the CSeries will feature a fuselage and wing structure of new lightweight (composite) materials, fly-by-wire and a very modern LCD cockpit. A higher MTOW version for extended range (CS300ER) and a eXtra Thrust version for short field length operations (CS300XT) will also be developed. The cabin will accommodate 3+2 abreast seating in economy class and roll-aboard based overhead bins. This all should make the CS300 at least 15% more efficient than its competitors today. But Airbus and Boeing have not been idle and the A319neo and the 737 MAX 7 will come a lot closer to the CS300 performance than today's products in terms of efficiency. In March 2013 Bombardier disclosed a high density variant of the CS300, which can now accommodate up to 160 seats. By launching the high-density design Bombardier added two extra over-wing exit doors and added 0.6m (1.97ft) to the length of the fuselage. These adjustments also led to an increase of the MTOW by 2.4% to 144,000lbs. With a seat capacity of up to 160, the CS300 competes with established names as the Airbus A320neo and Boeing 737-8.

The CS300 made its first flight on 27 February 2015 and its type certification was granted on 11 July 2016. Launch customer Air Baltic will receive its first CS300 late 2016. So far 235 CS300 have been ordered by eight airlines and four lease companies. Reportedly, many potential customers are a bit wary, about an all new design from a smaller manufacturer. In addition some airlines do not see a need for another type slotted in between the established single aisles (A320/737) and E-jets. There has long been some speculation in the media about a possible stretched version of the CS300, which will likely be called the CS500. This aircraft would compete with the larger Airbus A320neo and 737-8. However, Bombardier has said that for the time being it will concentrate on the smooth entry into service of the current CS100 and CS300.

In 2011 Bombardier signed an agreement with COMAC which might lead to cooperation and alignment with the C919 product. This could bring the CSeries more traction in Asia. However until September 2016, the only order for CSeries jets from Asia is an order for ten CS300 aircraft placed by Korean Air in July 2011. In 2015 COMAC closed a deal with Boeing to jointly operate a 737 completion centre in China. It is not clear how this cooperation with Boeing will influence COMAC's relation with Bombardier. COMAC can now obtain its much needed engineering experience and knowledge from Boeing, so it might lose its interest in working together with Bombardier.

Embraer ERJ-135

Class:	Small Regional Jet
First Flight:	4 July 1998
Standard Seating:	37 (1 class)
Range:	1,300 - 1,750 nm
Engine Options:	RR AE3007
In Service:	50
On Order:	0
In Storage:	48
Operators:	21
Last Delivery:	February 2005

The Embraer ERJ-135 is a 37-seat shrink version of the ERJ-145. The ERJ-135 was intended to replace the considerable number of small 30 to 40-seat turboprops such as the Saab 340, de Havilland Dash 8, Shorts 330/360 and Embraer EMB-120. It entered service with Continental Express and American Eagle in July 1999. Its commercial success has been limited. It seems more vulnerable to fuel price fluctuations than the slower but more efficient turboprops. 51% of the current passenger ERJ-135 fleet is stored. Embraer's smallest regional jet hasn't attracted any passenger aircraft orders since 2004. The ERJ-135 has just two different variants (i.e.-ER and-LR). The fleet and operator base is significantly smaller than that of the ERJ-145. Just 13 aircraft of the-ER variant and 37 of the-LR variant are in active service with 21 different operators. Biggest current operator is Airlink from South Africa with a fleet of 13 aircraft in active service. As a corporate/VIP aircraft, particularly the ERJ-135 'Legacy' has had considerable success-259 are in service and 16 'Legacies' are still on order for a total of 179 customers.

Embraer ERJ-140

Class:	Small Regional Jet
First Flight:	27 June 2000
Standard Seating:	44 (1 class)
Range:	1,250 - 1,650 nm
Engine Options:	RR AE3007
In Service:	30
On Order:	0
In Storage:	44
Operators:	3
Last Delivery:	September 2003

The ERJ-140 is a 44-seat shrink version of the ERJ-145 and was specifically developed for American Airlines, whose scope clause didn't allow 45+-seat jet aircraft to be operated by its regional affiliates. The rationale behind the decision to develop the aircraft specifically for American Airlines was two-fold. On the one-hand Embraer could gain the largest US major as a customer, while also blocking Fairchild Dornier, which at the time would have been able to launch its 428JET on the back of the American order and thus gaining a significant foot-hold in the US regional jet market. The American scope clause was relaxed after the 9/11 terrorist attacks and its remaining ERJ-140 orders were converted to the ERJ-145. Out of American's initial 139 aircraft order only 74 were delivered. A separate Midwest Connect order for 20 ERJ-140s has been cancelled later. Although the ERJ-135/140/145 production line is still open, there has been no delivery since September 2003 and it is not likely that any new-140s will be ordered. A year ago, the complete fleet of 74 aircraft was still in service, but in 2016 44 ERJ-140s were withdrawn from use and put in storage. American through its subsidiary Envoy (who operates as American Eagle) is currently the only operator of the type. The other two operators mentioned in the adjacent table are leasing companies GECAS and ECC who are the aircraft managers of 14 ex Chautauga Airlines (American Airlines' subsidiary) aircraft currently in storage. Although marketed as ERJ-140, this aircraft is called ERJ 135KL on Embraer's internal documents and FAA's certification papers.

Embraer ERJ-145

Class:	Small Regional Jet
First Flight:	11 August 1995
Standard Seating:	50 (1 class)
Range:	900 - 2,000 nm
Engine Options:	RR AE3007
In Service:	482
On Order:	0
In Storage:	164
Operators:	77
Last Delivery:	April 2011

The ERJ-145 has 7 different variants (excluding military and business jets), each tailored to match different range and MTOW requirements for different operators. Embraer has developed the-EU and-EP version of the ERJ-145ER and the LU variant of the ERJ-145LR for (European) airlines which prefer aircraft that fall in lower MTOW fee scales for airports and ATC. For airlines that did need the MTOW capabilities of the-LR, but didn't have a long-range capability requirement, Embraer developed the-MP. Furthermore, it developed the extra-long range-XR for Continental's ExpressJet. The combination of high fleet concentration in the US and the scope clause relaxations to 70+ seats or even more resulted in high ERJ-145 availability. In the secondary market, there is strong competition from the also massively available CRJ100/200. Although a high level of commonality remains among the seven different ERJ-145 versions (excluding military and business jet variants), it is obvious that all these different variants further complicate remarketing efforts. The-LR version is by far the preferred variant of the ERJ-145 with 36 operators, a fleet of 272 aircraft in service and 106 aircraft in storage.

In December 2002, Embraer announced that it would set up an assembly-line of the ERJ-145 in China in a joint venture with Harbin Aviation. The first aircraft was assembled in China in 2003. So far only 41 Chinese ERJ 145s have been built from which 31 aircraft are still in service and 10 aircraft are stored. In June 2015, Embraer and Harbin Aviation announced that they closed their joint venture, due to lack of further orders. Currently, there are no outstanding orders for passenger ERJ-145s and any new orders for the Embraer/Harbin regional jets seem unlikely as well.

With many US Airlines getting rid of this aircraft and many aircraft stored, the values for these aircraft are very low. This opens a new market in developing regions for which low acquisition prices are a pro and for charter/ wet-lease operators who also benefit from the low prices and for which the high operating costs of a 50-seat jet-engine powered aircraft are less a problem. But this market is probably not big enough for all the stored ERJ-145s, so scrapping has already begun. The Rolls Royce engine service agreements many operators have, make that there is hardly any use for additional spare engines and serviceable engine components that could be generated by part-outs. As a business/VIP aircraft (17 in service, no orders), the ERJ-145 is much less popular than the smaller ERJ-135. There are also 28 ERJ-145 active with the Belgian, Brazilian, Greece, Indian and Mexican Air Force in a military reconnaissance, (VIP)-Transport or Intelligence role.

Embraer 170

Class:	Medium Regional Jet
First Flight:	19 February 2002
Standard Seating:	66 (2 class) , 72 (1 class) , 78 (high density)
Range:	1,800 - 2,150 nm
In Service:	153
On Order:	3
In Storage:	33
Operators:	21
Last Delivery:	N/A
Last Delivery:	N/A

The E170 is the smallest member of the 70 to 108-seat E-jets family. Originally Embraer intended to enter the 70-seat market with a stretched ERJ145, but decided to develop a whole new aircraft family with narrowbody passenger comfort thanks to the 'double-bubble' fuselage cross-section. Following the bankruptcies of Fokker and Fairchild Dornier and the market exit of Avro, Embraer was the only manufacturer left with a 'mainline' 70 to 115 seat product. The E170 got a boost from the post-9/11 scope clause relaxation, allowing more 70-seaters to be operated by US mainline affiliates. However, this has also lead to significant concentration (43%) in North America at Republic, Compass and Shuttle America. The E170 is certified for steep approaches which enables it to operate from certain airports like London City. It is offered in a basic, mid and high gross weight version (STD/LR/AR) with increasing range. All new deliveries now feature the-AR structure, but MTOW is downgradeable to LR weights. This makes pre AR-standard airframes much less desirable. There are 3 Embraer 170 in use as Corporate / VIP aircraft with Saudi ARAMCO Aviation.

Currently, the main competitor is the lighter but narrower CRJ700 but also the more efficient 70 seat turboprops (ATR72-500 and Q400) have become increasingly popular due to lower fuel burn, lower noise and less emissions. In the substantial Chinese market, the Chinese regional jet ARJ21 (same engines as the E-Jets) will certainly take up some significant orders. Further scope clause relaxation in the US has increased competition from the larger CRJ900 and E175/190/195.

The arrival of new regional jets such as the MRJ70/90 and the SSJ100, which feature significantly more efficient ultra high bypass ratio engines, forced Embraer to revamp its E-jet family. Early 2013 Embraer announced an enhanced version of the E-Jet, featuring a redesigned wingtip and two packages of aerodynamic, structural and systems improvements to the wing and the fuselage. The E175 is the only member of the E-jet family that will feature the new wingtip design. All these adjustments lead to a reduction of fuel consumption by 1-2% on the E170. All improvements are retrofitable, with the exception of the E175 wingtip, and have been available since 2014. These fuel burn improvements must bridge the gap until the introduction of the E2 second-generation of E-jets in 2018. At the Paris Air Show in June 2013, Embraer launched the E-Jet E2 family. However, Embraer also announced at the Paris Air Show 2013 that it will drop the smallest member of the E-Jet family, and that they won't develop an E2 version of the E170. The E170 does not form part of the E2-programme, as there is no more demand for this size of aircraft. In summer 2016, the order back log consisted of 3 E170 for Japan's J-air. These 3 are part of 5 strong order placed in August 2014. This order was the last order for the E170.

Embraer 175

Class:	Medium Regional Jet
First Flight:	15 June 2003
Standard Seating:	76 (2 class), 78 (1 class), 88 (high density)
Range:	1,750 - 2,200 nm
Engine Options:	GE CF34
In Service:	379
On Order:	137
In Storage:	10
Operators:	19
Last Delivery:	N/A

The Embraer 175 is a two seat row (5.10ft) stretch of the E170, achieving its increased payload (8 more seats) at the cost of reduced range capability. Contrary to the E170, the E175 is not certified for steep approaches which exclude it from certain airports like London City. Scope clauses make the E175 especially popular in the US and as a result there is a huge concentration of E175s (78.6%) in the US at American Airlines (40 on order), Compass Airlines (56 in service), Mesa Airlines (46 in service), Envoy (20 in service), Republic Airlines (101 in service/ 6 on order), Horizon Air (30 on order), Shuttle America (16 in service / 24 on order) and SkyWest Airlines (63 in service / 36 on order). As can be seen from this list, the E175 has a large order backlog. In 2014, 2015 and the first half of 2016, exactly 175 E175s were ordered, from which 147 aircraft by US companies. These big US orders are a result of scope clause relaxation, agreed in 2012, allowing American Airlines' and United Airlines' affiliates/regionals to operate more aircraft up to 76-78 seats. Besides the US orders, the other 28 aircraft have been ordered by KLM (17), Fuji Dream Airlines (3) and still unannounced operators (8).

Like the E170, the E175 is offered in a basic, mid and high gross weight version (STD/LR/AR) with increasing range. All new deliveries now feature the-AR structure, but MTOW is downgradeable to LR weights. Pre AR-standard airframes are less desirable. Like the E170, the main competition comes from the lighter but narrower CRJ700 but also the more efficient 70 seat turboprops (ATR72-500 and Q400) have become increasingly popular due to lower fuel burn, lower noise and fewer emissions. The substantial Chinese market will probably be covered with their own regional jet (ARJ21, same engines as the E-Jets). Further scope clause relaxation has increased competition from the larger CRJ900 and E190/195.

The arrival of new regional jets such as the MRJ70/90 and the SSJ100, which feature significantly more efficient ultra high bypass ratio engines, forced Embraer to revamp its E-jet family. Early 2013 Embraer announced an enhanced version of the "1st" generation E-Jet, featuring a redesigned wingtip and two packages of aerodynamic, structural and systems improvements to the wing and the fuselage. The E175 is the only member of the E-jet family that will feature the new wingtip design. All these adjustments will lead to a reduction of fuel consumption by 5% for the E175 and 1-2% on the other three family members-the E170, E190 and E195. Embraer has chosen the E175 as the only aircraft to receive the full package of modifications, because it believes the performance improvements will be most pronounced on this variant. A retrofit for all the improvements was made available in 2014, with the exception of the E175 wingtip. These fuel burn improvements must bridge the gap until the introduction of the E2 second-generation of E-jets in 2018. The E175-E2 design currently does not meet the scope clause weight (MTOW) restriction. This could imply that the current E175 will be Embraer's main product in North America for much longer.

Embraer 175-E2

Class:	Medium Regional Jet
First Flight:	est. 2018/ EIS 2020
Standard Seating:	80 (2 class), 88 (1 class)
Range:	est. 2,060 nm
Engine Options:	PW1700G (GTF)
In Service:	0
On Order:	100
In Storage:	0
Operators:	1
Last Delivery:	N/A

At the Paris Air Show in June 2013, Embraer launched the E-Jet E2 family, to replace the predecessor E-jet family. Contrary to the GE powered "1st" generation E-jets, the E2 will be equipped with the new P&W Geared Turbofan (GTF) engines. P&W claims that its GTF Engine will burn 12 to 15% less fuel when compared to today's engines. Besides the new engines other improvements are the new wing aerodynamics, full fly-by-wire flight controls and advancements in other systems. All these modifications will result in double digit gains in fuel efficiency, maintenance costs and noise reduction. Besides all these improvements, the-E2 will also be produced with a stretched wing and-only for the E175 and E195-a stretched fuselage. The fuselage stretch involves a re-design incorporating fewer but longer fuselage sections, replacing the fuselage plugs used in the current E175 and E195. The wing for the E175-E2 will be stretched from 85ft 4 inch to 101ft 8in. The E175-E2 fuselage will be stretched from 103ft 11 in to 106 ft, which gives room to one extra row of seats compared to the E175. The re-design and added seat capacity, makes that the E175-E2 will burn 16% less fuel per seat/mile than the current version. The E175-E2 will be powered by the PW1700G variant of the geared turbofan engine, a different version than the GTF engine on the E190-E2 and E195-E2. It will also have a different wing than its larger siblings.

The E175-E2 will be the last member of the new E2 family to enter service, which is scheduled for 2020. US regional carrier SkyWest Airlines was the launch customer for the E175-E2 with a firm order for 100 and purchase rights for another 100 of the type placed during the Paris Air Show in 2013. With 150 orders at the Paris Air Show in 2013 (100 x E175-E2 Skywest; 25 x E190-E2 ILFC 25 x E195-E2) the launch of the E2-Family was very successful. In February 2014, during the Singapore Air Show, Embraer received an order for 50 E2-family aircraft (25 E-190 E2s and 25 E-195 E2s) by Indian start up airline Air Costa. However since Paris 2013 no new orders have been placed for the E175-E2. The E175-E2 does not fit in the latest US scope clauses, which limits the Maximum Take-off Weight (MTOW) of aircraft operated by regional affiliates to 86.000lb (39.010kg). The E175-E2 has an MTOW of 98.436lb (44.650kg). A relaxation of the US scope clauses will probably give a further boost to the E175-E2 sales. Embraer may continue the production of the older generation E175-E1 if the scope clauses are not changed.

Embraer 190

Class:	Large Regional Jet
First Flight:	12 March 2004
Standard Seating:	96 (2 class), 100 (1 class), 114 (high density)
Range:	1,850 - 2,450 nm
Engine Options:	GE CF34
In Service:	479
On Order:	53
In Storage:	41
Operators:	53
Last Delivery:	N/A

The Embraer 190 was launched by successful US low-cost carrier JetBlue Airways, with an order for 100 E190LRs. This meant a significant victory for Embraer, indicating the viability of an E-jet as low cost start up aircraft. Besides, the type could also serve well as complementary aircraft to mainline fleets. Apart from the North American market (with also Air Canada (45) and American (20, inherited after the US Airways merger) as important customers), significant orders were taken from Latin America, Europe and Asia. The E190 is a 20.6ft stretch of the E170 and has a larger wing and more powerful engines with FADEC technology. It got certified for steep approaches (e.g. London City airport) in 2010. The E190 enjoys a sound order book and operator base. It is currently offered in a standard, long and advanced range (STD/LR/AR) variant of which the-AR has become the production standard. Early built aircraft which didn't have the-AR designs as the starting point, suffer from a weaker (wing) structure resulting in a lower structural MTOW which limits range.

The E190's main competitor is the more efficient but narrower CRJ900/1000 and it is a replacement for the older Fokker F100, BAe146-300 and Avro RJ100. Also, for network operators, the E190 is an alternative for the smallest members of the 737 and A320 families. These are generally larger and enjoy fleet commonality benefits but are also significantly heavier, have much higher trip costs and are more difficult to fill. Going forward, the success of the E190 will be challenged by many new competitors of which the slightly larger CS100 (and MRJ100 if launched) and slightly smaller MRJ90 will be equipped with considerably more efficient engines. Also the cheaper SSJ100 and Chinese (domestic) ARJ21-900 will compete for orders. Consequently, Embraer was forced to revamp its E-jet family. Early 2013 Embraer announced an enhanced version of the "1st" generation E-Jet, featuring a redesigned wingtip and two packages of aerodynamic, structural and systems improvements to the wing and the fuselage. The new E190 will not feature the new wingtip, designed exclusively for the E175. All these adjustments will lead to a reduction of fuel consumption by 1-2% on the E190. A retrofit for all the improvements was made available in 2014, with the exception of the E175 wingtip. These fuel burn improvements must bridge the gap until the introduction of the E2 second-generation of E-jets in 2018. Mid-2016 Embraer still has some 100 open slots for the E1 before the E2 will enter production. Also some big operators: Air Canada, American and Virgin Australia has announced that they will phase out their E190 fleet in the near future. This developments will undoubtedly have its impact on the E190 values. 22 E190s are in service (10 on order; 3 stored) as Corporate/VIP aircraft with 30 operators. The bizjet version of the E190 is called E190 Lineage.

Embraer 190-E2

Class:	Large Regional Jet
First Flight:	23 May 2016 / EIS 1H2018
Standard Seating:	97 (2 class), 106 (1 class)
Range:	est. 2,800 nm
Engine Options:	PW1900G (GTF)
In Service:	a
On Order:	82
In Storage:	0
Operators:	6
Last Delivery:	N/A

At the Paris Air Show in June 2013, Embraer launched the E-Jet E2 family, to replace the predecessor E-jet family. Contrary to the GE powered "1st" generation E-jets, the E2 will be equipped with the new P&W Geared Turbofan (GTF) engines. P&W claims that it's Geared Turbofan Engine will burn 12 to 15% less fuel when compared to today's engines. Besides the new engines other improvements are the new wing aerodynamics, full fly-by-wire flight controls and advancements in other systems. All these modifications will result in double digit gains in fuel efficiency, maintenance costs and noise reduction. Besides all these improvements, the-E2 will also be produced with a stretched wing and-only for the E175 and E195-a stretched fuselage, making the E190 E2, the only new E-jet with the same cabin size as its predecessor. The E190-E2 will be powered by the PW1900G variant of the geared turbofan engine, a different version than the GTF engine on the E175-E2.

On 23 May 2016, the E190-E2 made its first flight. The E190-E2 will be the first re-engined E-jet to enter service in 2018. Lessor AerCap is the launch customer for the E190-E2 with 25 orders it inherited from the ILFC takeover. The launch order was placed at the Paris Air Show in 2013. With 150 orders at the Paris Air Show (100 x E175-E2 Skywest; 25 x E190-E2 ILFC 25 x E195-E2) the launch of the E2-Family was very successful. In February 2014, during the Singapore Air Show, Embraer received an order for 50 E2- family aircraft (25 E-190 E2s abd 25 E-195 E2s) by Indian start up airline Air Costa. Since mid-2014, an additional 32 E190-E2s have been ordered by ICBC Leasing (10), Tianjn Airlines (2), Aircastle Advisor (15) and Kalstar Aviation (5), bringing the total E190-E2 order backlog to 82. 50 (61%) of these 82 aircraf are ordered by lease companies and are still to be placed.

Embraer 195

Class:	Large Regional Jet
First Flight:	7 December 2004
Standard Seating:	100 (2 class), 116 (1 class), 124 (high density)
Range:	1,600 - 2,300 nm
Engine Options:	GE CF34
In Service:	146
On Order:	15
In Storage:	5
Operators:	18
Last Delivery:	N/A

The E195 is a further 8.3ft stretch of the E190, giving it an additional 10 seats in single class. This makes it the largest member of the E-jets family with over 85% commonality. Sales success has been fairly limited and is concentrated at Azul (63 aircraft in service) and airlines belonging to the Lufthansa Group (Lufthansa Cityline; Air Dolomiti; Austrian: 32 aircraft in service and 2 stored). If equipped with more than 100 seats, an additional 3rd crew member is required which increases costs. Like its smaller family members, the E195 is offered in a standard (-STD), long range (-LR) and advanced range (-AR) version. The-AR has become the production standard and is 'downgradeable to the-LR or-STD specifications. Early built aircraft which didn't have the-AR designs as starting point, suffer from a weaker (wing) structure resulting in a lower structural MTOW which limits range.

The E195's main competitors are the more efficient but narrower CRJ900/1000 but also its slightly smaller sister the E190. For network operators, the E195 could be a slightly smaller and cheaper (trip cost) alternative for the smallest members of the 737 and A320 narrowbody families but it falls a bit short on range. Going forward, competition will further increase with the arrival of the longer range CS100 (and MRJ100 if launched) which will be equipped with considerably more efficient engines. Also the cheaper SSJ100 and Chinese (domestic) ARJ21-900 will compete for orders. As a consequence, Embraer was forced to revamp its E-jet family. Early 2013 Embraer announced an enhanced version of the "1st" generation E-Jet, featuring a redesigned wingtip and two packages of aerodynamic, structural and systems improvements to the wing and the fuselage. The new E195 will not feature the new wingtip, designed exclusively for the E175. All these adjustments will lead to a reduction of fuel consumption by 1-2% on the E190. A retrofit for all the improvements was made available in 2014, with the exception of the E175 wingtip. These fuel burn improvements must bridge the gap until the introduction of the E2 second-generation of E-jets in 2018. All 15 E195 currently on order backlog are destined for China's Tianjin Airlines, which placed an order for 20 E195 in May 2015. Five out of these 20 E195s have been deliverd by late September 2016.

Embraer 195-E2

Class:	Large Regional Jet
First Flight:	est.2017 / EIS 2019
Standard Seating:	120 (2 class), 132 (1 class)
Range:	est. 2,000 nm
Engine Options:	PW1900G (GTF)
In Service:	0
On Order:	90
In Storage:	0
Operators:	4
Last Delivery:	N/A

At the Paris Air Show in June 2013, Embraer launched the E-Jet E2 family, to replace the predecessor E-jet family. Contrary to the GE powered "1st" generation E-jets, the E2 will be equipped with the new P&W Geared Turbofan (GTF) engines. P&W claims that its Geared Turbofan Engine will burn 12 to 15% less fuel when compared to today's engines. Besides the new engines other improvements are the new wing aerodynamics, full fly-by-wire flight controls and advancements in other systems. All these modifications will result in double digit gains in fuel efficiency, maintenance costs and noise reduction. Besides all these improvements, the-E2 will also be produced with a stretched wing and-only for the E175 and E195-a stretched fuselage. The fuselage stretch involves a re-design incorporating fewer but longer fuselage sections, replacing the fuselage plugs used in the current E175 and E195. The E195-E2 fuselage will be stretched from 126ft 10in to 136ft 2in, which gives room to three rows of seats compared to the E195. The re-design and added seat capacity, makes that the E195-E2 will burn 23% less fuel per passenger than the current version. The E195-E2 will be powered by the PW1900G variant of the geared turbofan engine, a different version than the GTF engine on the E175-E2.

The E195-E2 will be the second member of the new E2 family to enter service, which is scheduled for 2019. As a far bigger variant than the current E195, the 195-E2 is aimed for capacity growth for current E-jet operators and-because it offers the similar cost-per set as the A320neo and 737-8-it is especially developed for low cost operations in mid-density markets. Lessor ILFC (now AerCap) is the launch customer for the E195-E2 with 25 orders placed at the Paris Air Show. With 150 orders at the Paris Air Show (100 x E175-E2 Skywest; 25 x E190-E2 ILFC 25 x E195-E2) the launch of the E2-Family was very successful. In February 2014, during the Singapore Air Show, Embraer received an order for 50 E2- family aircraft (25 E-190 E2s and 25 E-195 E2s) by Indian start up airline Air Costa. In May 2015 Azul from Brazil ordered 30 E-195-E2s. Lessor Aircastle ordered 10 E195-E2 in June 2015. Since then no new orders have been signed, so the total backlog is 90 aircraft.

Fokker 70

Class:	Medium Regional Jet
First Flight:	4 April 1993
Standard Seating:	70 (2 class), 80 (1 class)
Range:	1,085 - 1,875 nm
Engine Options:	RR Tay
In Service:	37
On Order:	0
In Storage:	5
Operators:	8
Last Delivery:	April 1998

The Fokker 70 is a shrink of the Fokker 100 and only 48 were built as a result of the Fokker bankruptcy just 3 years after the Fokker 70 entered production. The few customers seemed very content with its performance and KLM Cityhopper, which only saw 7 delivered of its 10 aircraft order, acquired 19 additional Fokker 70s on the secondary market. KLM however plans to have its Fokker 70 fleet replaced by E-jets in October 2017. The same goes for Austrian Airlines, which will replace its Fokker 70 and 100s with Embraer E-jets in the coming years. Austrian sold its Fokker fleet to Alliance Airlines, an Australian air charter company providing fly-in fly-out (FIFO) transportation to the mining and energy sector. Besides Alliance Airlines other operators of the Fokker 70 are Air Niugini (5), InselAir Aruba (3), TransNusa Air Service (1), Golden Wings Aviation (1) and Fly Allways (1). Air Niuguni and InselAir Aruba bought many ex KLM Fokker 70, which will enter their fleet in the course of 2017. The Government of the Netherlands and the Government of Kenya operate a VIP version of the Fokker 70.

In 2012 Rekkof/NG Aircraft proposed a stretched update of the Fokker 100NG, called the Fokker 120NG later, powered by a variant of the PW geared turbofan jet engine and equipped with winglets and the newest technology and interior design. In 2016 the 120NG was stretched and now named the 130NG. In line with the F-130NG project, Rekkof / NG Aircraft has also plans to develop a stretched version of the Fokker 70, called the F-90NG, with a capacity of 100 seats. It seems increasingly unlikely the FokkerNG's plans will be realized.

Fokker 100

Class:	Large Regional Jet
First Flight:	30 November 1986
Standard Seating:	97 (2 class), 107 (1 class)
Range:	1,260 - 1.680 nm
Engine Options:	RR Tay
In Service:	115
On Order:	0
In Storage:	58
Operators:	35
Last Delivery:	April 1996

The Fokker 100 was the first of a planned 70 to 130 seat family of jet aircraft intended to replace the Fokker F.28. Its main competition came from the BAe 146 and later the Avro RJ100. Comparable 100-seat aircraft from Boeing and McDonnell-Douglas had much greater payload/range. Production of the Fokker 100 ceased in 1996 after the Fokker bankruptcy. As a result a planned 130-seat variant never reached production. In 2012 Rekkof/NG Aircraft proposed a stretched update of the Fokker 100NG, called the Fokker 120NG, powered by a variant of the PW geared turbofan jet engine. Because the PW is heavier than the Rolls-Royce Tay engines used to power the Fokker 100, the aircraft would have needed ballast in the nose. Therefore Rekkof / NG Aircraft has chosen to stretch the fuselage with a 112cm (44in) plug forward of the wing. This increases the capacity of the cabin, now accommodating up to 125 passengers. The Fokker 120NG will also feature winglets. In 2013 the original F-100 prototype was acquired for conversion to F-120NG. In 2016 the 120 design was stretched and now named the 130NG. The 130NG will have a capacity of 130-138 passengers. The Fokker 130NG will be 48% more economical than the original Fokker 100. In the meantime Rekkof/NG Aircraft has changed its name to 'Netherlands Aircraft Company" (NAC) and still plans to make a first flight with the Fokker 130NG in 2020. However without any customers and very uncertain financial funding, it remains very questionable whether the F-130NG will ever enter the market.

In the secondary market, the Fokker 100 had a strong revival as large fleets from American Airlines (75), TAM (50) and US Airways (40) found a new operator base. However, availability figures have been increasing over the last years as operators such as KLM (8) and Avianca (20) have already phased-out their fleets and Austrian and TAP Express have also decided to phase out their fleets in the coming years. A lot of remaining Fokker 100s have found a home in Australia with 45 active Fokker 100s in service with Alliance Airlines (15 & 4 in storage), Network Aviation Australia (14), Virgin Australia Regional Airlines (14 & 1 storage) and Skippers Aviation (2). Most of these Fokkers in Australia are used for charter operations in the mining sector. Alliance Airlines has bought the Austrian Fokker 100 fleet of twelve aircraft (and 5 Austrian Fokker 70), which will be delivered in the near future. Iran also has a large contingent of Fokker 100 with 20 Fokker 100s in active service with Iran Asseman Airlines (4), Iranian Naft Airlines (4), Qeshm Airlines (4), Iran Air (4) and Kish Air (4). However the Iranian Fokker feet is already dwindling down a bit as already a large part of the fleet has been phased out by the airlines due to lack of spares. 23 Fokker 100s (10 Iran Air and 13 Iran Aseman) are currently stored in Iran. With the lifting of the economic sanctions, it is expected that the Iranian Fokker 100s will soon be replaced by more modern western equipment.

McDonnel Douglas MD-81/82/83/88

Class:	Medium Narrowbody
First Flight:	19 October 1979
Standard Seating:	135 (2 class), 155 (1 class)
Range:	1,564 - 2,620 nm
Engine Options:	PW JT8D
In Service:	372
On Order:	0
In Storage:	182
Operators:	76
Last Delivery:	December 1999

The MD-80 family is the generic term for a number of developments (i.e. MD-81/82/83/87/88) of the DC-9, initially referred to as DC-9 'Super 80'. The MD-81 differed from the DC-9-50 by a 14ft fuselage stretch, improved PW JT8D Series 200 engines and extended wing. The increased payload/range MD-82, the most successful MD-80, is equipped with the higher thrust JT8D-217 engines. The MD-83 incorporated the slightly higher trust JT8D-219 engines and additional fuel tanks which increased its payload/range capability. The MD-88 is similar to the MD-83, but is equipped with the more advance EFIS-cockpit. Initially the MD-80 was a commercial success, although it lost out against the more advanced CFM56 and V2500 powered Airbus A320 and Boeing 737, once these were introduced.

Currently, Delta Air Lines still operates a huge fleet of 116 MD-80s in active service. American has a fleet of 62 active MD-80s, but has started phasing out the type rapidly. In the last two years more than 100 MD-80s have been withdrawn from use by American. On 23 August 2016 American removed 20 MD-80s from its fleet. Never before did an airline retire so many aircraft in one single day, and the massive MD-80 phase out on 23 August actually became some kind of media event. More or faster phase outs by American or Delta are to be expected and will make availability explode and values (also for part out) collapse further. American has said it will retire all of its MD-80s by mid-2018. Delta has ordered 75 CS100s as a replacement for its MD-80 fleet, starting in 2018. Besides American and Delta only Allegiant Air has a significant MD-80 fleet with 48 aircraft. But, Allegiant has already started to replace the MD-80 with Airbus narrowbody aircraft and has announced that it will be out of the MD-80 fleet no later than end-2019. All other operators operate small fleets with 11 aircraft or less.

Many MD-80s are expected to be permanently parked as other aircraft types are preferred in the secondary passenger market. Possibly, a few will be converted to MD80SF as freighter conversion programmes have been launched by AEI and Wagner Aeronautical in 2010. This market is however expected to be quite thin, because the narrow MD-80 fuselage cannot accommodate standard size pallets/containers.

McDonnel Douglas MD-87

Class:	Small Narrowbody
First Flight:	4 December 1986
Standard Seating:	114 (2 class), 130 (1 class)
Range:	2,374 nm
Engine Options:	PW JT8D
In Service:	4
On Order:	0
In Storage:	16
Operators:	10
Last Delivery:	March 1992

The MD-87 is 17 feet 4 inch shrink of the MD-83 and incorporated a new 'beaver'- tailcone, reducing fuel consumption by 0.5%. The MD-87 wasn't a commercial success, with only 75 delivered to ten customers with Iberia (24) and SAS (18) as the largest original operators. Today only 4 MD-87s are still in passenger service with three different civil operators. An additional 8 MD-87s remain in service as corporate/ VIP aircraft. 3 MD-87s (one former Japan Air System aircraft and two former SAS aircraft) have been converted to Water-Bomber/ Chemical Spray and have been operated as such by Erickson Aero Tanker in the US since 2013. Production of all MD-80 aircraft was ceased after the outstanding orders placed before the Boeing take-over of McDonnell Douglas in 1997, had been completed. The final MD-80 to be produced was a MD-83 for TWA in December 1999. Due to its short fuselage, the MD-87 won't qualify for freighter conversion.

McDonnel Douglas MD-90-30

Class:	Medium Narrowbody
First Flight:	22 February 1992
Standard Seating:	158 (2 class), 163 (1 class)
Range:	2,085 - 2,700 nm
Engine Options:	IAE V2500-D5
In Service:	65
On Order:	0
In Storage:	0
Operators:	1
Last Delivery:	October 2000

After a failed attempt to introduce a fuel efficient propfan powered aircraft family for the 110-180 seats market, dubbed the MD-90, McDonnell Douglas shifted to IAE V2500 turbofan power for this aircraft family that was to compete with the 737-'Classics' and A320 family. Initial plans called for three different fuselage sizes, of which the 153-seat MD-90-30 was selected by launch customer Delta Airlines. Plans for other variants as well as a production line in China never materialized following the take-over by Boeing. The last MD-90 was delivered to Saudi Arabian in late 2000. Delta is still quite positive about the MD-90's role in its network and has been picking up available MD-90s from other airlines over the last years. Currently, with 65 MD-90s in active service, Delta is the sole operator of the aircraft. In total 117 MD-90-30s were built. The V2500-D5 engines' high similarity with the Airbus A320 family V2500-A5 engines makes the MD-90 attractive for part-out. All MD-90s that did not end up with Delta are therefore permanently withdrawn form use and parted out.

Mitsubishi MRJ70

Class:	Medium Regional Jet
First Flight:	est. 4Q2017
Standard Seating:	69 (2 class), 76-80 (1 class)
Range:	est. 1,020 - 2,020 nm
Engine Options:	PW1215G (GTF)
In Service:	0
On Order:	0
In Storage:	0
Operators:	0
Last Delivery:	N/A

With its Mitsubishi Regional Jet (MRJ) programme, the Mitsubishi Aircraft Corporation (a JV of Mitsubishi Heavy Industries, Toyota and various Japanese banks/investors) aims to set a new standard of regional jets. The smaller of the two types which are currently under development is the MRJ70. An important element of the MRJ product will be the geared turbo fan engine (GTF) which is claimed to be c.15% more fuel efficient, 50% less noisy and up to 40% cheaper to maintain than current technology engines. The MRJ70 is equipped with the PW1215G variant instead of the PW1217G that powers its larger siblings. To better facilitate possible stretching, the proportion of composite in the (wing) structure is less than initially anticipated. The MRJ70 faces strong competition from the latest versions of the E170/175, E175-E2 and CRJ700 which are dominating the 70-seater market segment for quite some years. Also, the more efficient 70 seat turboprops (ATR72-500 and Q400) have become increasingly popular due to lower fuel burn, lower noise and fewer emissions. In the substantial Chinese market, the Chinese regional jet ARJ21 will certainly take up some significant orders. Older equipment like the Avro RJ70/85, BAe146-100/200 and Fokker 70 but also smaller 50-seater planes are (growth) replacement targets of the MRJ70. The success of the MRJ70 is largely depending on the scope clause dominated US domestic regional market. Generally, more easing of scope clauses that cap the size of the major's feeder aircraft to 70-seaters, will have a very negative effect on the 'artificial' demand for the MRJ70 and its same size competitors.

The MRJ70 will have three variants (STD,-ER and-LR) with the same dimensions but increasing MTOWs for increasing range capability. Mitsubishi's focus is to finish the MRJ90 test programme and deliver the first aircraft to launch Customer ANA-All Nippon Airways in 2018. It will start flying tests with the MRJ70 after this is done for the MRJ90. Parts production for the MR70 has already begun and Mitsubishi expects the first aircraft to be completed in 2017. First delivery to a customer will be in 2019. So far, there have been no orders for the MRJ70, as all 233 orders for the MRJ programme are for the MRJ90. However many customers like SkyWest, Trans States and Japan Airlines have options to convert to MRJ70s. As already expected and 'requested' by many in the industry, Mitsubishi Aircraft is now also looking into a further stretch of the MRJ platform. Work on this MRJ100X variant for approximately 100-110 passengers will however not start until the first flights of the MRJ90 and the MRJ70 have taken place. Mitsubishi announced in June 2013 that it would establish a quality control facility in Chicago and Munich for the sourcing of MRJ components from the United States and Europe. Mitsubishi also has a 10-year partnership with-long-time ally-Boeing for customer support. Boeing will deliver 24h support for all MRJ operators covering parts distribution, service operation and field services.

Mitsubishi MRJ90

Class:	Large Regional Jet
First Flight:	11 November 2015
Standard Seating:	81 (2 Class), 88-92(1 class)
Range:	est. 1,150 - 2,040 nm
Engine Options:	PW1217G (GTF)
In Service:	0
On Order:	233
In Storage:	0
Operators:	7
Last Delivery:	N/A

With its Mitsubishi Regional Jet (MRJ) programme, the Mitsubishi Aircraft Corporation (a JV of Mitsubishi Heavy Industries, Toyota andvarious Japanese banks/investors) aims to set a new standard of regional jets. The MRJ90 will be the first and base line MRJ model to enter service in mid-2018. It will feature a fuselage which will be c.8 ft longer than the MRJ70 to accommodate approximately 12 more passengers. An important element of the MRJ product will be the PWPW1217G geared turbo fan engine (GTF) which is claimed to be c.15% more fuel efficient, 50% less noisy and up to 40% cheaper to maintain than current technology engines. To better facilitate possible stretching, the proportion of composite in the (wing) structure is less than initially anticipated. The MRJ90 faces strong competition from the latest versions of the E175, E175-E2, E190, E190-E2 and the CRJ900 which have been dominating the 90-seater market segment for quite some years. Additionally, slightly larger aircraft such as the E195, E195-E2, CRJ1000 and CS100 (with the same engines) could turn out to be competitors, especially in a growth market. In the substantial future Chinese market, the Chinese regional jet ARJ21 will certainly take up some significant orders. Older equipment likes the Avro RJ100, BAe146-300 but also older 70-seat aircraft are (growth) replacement targets of the MRJ90. The success of the MRJ90 is largely depending on the scope clause dominated US domestic regional market. Generally, more easing of scope clauses could create demand if more 90 seaters would be permitted but if further loosened, larger aircraft become competitors. To date, Mitsubishi Aircraft Corporation is actually quite successful in this market and managed to get two landmark orders for the MRJ90 in the US. Trans States Holdings ordered 50 MRJs (+ 50 options) in 2009 and in 2012 SkyWest Airlines ordered 100 MRJ90s (+ 100 Options). Other US companies that ordered the MRJ are the new Eastern Air Lines who ordered 20 MRJ90s in September 2014 and Leasing Company Aerolease International who placed an order for 10 MRJs (+10 options) in August 2016. Besides these US orders , Mitsubishi received orders from ANA who was the launch customer when it ordered 15 MRJs in 2008 and Japan Airlines who placed an order for 32 MRJs in January 2015. The only non USA and non-Japanese airline that ordered the MRJ is Air Mandalay who placed an order for six aircraft in the summer of 2014. Besides these 233 orders Mitsubishi has 214 LoIs/Options for the MRJ. 20 of them was placed by Swedish lessor Rockton during the Farnborough Air Show in July 2016.

The MRJ90 will have three variants (STD,-ER and-LR) with the same size but increasing MTOWs for increasing range capability. AI ordered MRJ90s so far are the-STD variant. In August 2013 Mitsubishi announced that it was pushing its first flight back by more than a year from September 2013 to the second quarter of 2015. First delivery of the aircraft has also been delayed from summer 2015 to the second quarter of 2017. Mitsubishi cited certification issues as the reason for this delay. So far this delay has not led to the cancellation of any orders and on 11 November 2015 the MRJ finally made its first flight.

A software bug during ground test in the summer was the reason that this first flight was postponed from the second quarter. Initially Mitsubishi announced that this delay will have no impact on its second quarter 2017 delivery and EIS, but one month later in December 2015 Mitsubishi announced a one-year delay for the first delivery of the MRJ to mid-2018. This delay was caused by structural reinforcements as it turned out the aircraft has insufficient wing strength and it had to strengthen its wing roots and fuselage frame above the centre wing with additional plates. Also a redesign of the landing gear was needed. Besides these structural reinforcements some software upgrades were installed. Bad weather in Japan was another reason that that the first prototype spent much time on the ground. This EIS delay to mid-2018 means that the MRJ lost the advantage to be one year ahead of the EIS of the E190-E2, but it is still ahead of the EIS of its biggest rival, the E175-E2. The MRJ flight test campaign will for a large part occur in the US, where Mitsubishi will base 4 of its 5 test aircraft at Moses Lake Airport in Washington State. This US test campaign had a false start as the first prototype made headlines, when it had abort the ferry flight twice, due to some technical issues. It arrived at Moses Lake late September 2016, a month after the initial attempt to cross the Pacific. Despite this new setback in the test programme, Mitsubishi sticks to a mid-2018 EIS with ANA-All Nippon Airways.

In May 2016 SkyWest's CEO, with 100 aircraft on order, the biggest customer so far, said that as long as scope clauses in the US are not relieved, it will be highly unlikely that Skywest will take delivery of the MRJ90. The MRJ90 has a Maximum Take-off Weight of 87.303lb (39.600kh) and offers 88 seat, while the scope clause limits regional jets that may be flown by regional affiliates of the mainline carriers to 86,000lb (39.010kg) and 76 seats. SkyWest has the option to change to the MRJ70, but from Mitsubishi's perspective, this is not ideal.

Mitsubishi MRJ100X

Class:	Large Regional Jet
First Flight:	est. 2018
Standard Seating:	92 (2 class), 106 (1 class)
Range:	N/A
Engine Options:	PW1200G (GTF)
In Service:	0
On Order:	0
In Storage:	0
Operators:	0
Last Delivery:	N/A

Mitsubishi's MRJ100X is still a preliminary design study which has not been officially launched. Nevertheless, it is deemed quite likely that this further stretch of the MRJ90 will eventually hit the markets as regional jets generally tend to become larger and larger over time. Like the smaller MRJ70 and MRJ90, the MRJ100X will probably be powered by the efficient PW1200G Geared Turbo Fan engines from Pratt & Whitney. Competitors would be the re-engined E195-E2, CRJ1000, CS100. Also new Russian and Chinese products (SSJ100, ARJ21 respectively) would take up substantial (regional) orders. Mitsubishi Aircraft Corp says that work on this MRJ100X variant not start until the first flights of the MRJ90 and of the MRJ70 have taken place. Assuming the MRJ100X will be launched, it will enter the market one year after the MRJ70 in 2020.

SUKHOI

Sukhoi Super Jet SSJ100-95

Class:	Large Regional Jet
First Flight:	19 May 2008
Standard Seating:	86 (2 class), 98-108 (1 class)
Range:	1,645 - 2,470 nm
Engine Options:	SaM-146
In Service:	69
On Order:	60
In Storage:	18
Operators:	14
Last Delivery:	N/A

With the SSJ100 regional jet, the Russian aerospace industry, represented by Sukhoi, together with Alenia Aeronautica of Italy and engine supplier Snecma of France, has developed a large regional jet which is intended to compete with (Western built) competitors like the Embraer E190/190-E2/195/E195-E2, Bombardier CRJ900/1000, Mitsubishi MRJ90 and the Chinese ARJ21-900.The SaM-146 engines are claimed to be significantly (10%) more efficient than the engines of today's competitors but are likely to be beaten (on fuel burn) by e.g. the PW1000G Geared Turbo Fan which will power the MRJ products. The capital/investment costs of the SSJ100-95 will probably be significantly less than the competition and on range the SSJ100 is claimed to be slightly better than e.g. the E-Jets. Of the initial 2 variants family, only the SSJ100-95 remains as the 11.5ft smaller SSJ100-75 design for 78 passengers was dropped due to lack of interest from the market. Sukhoi announced several new modifications of this type with a more powerful version of the current Sam-146 engines and a new wing design with raked winglets (Superjet NG). These winglets will also be made available as a retrofit for existing aircraft. The improved Superjet NG would typically compete with the E195-E2 and CRJ1000. Also China's ARJ21 will take up substantial (regional) orders. In the summer of 2016 Sukhoi confirmed it was working on a stretched 130-135 passenger version of the Superjet (Superjet SV). This Superjet SV may be launched in 2017 with a planned EIS in 2020.

A problem for Sukhoi are the changed geopolitical and economic forces. Russia has been hit hard by the devaluation of the rouble, the falling commodity prices and the sanctions prompted by the country's alleged involvement in Ukraine's civil conflict. In 2015 Sukhoi revealed a plan to reduce the cost of the Superjet by replacing Western suppliers with Russian ones. This would reduce the cost of a Superjet by ~$2.5 mln. This is quite a big step, as much of the marketing in the western world is based on the Western systems in the aircraft. Until late September 2016, these planes have not been materialized.

The SSJ100-95 has an-LR and a 'non-LR' variant. The first Superjet was delivered to Armavia in April 2011. The first year of service of the Superjet was not without problems. In March 2012 all seven delivered Superjets at that time, were grounded for a short time due to some landing gear problems. In May 2012 a factory demonstrator aircraft crashed during a flight at Indonesia with 45 fatalities, reportedly due to pilot error. In August 2012 Armavia returned its Superjets to the manufacturer for unknown reasons. In March 2012 Aeroflot-the biggest operator of the type-asked Superjet for compensation since it six Superjets in service at that time were in the air only 3.9 hours a day on average instead of the standard 8 to 9 hours. According to Sukhoi, these problems are normal in newly operated aircraft.

However all these technical hitches resulted in Aeroflot swapping out its first 10 SSJ100s in exchange for updated versions. In 2013 the Superjet started service with Mexican LCC and Airbus A320 operator Interjet and contrary to the Armavia and Aeroflot experience the introduction of the type in Interjet 's fleet has been very smooth.

The Superjet has a backlog with 60 orders. Besides orders from Russian airlines like Aeroflot and UTair, there are also some substantial orders from Interjet (8 from an order of 30 from which 22are already delivered) and from Russian lease companies as Illyushin Finance, and VEB_leasing. So far 87 Superjets have been delivered to 14 different operators. 69 of these aircraft are in service while 18 aircraft (20.7%) are still stored. In October 2014, Belgian airline VLM Airlines became the first European customer of the Sukhoi Superjet as it will lease two aircraft from Illyushin. The two aircraft should be delivered to the Antwerp based airline in April 2015, but these deal fell through. However the Superjet scored another Western customer when Cityjet ordered 15 Superjets in October 2015. The first two aircraft out of this order were delivered in the summer of 2016. Besides these 15 orders Cityjet also placed 16 options. Cityjet ordered the Superjet as a replacement for its large RJ85 fleet. Cityjet's network is centred on London City Airport, so crucial for Cityjet is the Steep Approach certification of the Superjet. Sukhoi foresees the Superjet being certified for steep landing approaches at London City Airport in 2017. Awaiting this certification, Cityjet operates the Superjet on wet-leaese operations for other airlines. Aeroflot the biggest operator of the type with 30 aircraft in its fleet placed an order for an additional 10 Superjets in September 2016.

MS-21-200/300

Class:	Medium Narrowbody
First Flight:	est. 2017 / EIS 4Q2018
Standard Seating:	MS-21-200: 132 (2 class), 156-176 (1 class) MS-21-300: 163 (2 class), 181-211 (1 class-high density) MS-21-400: 178 (2 class), 212-230 (1 class)
Range:	MS-21-200 est. 3.500 nm MS-21-300 est. 3.200 nm MS-21-400 est. 3.000 nm
Engine Options:	PW1000G (GTF) 45% (-200) / 66% (-300) Aviadvigatel PD-14 55% (-200) / 19% (-300) TBD 15% (-300)
In Service:	0
On Order:	33 (-200) / 142 (-300)
In Storage:	0
Operators:	4 (-200) / 9 (-300)
Last Delivery:	N/A

Russian aviation corporation Irkut together with Yakovlev Design launched the development of the MS-21 family of narrowbody aircraft in 2008. Irkut intends to build this Russian competitor to the mainline 737NG/MAX and A320ceo/neo family programmes. The MS-21 comes with two engine options: the PW1400G Geared Turbo Fan engines next to the Russian built AVIADVIGATEL PD-14 twin-shaft turbofan. Also the interior, supplied by Zodiac is intended to match modern western standards. The structure is targeted to be 50% composite including the wing. The MS-21 family (also referred to as MC-21 in Cyrillic Russian: МС-21 "Магистральный Самолёт 21 века"-"Magistralny Samolyot 21 veka"-"Airliner of the 21st Century"), will consist of a-200,-300 and-400 variant for 150, 181 and 212 passengers respectively in standard (32in pitch) configuration. The-200, and-300 variant are currently marketed on Irkut's website and can be ordered. The "-400" is still object of study. It remains to be seen whether the programme will attract many 'western' or 'modern asia' orders but the MS-21 family seems well positioned to finally replace a large part of the Tupolev fleet (c. 77 in service with civil operators) in the former CIS countries. International competition will come from the 737NG/MAX and A320ceo/neo family. Also China's COMAC C919 will certainly attract orders in the same capacity segment particularly in Asia. The probably lowish capital/investment costs of the MS-21 products could make it competitive.

Irkut begun production of the first three MS-21-300s, the baseline version of the aircraft, early 2014. On 8 June 2016, the first MS-21-300 was unveiled. First flight was originally scheduled for late 2016, but this has slipped to early 2017. Delivery to its first customer Aeroflot is still targeted for late 2018. Problems Irkut faces, are the collapse of the rouble and the Russian national policy to replace Western goods with local goods as a reaction to the sanctions imposed on the country because of its involvement in the Ukrainian civil war. Many parts of the Irkut MS-21 are from western origin. Replacing them with Russian alternatives can cause some significant delay. So far Irkut has successfully managed to evade these restrictions and is working to get the aircraft certified with its current western suppliers. So far, 33 MS-21-200s and 142 MS-21-300 have been ordered, only by Russian airlines and operating leasing companies. The last order already dates back to August 2013. There are 89 LoI/Options for the MS-21. 50 of them are from Malaysian lease company Crecom Burj Resources, 10 from Azerbaijan Airlines, 6 from Egypt's Cairo Aviation, 20 form Sberbank leasing and 3 for Russian charter airline Nordwind.

In October 2013 Russian government officials indicated that the Irkut MS-21 will be re-designated as the Yak-242 once the aircraft goes into serial production. The Yakovlev Yak-242 name was originally attached to a 130-180 proposal of the 1990s, which eventually evolved into the MS-21. However, until mid-2016, Irkut has not confirmed the plans to rename the MS-21 programme.

Lessons learned with the Superjet and the MS-21 will give Russia enough experience to start developing a new widebody aircraft. On 25 June 2016 President Putin signed an agreement during his visit to China to establish a joint venture between Russia's UAC (United Aircraft Corporation = Russian state owned company that controls the military and civil aircraft development and production in Russia) and Chinese COMAC to design and develop a new widebody aircraft. It is aimed that this Russian-Chinese widebody will enter service around 2025.

COMAC ARJ21-700/900

Class:	Large Regional Jet
First Flight:	28 November 2008
Standard Seating:	78 (2 class), 90 (1 class), 98 (2 class), 105 (1 class)
Range:	1,200-2,000 nm, 1,200-1,800 nm
Engine Options:	GE CF34-10A
In Service:	1
On Order:	158
In Storage:	0
Operators:	9
Last Delivery:	N/A

The ARJ21 regional jet is China's first domestically developed aircraft by government-controlled COMAC (formerly ACAC). The initial family is planned to consist of two passenger types-the ARJ21-700 and the stretched ARJ21-900 and probably a freighter and business variant as well. The ARJ21s are primarily aimed at the Chinese domestic regional market. Both versions will have a standard and an extended range (-ER) variant. The design has some exterior resemblance with the DC-9, though features a newly (Antonov) designed wing with winglets and GE's CF34-10 engines which also power the E190/195. Other involvement from western countries is Rockwell Collins avionics and Honeywell's fly-by-wire systems.

So far, only the smaller ARJ21-700 has been ordered. Henan Airlines (formerly Kunpeng), a Chinese regional airline owned by Shenzen, is the largest customer with 50 aircraft on order. Launch customer Chengdu Airlines has ordered 30 ARJ21-700s and Hebei Airlines and Shandong Airlines both 10. GECAS (the leasing arm of engine provider General Electric) also ordered 5 aircraft. There have long been no new orders for the ARJ-21 since June 2011, but in March 2015 ICBC leasing ordered 30 ARJ21-700 and in September 2015 City Airways from Thailand ordered 10 ARJ21-700.

The first commercial delivery of the ARJ21-700 slipped several times as engineers encountered problems in the development as well in the certification process. Late December 2014, COMAC finished the last functional and reliability tests on one off the prototypes, marking the completion of all test modules required for the ARJ21-700. On 30 December 2014, the Chinese aviation authorities finally issued the type certification for the ARJ21 (initially scheduled for 2007). A major milestone for the commercial aviation sector in China.
The first ARJ21 was delivered to Chengdu Airlines on 29 November 2015. The first commercial flight took place 7 months later on 28 June 2016. As of late September 2016 only two ARJ-21s have been delivered. The ARJ-21's entry in operation is far from smooth. The aircraft is only operated in fine weather, as the ARJ21 is currently restricted to operations where runway water depth does not exceed 3mm, following its limited success in water ingestion trials during its certification process. Besides that, the aircraft is also plagued by all kind of teething problems, like noise and vibrations. Other improvements to be made are better aircraft warning systems, the installation of ACARS equipment and-most challenging-weight reductions. These improvements needs to be made to receive the production certificate for the ARJ21 from the Chinese Aviation authorities, as for now each aircraft has to be certified individually. COMAC works hard to have all the necessary improvements for the production certificate ready by late 2016. COMAC is also working on further improving the ARJ-21, which will lead to some design changes of future aircraft. COMAC expects this improved and lighter version of the ARJ21 will be ready by 2019.

COMAC C919

Class:	Medium Narrowbody
First Flight:	est. 4Q2016
Standard Seating:	156 (2 class), 168-174 (1 class)
Range:	est. 2,200 - 2,999 nm
Engine Options:	CFM LEAP-1C, Domestic
In Service:	0
On Order:	282
In Storage:	0
Operators:	13
Last Delivery:	N/A

With the C919, Commercial Aircraft Corporation of China (COMAC) does a serious attempt to break into the Airbus and Boeing duopoly in the mainline single aisle market. The C919 is designed and will be built in China with support from reputably western aviation industry suppliers such as CFMI, Hamilton Sundstrand, Honeywell and GE. Initially, the C919 will feature CFM's new Leap-IC engines but this could be complemented with a Chinese domestically developed engine at a later stage as well. With 156 passengers and c.3000nm range this is very similar to the A320neo. When compared to the A320 family and 737 family, the C919's fuselage will be approximately 25cm wider and be able to accommodate an LD3 container in its belly. The Leap-1C engines are claimed to be up to 15% better than today's standard but A320neo features the same engines and also Pratt & Whitney's PW1000G GTF engines which will probably be equally efficient. Besides the A320neo the COMAC 919 will also compete against the new Boeing 737 Max and Russia's Irkut MS-21. Contrary to its competitors from Airbus, Boeing and Irkut, the COMAC C919 is only offered in one size. So far 282 C919s are ordered, mainly by Chinese airlines or leasing companies. There had not been any new orders for the C919 since September 2012, but in September 2015 City Airways from Thailand ordered 7 COMAC C919s. The first flight of the C919 was targeted for late 2015, but as with so many new aircraft programmes, the development was plagued with delays and the first flight has been pushed back by at least one year to late 2016. COMAC rolled out the first prototype of the C919 with a big ceremony on 2 November 2015. COMAC will build eight test aircraft of the C919. Six will be used for flight test, while the other two will be used for ground test.

It is already clear that the C919s will supply a significant part of aircraft demand in the Chinese market. It is not yet clear whether this first Chinese commercial mainline aircraft will also be successful abroad. However, in 2011, Bombardier and COMAC signed an agreement to cooperate in the fields of marketing and support but also collaboration on the complementary C919 and CSeries programmes and future aircraft development was not excluded. If this materializes, it would clearly enhance the C919's immediate international profile. In 2015 COMAC closed a deal with Boeing to jointly operate a 737 completion centre in China. This can have its impact on the cooperation between Bombardier and COMAC, as engineering experience, certification and after service knowledge can now be obtained by COMAC from the Americans.

In June 2015 during a state visit of Russian President Putin COMAC signed an agreement with Russian UAC to establish a joint venture between Russia's UAC and China's COMAC to design and develop a new widebody aircraft. It is aimed that this Russian-Chinese widebody will enter service around 2025.

ATR 72-500/600

Class:	Regional Turboprop
First Flight:	19 January 1996 / 24 July 2009
Standard Seating:	68-78 (1 class)
Range:	825 nm
Engine Options:	PW100-127
In Service:	305 (-500) 291 (-600)
On Order:	216 (-600)
In Storage:	37 (-500) 12 (-600)
Operators:	89 (-500) 59 (-600)
Last Delivery:	N/A

The ATR-72 is a stretched development of the popular ATR-42 and was launched in January 1986. The aircraft is built by the French/Italian manufacturer ATR (Avions de Transport Regional / Aere di Trasporto Regionale) in Toulouse. The ATR 72 was developed from the ATR 42 to increase the seating capacity (48 to 78) by stretching the fuselage by 4.5 metres (15ft), increasing the wingspan, adding more powerful engines and increasing fuel capacity by approximately 10 percent. The ATR 72 development aircraft flew for the first time on 27 October 1988. Entry into service was on 27 October 1989 with Kar Air of Finland. The original production versions were called the ATR 72-200, powered by PW124B, and the ATR 72-210, which was powered by the more powerful PW127 engines and optimized for operations in hot and high conditions. A further development, the ATR 72-210A improved the hot and high capabilities and features a PW-127F engine driving six blade Hamilton Sundstrand propellers. This ATR 72-210A was renamed for marketing purposes as ATR 72-500 in May 1998. Besides the engines, other improvements include higher maximum weights and superior performance, as well as a greater automation of power management to ease the workload of the pilot. The ATR 72s wings are new outboard of the engine nacelles and with 30% of it made up of composite materials, comprising composite spars and skin panels and a carbon fibre wing box. Later versions (after 2008) of the ATR 72-500 were also powered by the PW127M engine. PW127M engines are designed to be retrofitable on early built ATR 72-500s. In 2007 ATR announced the ATR 72-600. This version is powered by the latest derivative of the "new" PW127M engines offering enhanced performance and features a glass cockpit with five LCD screens and new avionics. The cabin was improved by lighter seats and larger overhead bins. The ATR 72-600 first flew on 24 July 2009. The steady increase in oil prices in the first half of the current decade and growth in emerging markets such as Asia and Latin America with lack of developed infrastructure in certain rural areas, spurred the growth of orders and nowadays the ATR 72-600 has a healthy backlog with more than 200 orders and is more popular than its Canadian rival the Dash-8 Q400.

For older ATR 72-210s, a cargo conversion is available. So far only 57 ATR-72-200s&210s and 2 ATR-72-500s have been converted. In 2015 ATR launched the Cargoflex option for the ATR 72. This option allows for cargo pods to be installed in place of some rows of seats at the front of the aircraft, allowing it to carry 44 passengers and around 3 tonnes of freight. The aircraft can be easily reconfigured to a full passenger aircraft. ATR sold seven of these Cargoflex versions to Papua New Guinean carrier PNG Air. In December 2015, ATR received certification from the European Aviation Authorities for a 78-seat high density option for the ATR-72-600. Based on the existing cabin, ATR added an additional row of four seats by reducing pitch and replacing the galley compartment with a new aft foldable galley. This 78-seat option is also offered as a retrofit for existing ATR-72s. Philippine's CEBU Pacific took delivery of the first 78-seat ATR-72 late September 2016.

At the Farnborough Air Show 2016, ATR's CEO said that the company was examining the possibility to replace the current ATR P&W PW127 engines by new offerings from Pratt&Whitney, but also the GE38 engine from General Electric. Although the current PW127 engine still performed very well on the ATR, a new engine offering a 15% lower fuel bill was necessary to remain competitive against the latest regional jets. A potential re-engined ATR must be seen as a "bridge" solution to an all new larger 100-seat design, according to the CEO.

BOMBARDIER

Bombardier Dash-8 Q400/Q400 NextGen

Class:	Regional Turboprop
First Flight:	31 January 1998 / December 2008
Standard Seating:	74-90 (1 class)
Range:	1,114 nm
Engine Options:	PW100-150
In Service:	228 237 (-NG)
On Order:	35 (-NG)
In Storage:	15 11 (-NG)
Operators:	36 37 (-NG)
Last Delivery:	N/A

The Dash-8 Q400 is a 70 seat twin-engined, medium range turboprop airliner. The-Q400 is the latest and longest member of the Dash-8 family, which besides the-Q400 consists of the Series 100 (39 seats), the Series 200 (same capacity, more powerful engines) and the Series 300 (a stretched 50 seats). All models delivered after mid 1996 have cabin noise and vibration suppression and are re-designated with the Q-prefix. Bombardier stopped production of the Q100 in 2006 and of the Q200 and Q300 in 2009, leaving only the Q400 in production. The Q400 was developed in the late nineties and entered commercial service in 2000. It was developed to meet the requirements of regional airlines for larger aircraft on high density, short-haul routes. The Q400 has a new stretched fuselage of 6.83M (22ft.5in) compared to the Q300. It has the same nose section and vertical tail as the other Dash-8 family aircraft, but has a new developed horizontal tail. The fuselage's cross section and structure are based on the earlier Dash-8s but with two entry doors at forward and aft ends of the fuselage on the left side. The inner wing section and wing fuselage wing join are also developed new for the Q400. The outer wing of the Q400 has been strengthened. The Dash-8 Q400 is powered by two FADEC equipped PW150 turboprop engines with six bladed propellers. To operate in noise restricted area's and to improve the passenger's comfort, the Q400 is fitted with Bombardier's newest systems to reduce noise and vibration to levels comparable with a CRJ. The flightdeck consist of five LCD screens, showing the same information to the pilot as in the earlier versions, so all the Dash-8s have a common type rating. In March 2008 Bombardier launched the "NextGen" version of the-Q400. The main differences between the Q400 and Q400 NextGen can be found in the cabin. The Q400 NextGen has LED lightning, new ceiling panels, new window sidewalls and larger overhead bins. Other improvements on the Dash-8 Q400 are the landing gear, as well as reduced fuel and maintenance costs.

At the Farnborough Air Show of 2014 Bombardier launched a cargo-passenger combi version of its Q400 turboprop. Bombardier is offering the combi version of the Q400 in various configurations. The version with the highest payload capability will offer up to 8,200lb of cargo capacity and up to 1,150ft3 of cargo volume. This configuration can accommodate 50 passengers. Launch customer for the Combi version is Ryuku Air Commuter from Japan, which ordered 5 Q400NG combi's. By late September 2016, two of them have been delivered.

In August 2014 Bombardier delivered the first high density version of the Q400NG to Thai airline Nok Air. The high density version can accommodate 86 passengers in a single class lay out. In February 2016 Bombardier launched a 90-seat version of the Q400NextGen, which will be on the market in 2018. The 90-seat version is accomplished by moving back the rear bulkhead and a reconfiguration from the front right-hand door to accommodate an extra row of seats. The seat pitch will remain at 28inch and Bombardier is studying the possibility to offer this 90-seat configuration as a retrofit for existing Q400s.

So far 491 Q400/Q400NextGens are delivered to commercial operators, from which 248 are from the newer "Next Generation" variant. The backlog consists of 35 Q400NextGen. The Q400 is the fastest and largest turboprop on the market, but it is outsold by the ATR 72-500/600. The ATR offers very low operating costs, and this is a big advantage for the typical emerging markets where turboprops operate. Besides these 465 aircraft in active passenger service, 6 Q400s are in use as Corporate / VIP aircraft and five aircraft are-after P2F conversion-in use as cargo aircraft. Two Q400s are converted to water bomber and operate for the French Securite Civile.

BOMBARDIER

Bombardier CRJ100/200PF & CRJ100/200SF

Class:	Regional Freighter
First Conversion:	2007 / 2016
Payload:	14,800 lb
Range:	1,345 - 1,700 nm
Engine Options:	GE CF34
In Service:	7
On Order:	0
In Storage:	2
Operators:	5
Last Conversion:	N/A

To keep the CRJ100/200 attractive in the second hand market, Bombardier worked together with Cascade Aerospace on the design, certification and build-up of a freighter version of the CRJ100/200. This version was called the CRJ200PF (package freighter) and was first delivered to launch customer West Air Europe in 2007 after a successful bid by this airline for a postal contract. The CRJ100/200PF does not have a large freight door, so it is a relatively cheap conversion. To date only 10 CRJs have been converted to package freighter. 5 of them has been delivered to two Mexican airlines (MCS Aero Carga 3 in service / Estafeta Carga Aerea 2 in service) and 3 has been delivered to Scandinavia with West Atlantic Sweden (2 in service and 1 written off after a crash early 2016). One CRJ PFs is currently in storage.

Early 2013, Aeronautical Engineers Inc (AEI) launched a conversion kit for the CRJ100/200 aircraft. Marketed by AEI as CRJ 100/200 Special Freighter (SF), this aircraft will feature a 2.39m (94in) by 1.96m (77in) cargo door on the left side of the fuselage, installation of a 9G rigid cargo/smoke barrier and modification of the main deck to a Class E cargo compartment. The CRJ100/200SF will be able to carry containerized or bulk cargo up to 6.7t tones. In December 2014, US-Based IFL group became the launch customer for the AEI CRJ100/200SF when it signed an agreement to convert one ex SkyWest Airlines CRJ from passenger to freighter. This first conversion of this aircraft was completed in summer 2016 and the first CRJ200SF made its first flight on 14 July 2016. IFL hopes to take delivery of the aircraft after the AEI CRJ200SF has received a FAA supplemental type certificate, by late 2016. AEI expects to convert about 100 CRJ200s to freighter over the life of the programme and-as of mid-2016-says it has received 45 orders and commitments for the CRJ200SF. The cost of an "SF"-conversion is ~$1.8 million.

McDonnell Douglas MD-80SF

Class:	Medium Size Short Range Narrowbody Freighter
First Conversion:	September 2012
Payload:	46.600 lb
Range:	Around 2,000 nm
Engine Options:	PW JT8D-217
In Service:	7
On Order:	0
In Storage:	0
Operators:	4
Last Conversion:	N/A

Probably encouraged by the high availability and very low prices of MD-80s, both Aeronautical Engineers Inc (AEI) and Wagner Aeronautical Inc decided in 2010 to start developing an MD80 freighter conversion programme. Operationally, the MD-80SF will probably be less attractive than e.g. the 737-400SF due to its narrower fuselage which makes it more complicated to efficiently accommodate standardized containers. However, the conversion will probably be low cost and, contrary to payload volume, its payload weight and range capabilities could be competitive. The specs of AEI indicate the MD-80SF will have a payload of up to 21,1t (47k lb) and could accommodate e.g. 12 non-standard 88 x 108in containers or 8 standard 96 x 125in netted pallets on the main deck. The AEI converted MD-80SF-an ex American Airlines MD-82-got it FAA certification in October 2012 and was delivered to launch customer Everts Air Cargo in spring 2013.

AEI claims to have firm orders for 20 more MD-80 conversions from customers in the US, Africa, Central America and Europe and believes it will convert over 100 MD-80 family aircraft over the next ten years. The main market for the MD-80SF is expected to be in developing countries with poor runways, causing problems for e.g. 737 freighters with little ground clearance. The first converted aircraft was an MD-82, but the program will also cover the MD-81, the longer-range MD-83, as well as the MD-88. The short fuselage MD-87 won't qualify for conversion. So far, only 7 MD-80SFs have been delivered and it seems the MD-80SF market has failed to develop. The status of the Wagner conversion is unclear, but it seems they have stopped the development of the MD-80 conversion program as they-according to their website-are focusing on a 767-200 conversion program.

BOEING

Boeing 737-300SF/300C

Class:	Moderate Size Short Range Narrowbody Freighter
First Conversion:	1992
Payload:	42,500 - 43,100 lb
Range:	1,640 - 2,260 nm
Engine Options:	CFM56-3
In Service:	103
On Order:	0
In Storage:	16
Operators:	47
Last Conversion:	N/A

A cargo conversion programme for the 737-300 was already offered by Pemco in 1991. Currently, Pemco, Aeronautical Engineers Inc (AEI) and IAI/Bedek offer conversions for the 737-300 and-400. The 737-300SF/400SF was targeted to replace older freighters like the 727, 737-200 and DC-9 although it faces competition from the larger but heavier 757-200SF (preferred by Fedex). The main adjustments are the installation of a cargo door at the forward left side of the fuselage, a 9G-net barrier, smoke/fire detectors and floor modifications. The-400SF has a 6,600lb or 1 pallet payload advantage over the-300SF but less range. The increased storage of 737'classics' during the crisis and the related value effects made not only the 737-300 but also the 737-400 feedstock cheap enough to make conversion attractive. The pick-up in 737-300/400 conversions in recent years was also helped by the recovery of freighter demand, particularly in Asia and especially China. But also interest is coming from carriers in South America, Eastern Europe and Africa. Canadian carriers serving mining and drilling areas are also targeted as potential customers. Largest operators of 737-300 converted freighters are Chinese companies, SF Airlines (12), China Postal Airlines (12) and Yangtze River Express (11). So far 119 737-300s have been converted to 300 Special Freighter. Although the bigger 737-400SF has become more popular than the 737-300SF, because it can carry one pallet more, the 737-300SF offers lower fuel costs to its operator.

The last IAI Bedek 737 conversion was completed at Tel Aviv in 2010. Since then only PEMCO and AEI have converted classic 737s. For highly cycled 737'classic' aircraft structural issues will lead to increased maintenance/inspection costs, possibly with costly repairs required. Such planes are less suitable for conversion (economically unviable). A combi conversion programme for the 737-300 (3 pallet positions, 66 pax) is also offered by Pemco, but until now did not attract any customers. The introduction of new conversion programmes for the Boeing 737-700&800 and Airbus A320/A321 in combination with the declining feedstock for new conversions means that the market for 737 classic freighters is shrinking

Boeing 737-300QC

Class:	Moderate Size Short Range Narrowbody Freighter
First Conversion:	1991
Payload:	38,000 - 43,100 lb
Range:	1,640-2,260 nm
Engine Options:	CFM56-3
In Service:	31
On Order:	0
In Storage:	3
Operators:	17
Last Conversion:	N/A

The QC-conversion enables a 'Quick Change' (30 minutes) of the 737-300's interior from passenger configuration into cargo configuration and vice versa. This requires a side cargo door, floor modifications with a special QC cargo system, a 9g barrier net, special overhead bins and an independent smoke/fire detection system (a.o.). Pemco launched QC-conversions already in 1991 for brand new 737-300s, followed by used-300s and the-SF conversion. So far 40 737-300s have been converted to 300QC-34 by Pemco and 6 by IAI Bedek. 31 of them are still in service with Jet2 (8 aircraft) as biggest operator. 3 are stored and 6 300QCs are permanently withdrawn form use.

Boeing 737-400SF/400C

Class:	Medium Size Short Range Narrowbody Freighter
First Conversion:	1992
Payload:	43,100 - 48,000 lb
Range:	1,915 - 2,070 nm
Engine Options:	CFM56-3
In Service:	109
On Order:	0
In Storage:	4
Operators:	37
Last Conversion:	N/A

A cargo conversion programme for the 737-300 was already offered by Pemco in 1991. Currently, Pemco, Aeronautical Engineers Inc (AEI) and IAI/Bedek offer conversions for the 737-300 and-400. The last IAI Bedek 737 conversion was completed at Tel Aviv in 2010. Since then only PEMCO and AEI have converted classic 737s. The 737-300SF/400SF was targeted to replace older freighters like the 727, 737-200 and DC-9 although it faces competition from the larger but heavier 757-200SF (preferred by Fedex). The main adjustments are the installation of a cargo door at the forward left side of the fuselage, a 9G-net barrier, smoke/fire detectors and floor modifications. The-400SF has a 6,600lb or 1 pallet payload advantage over the-300SF but a little less range. So far, 101-400SF conversions have taken place with a remarkable increase of-400 conversions in recent years. In the last three years 63 737-400s have been converted (compared to 27 737-300 conversions in the same period). The increased storage of 737'classics' during the crisis and the related value effects made not only the 737-300 but also the 737-400 feedstock cheap enough to make conversion attractive. The pick-up in 737-300/400 conversion activity in recent years was also helped by the recovery of freighter demand, particularly in Asia and especially with express carriers in China. But also interest is seen from carriers in South America, Eastern Europe and Africa. Canadian carriers serving mining and drilling areas are also targeted as potential customers. Biggest operator of the 737-400SF is however Europe based ASL Airlines Belgium (formerly known as TNT Airways with a fleet of 15 737-400SFs.

A combi conversion programme for the 737-400 (4 pallet positions, 72 pax) is also offered by Pemco. Only 13 737-400s were converted into combi's. They operated mainly in niche markets in Alaska, Northern Canada, South Africa and for government agencies in the USA and Colombia. For highly cycled 737'classic' aircraft structural issues will lead to increased maintenance/inspection costs, possibly with costly repairs required. Such planes are less suitable for conversion (economically unviable). The introduction of new conversion programmes for the Boeing 737-700&800 and Airbus A320/A321 in combination with the declining feedstock for new conversions means that the market for 737 classic freighter is shrinking.

Boeing 737-800SF/800BCF

Class:	Medium Size Short Range Narrowbody Freighter
First Conversion:	est. 2016
Payload:	52,000 lb (-SF) / 30,000 lb (-C)
Range:	2,030 - 3,085 nm
Engine Options:	CFM56-7B
In Service:	0
On Order:	0
In Storage:	0
Operators:	0
Last Conversion:	N/A

While Boeing had been studying a cargo conversion for the 737-800, it was US based Aeronautical Engineers Inc (AEI), who first launched a passenger-to-freighter programme and a passenger-to-combi conversion programme for the 737-800 in March 2014. AEI stated that they had two (undisclosed) customers for their 737-800 conversion and that the development and certification of the 737-800SF will take approximately 2.5 years, which means entry into service will likely take place sometime in 2017. The AEI converted 737-800 would be able to carry 12 pallets (one more than the 737-400SF), the combi is to accommodate six pallets in the forward section of the cabin and 90 passengers in the economy class seating in the aft section. In October 2014 AEI became a STC holder for the 737-800 passenger-to-freighter conversion and for the 737 passenger-to-combi conversion. Being an STC holder, AEI can work with licenses Boeing engineering data and AEI customers will be eligible for access to Boeing technical support at reduced costs compared with freighters converted without data licensed from Boeing. In June 2015 AEI secured its first order from US Lessor GECAS. GECAS intends to convert up to 20 Boeing 737-800s. Lessor ACG-Aviation Capital Group ordered 15 737-800SF with AEI in October 2015. AEI started its first 737-800 conversion in Spring 2016. Conversions will take place in Miami and in Asia. AEI expects that the conversion and certification process will take approximately a year.

In October 2014, the Boeing board granted the company authority to offer a 737-800BCF passenger-to-freighter conversion programme. The "authority-to-offer" is not the same as a formal launch of the programme, which remains dependent on Boeing able to secure a launch order. On 24 February 2016 Boeing launched the 737-800BCF officially when it secured orders and commitments for 55 conversions from leasing company GECAS and Chinese express carriers YTO Airlines, SF Airlines and China Postal Airlines and Bulgaria based Cargo Air. During the Farnborough Air Show 2016 Boeing received additional orders from Colombia's LAS Cargo and Air Algerie. Boeing has said that the conversion will take place at facilities located near the conversion demand. Given the large orders from China, many 737-800s will be converted at Boeing's Shanghai facilities. Boeing expects the first 737-800BCF to be delivered in 4Q2017. The Boeing conversion will have a capacity of 12 pallet positions compromising 11 standard pallets and one half-pallet.

IAI Bedek is studying a freighter conversion 737-800SF as well, but has in the meantime launched a P2F programme for the 737-700 for which it has secured three orders from Alaska Airlines. By 2017 the 737NG will be on the market for about twenty years and with the 737 MAX 8 entering the market by that time, older 737-800s will start to exit the passenger fleets of many operators, providing enough feedstock with reasonable prices to make a conversion for a 737-800SF/C economical viable.

Airbus A320-P2F

Class:	Medium Size Short Range Narrowbody Freighter
First Conversion:	est. 2020
Payload:	est. 46,300 lb
Range:	est.2,300 nm
Engine Options:	CFM56-5B; IAE V2500-A5
In Service:	0
On Order:	0
In Storage:	0
Operators:	0
Last Delivery:	0

Airbus narrowbody conversion programmas have long been a topic in the aviation media, but until today not one single aircraft has been converted. In 2008 AerCap announced its intention to convert up to 30 Airbus narrowbody aircraft. This conversions would be executed by AFC (Airbus Freighter Conversions), a special JV between Airbus with EFW and Russian companies IRKUT and UAC. Airbus forecasted a market for 900 conversions in the twenty years after 2011, the year in which the first converted A320 could be delivered. However, despite the healthy market forecast and AerCap's interest in the programme the first converted A320 was not delivered in 2011. Instead in that year Airbus and its partners announced a decision "to stop and freeze" the programme and dissolve the partnership for economic reasons.

US/German company PacAvi announced an independent passenger-to-freighter conversion for the A320 and A321, branded as "PacAvi freighter LITE" in 2014 and has inducted one A320-200 for conversion in a facility at Hahn airport, Germany. Conversion on this aircraft began in January 2015. PacAvi aims to get the A320P2F supplemental certificate (STC) in due course and will be joined in this programme by AeroTribune (an AerCap subsidiary) and GAMECO (Guangzhou Aircraft Maintenance Engineering Co.). Conversions will be done at Goodyear (Arizona, USA) for the A320 and Guangzhou for the A321. Today PacAvi has 6 fixed orders for A320 conversions from Norwegian Airline Management Group. Under the PacAvi programme, both the A320 and A321 will be equipped with a 121inch wide deck cargo door just aft of the forward left passenger entry. The A320 Freighter LITE will accommodate 10 unit load devices (ULD) on the main deck and can carry a payload of 23.1 tonnes.

Airbus/EFW, now together with ST Aerospace re-launched a passenger-to-freighter programme for the A320 and A321 in June 2015, with the first deliveries scheduled to take place in 2019 (A321) and 2020 (A320). There will be four facilities for this conversion programme in Dresden, Singapore, Mobile and Guangzhou. The Airbus-EFW conversion A320 can carry 10 ULDs on the main deck and can carry a payload of 23.0 tonnes. Until now, Airbus has not revealed any customers for its A320 conversion. Conversion cost for an A320 are around $ 4miliion.

Airbus A321-P2F

Class:	Large Size Short Range Narrowbody Freighter
First Conversion:	est. 2020
Payload:	est. 59,500 lb
Range:	est.2,300 nm
Engine Options:	CFM56-5B; IAE V2500-A5
In Service:	0
On Order:	0
In Storage:	0
Operators:	0
Last Delivery:	0

Airbus narrowbody conversion programmes have long been a topic in the media, but until today not one single aircraft has been converted. In 2008 AerCap announced its intention to convert up to 30 Airbus narrowbody aircraft. This conversions would be executed by AFC (Airbus Freighter Conversions), a special JV between Airbus with EFW and Russian companies IRKUT and UAC. Airbus forecasted a market for 900 conversions in the twenty year after 2011, the year in which the first A320 could be delivered. However, despite the healthy market forecast and AerCap's interest in the programme the first converted A320 was not delivered in 2011. Instead in that year Airbus and its partners announced a decision "to stop and freeze" the programme and dissolve the partnership for economic reasons.

US/German company PacAvi announced an independent passenger-to-freighter conversion for the A320 and A321, branded as "PacAvi Freighter LITE" in 2014 and has inducted an A320-200 for conversion in a facility at Hahn airport, Germany. Conversion on this aircraft began in January 2015. PacAvi aims to get the A320P2F supplemental certificate (STC) in due course and will be joined in this programme by AeroTribune (an AerCap subsidiary) and GAMECO (Guangzhou Aircraft Maintenance Engineering Co.). Conversions will be done at Goodyear (Arizona, USA) for the A320 and Guangzhou for the A321. Today PacAvia has some 2 fixed orders for A321 conversion from Brasil's Colt Cargo. Under the PacAvi programme, both the A320 and A321 will be equipped with a 121inch wide deck cargo door just aft of the forward left passenger entry. The A321 freighter LITE will accommodate 13 unit load devices (ULD) on the main deck and can carry a payload of 27.5 tonnes.

Airbus/EFW, now together with ST Aerospace re-launched a passenger-to-freighter programme for the A320 and A321 in June 2015, with the first deliveries scheduled to take place in 2019 (A321) and 2020 (A320). There will be four facilities for this conversion programme in Dresden, Singapore, Mobile and Guangzhou. The Airbus-EFW conversion A321 can 13 ULDs on the main deck and can carry a payload of 27.0 tonnes. Until now, Airbus has not revealed any customers for its A321 conversion. Conversion cost for an A321 are around $ 4million.

Boeing 757-200PF

Class:	Large Size Short/ Medium Range Narrowbody Freighter
First Flight:	11 August 1987
Payload:	84,120 lb
Range:	2,890 - 3,140 nm
Engine Options:	PW2000 (46%), RR RB211-535 (54%)
In Service:	79
On Order:	0
In Storage:	0
Operators:	5
Last Delivery:	November 1997

The 757-200PF (also referred to as '757-200F') is a factory built 'Package Freighter' which was first delivered in 1987 to UPS which ordered 75. It basically comprises a high gross weight passenger 757-200 with forward side cargo door, no windows, a stripped cabin with 9g-cargo barrier and a re-positioned forward entry door for the crew. The payload can be stowed on a max of 15 main deck pallets and in belly hold. Compared to the later developed 757-200SF (converted freighter) for DHL, the-PF has a higher structural MTOW which gives it a higher payload capacity and additional range. The 757PF replaces 727 and DC-8 freighters. The larger volume A310-300F also offers a similar weight of payload. With 95% of the 757-200PF built flying for UPS, the fleet is highly concentrated. Besides UPS other operators (who all operate one aircraft of the type) are Ethiopian Airlines, DHL Air, Icelandair and ASL Airlines Belgium (formerly TNT Airways).

Boeing 757-200SF

Class:	Large Size Short/ Medium Range Narrowbody Freighter
First Conversion:	2001
Payload:	67,000 - 72,000 lb
Range:	1,200 - 3,000 nm
Engine Options:	PW2000, (28%), RR RB211-535(72%)
In Service:	199
On Order:	0
In Storage:	2
Operators:	21
Last Conversion:	N/A

The Boeing 757-200SF programme was launched by DHL who ordered the conversion of 34 757s in March 2001. The conversions were executed under a Boeing STC between 2001 and 2003 at IAI-Bedek and ST Aero. Currently, 757 conversion programmes are offered by Precision Conversions and ST Aero. Pemco who bought the Alcoa-SIE programme/STC in 2010, does not offer 757 conversions anymore. The same applies for IAI Bedek, who stopped marketing for 757 conversions as well. In September 2012 Precision Conversions received FAA approval for a conversion of a 757 with winglets. The conversion of a 757 with winglets into freighters does not require any modifications to the aircraft beyond fitting standard cargo capabilities. As of summer 2016, 8 757-200 with winglets have been converted.

The 757-200 cargo conversion market has been slow until October 2006 when FedEx dramatically changed the market when it announced its decision to convert 90 757-200s into freighters to replace its aging 727 freighters. Since 2006 Fedex has bought more 757s and projects that by May 2018 its fleet will grow to 143 aircraft. It is with 107 freighter in active service today the biggest operator of the 757-200SF. Besides Fedex, large fleets of converted 757s can be found at DHL (40 in the fleets of all DHL's affiliate airlines combined) and China's SF Airlines (16). DHL Air has recently started to replace its older 14-pallet ex British Airways 757-200SF by younger ones with a 15-pallet configuration. It intends to replace all 34 former BA aircraft in the near future. The ST Aero "14 pallet" 757s have been ordered by Fedex. Most Fedex 757s are mainly older aircrafts 757s from the US majors and some European charter airlines. Interestingly, Fedex doesn't accept winglet equipped 757s as feedstock as these wouldn't fit in the narrow parking boxes at its cargo hubs. Precision Conversions offers a 15-pallet modification. ST Aero also offers a 14.5 pallet and a "15" pallet configuration.

So far 201 757-200s have been converted to Special Freighter. Best suited for conversion are aircraft from L/N 210 and above with less than 30.000 flight cycles as they offer better payloads and are more likely to be within the acceptable range for investors. Aircraft with less than 30.000 flight cycles would offer many more years of operations as the 757-200 design service goal is 50.000 flight cycles. The averages accumulated flight cycles of a 757 before conversion is 23,000. Most converted 757 fly 1,000 flight cycles a year (2 to 3 sorties a day; 5 or 6 days a week), so aircraft with less than 30.000 flight cycles would be able to operate for at least 20 years. With the declining feedstock and introduction of the 737-800 and A321 P2F conversion programmes on the market in 2018, the end of the heydays of the 757-200 conversion market is near.

Boeing 757-200Combi

Class:	Large Size Short/ Medium Range Narrowbody Freighter
First Conversion:	2001
Payload:	67,000 - 72,000 lb
Range:	2,460 - 3,000 nm
Engine Options:	PW2000 (17%), RR RB211-535 (83%)
In Service:	5
On Order:	0
In Storage:	1
Operators:	3
Last Conversion:	N/A

In 2010, three 757-200'passenger-to-combi' conversion programmes were launched. Pemco and Precision Conversions were followed by ST Aerospace. The expected success is based on anticipated (future) availability of significant numbers of cheap 757s, combined with its payload range capabilities and expected demand from particularly the US military. So far 8 757s have been converted to combis from which five are currently in service and one stored with civil operators (two are in service with the Royal New Zealand Air Force). Biggest operator is US ATI-Air Transport International, who operates 4 757-200combis. The other civil operators are National Airlines (1 aircraft currently stored) and ASL Airlines Belgium who operates one 757-200 on behalf of the NATO. Generally, the split between cargo/pallet positions and passengers can be flexible. Conversion includes the instalment of a cargo door in the front fuselage section, a cargo handling system, 9G-rigid cargo barrier, main deck floor strengthening and instalment of an Environmental Control System.

Airbus A310-200F/300F

Class:	Medium Size Short/ Medium Range Widebody Freighter Freighter
First Conversion:	1994
Payload:	86,300 - 88,400 lb
Range:	2,650 - 3,800 nm
Engine Options:	GE CF6 (50%), PW JT9D (6%), PW4000 (44%)
In Service:	12
On Order:	6
In Storage:	0
Operators:	3
Last Conversion:	September 2009

The A310 Freighter programme was mainly developed by EADS cargo conversion subsidiary EADS Elbe Flugzeugwerke (EFW) on the basis of a Fedex requirement. Fedex ordered a total of 65 conversions (48-200Fs) which were delivered between June 1994 and 2004. Compared to the-200F, the-300F, like the passenger version, has more powerful engines and an additional tail tank which makes it more capable in terms of payload and range. Both variants have the same external dimensions. Compared to the competing 767-200SF, the A310Fs have less range but a slightly larger fuselage cross section which enables them to accommodate standard containers in a transverse position which maximizes volume. In recent years Fedex has withdrawn many A310s from its active fleet and today only 8 A310s are still in service with Fedex, from a large fleet of 66 aircraft it operated a few years ago. Besides Fedex the only two other A310-200/300 freighter operators are Turkish Airlines (3) and Royal Jordanian (1). All A310 freighters still in service today are-300 Freighters. 5 of the 6 A310 freighter currently stored are A310-200 freighters (all ex Fedex).The last three A310s were converted in 2009. An A330 passenger-to-freighter P2F programme is broadly seen as a natural successor and creates a growth replacement product.

Airbus A300-600F

Class:	Medium Size Short Range Widebody Freighter
First Flight:	2 December 1993
Payload:	105,900 - 120,200 lb
Range:	1,950 - 2,650 nm
Engine Options:	GE CF6 (50%), PW4000 (50%)
In Service:	105
On Order:	0
In Storage:	0
Operators:	5
Last Delivery:	July 2007

The market for the A300-600F is dominated by the large integrators. Fedex ordered and took delivery of 42 A300-600F (factory built freighters based on the A300-600R), while UPS ordered 90 but only took delivery of 53 and cancelled the remainder. Combined, these two integrators operate 89.5% of the A300-600F fleet. Compared to the competing 767-300F (Boeing's factory built freighter based on the 767-300ER), the A300-600F has less range but a slightly larger fuselage cross section which enables it to accommodate "interline-friendly" standard containers in a transverse position which maximizes volume. The A300-600F includes an option to operate in either maximum payload operations or maximum range operations. The A330-200F is a growth replacement option for operators of the A300-600F in the cargo market and has been available as from 2010. An A330P2F converted freighter would be a cheaper replacement as well.

Airbus A300-600 Converted Freighter

Class:	Medium Size Short Range Widebody Freighter
First Conversion:	2001
Payload:	108,910 lb
Range:	2,130 - 2,650 nm
Engine Options:	GE CF6 (15%), PW4000 (85%)
In Service:	64
On Order:	0
In Storage:	2
Operators:	11
Last Conversion:	N/A

A300-600(R) conversion programmes are offered by EADS-EFW and MNG Technic which took over the existing BAE STC for the type's passenger-to-freighter conversion from FSI/GAMECO in 2012. So far MNG has only converted 3 aircraft. Some early A300-600s were converted but the vast majority were A300-600Rs, converted by EADS-EFW. Converted aircraft (sometimes, unofficially, indicated by an 'M' suffix for Modified) may be operated in either maximum payload mode or maximum range mode. Like the A300-600F, the A300-600 Converted Freighter benefits from the slightly larger fuselage cross section than the 767-300F which enables it to accommodate "interline-friendly" standard containers in a transverse position which maximizes volume and avoids the costly re-packaging of containerised freight. This makes it especially popular among integrators that don't need the longer range of the competing 767-300F. Fedex ordered 29 A300-600(R) conversions of which EFW delivered the last one in 2009. In 2013 the last conversion of an Airbus A300-600 at EADS-EFW was finished and it looked like this was the end of the EADS-EFW A310/A300 P2F programme. However in March 2014, Wuhan-based Uni-Top Airlines signed an order with EADS-EFW for four A300-600 passenger-to-freighter conversions. MNG Technic also still expects to convert some A300-600s. In total 72 A300-600s have been converted to freighter. The launch of an A330-300P2F programme is broadly seen as a natural successor.

Airbus A330-200F

Class:	Medium Size Medium Range Widebody Freighter
First Flight:	5 November 2009
Payload:	143,300 - 154,300 lb
Range:	3,200 - 4,000 nm
Engine Options:	PW4000 (10), RR Trent 700 (90%)
In Service:	35
On Order:	7
In Storage:	0
Operators:	8
Last Delivery:	N/A

In January 2007 Airbus announced a freighter version of the A330, based on the-200 fuselage. This A330-200F can be operated in "maximum range mode", in "maximum payload mode" (by deactivating the tail tank) and since 2011 also in "dynamic payload-range mode" which adds up to 2.5t payload capability for routes in between the initial two mode limits. It has a characteristic 'blister' or 'chin' to accommodate an extended nose gear which was required to ease the cargo loading process. Airlines consider the A330-200F to be a growth replacement of the A300-600F on domestic and transcontinental routes. Out of the Middle East it is capable to reach most of the Asian and European markets. Its nearest competitor is the (comparatively) payload/range constrained 767-300F, which is less capable to efficiently accommodate the "interline-friendly" containers and pallets of the A330-200F. The Boeing 777F and the MD-11F both lift larger payloads although the MD-11F may be considered a much less efficient competitor if operators choose to use the A330-200F in "range mode".

The A330-200F initially attracted much interest from the operating lessor community but enthusiasm has faded and some customers announced order switches to the passenger A330-200 and-300. Further, the important integrator market hasn't placed any orders. In July 2010, the first A330-200F was delivered to Etihad Airways. So far only 35 A330-200Fs have been delivered and the order backlog is still very small with 7 aircraft on order. The RR is clearly the preferred engine choice for the A330 freighter. Only one operator (Malaysia Airlines) has chosen the P&W engine for its current fleet of 4 A330 Freighters.

Airbus A330-200/300 P2F

Class:	Medium/Large Size Medium Range Widebody Freighter
First Conversion:	2017
Payload:	est. 132,000 - 135,000 lb
Range:	est. 3,200 - 3,900 nm
Engine Options:	GE CF6, PW4000, RR Trent 700
In Service:	0
On Order:	6
In Storage:	0
Operators:	0
Last Conversion:	N/A

The launch of an A330 freighter conversion programme has been a point of discussion within Airbus for several years. With possibly increased A330 availability when 787 and A350 start delivering in significant numbers, a conversion programme would extend the operational life of the A330 type and absorb some of the available aircraft. It would also be a replacement product for EADS-EFW's A310/A300 conversion. However, a successful A330 passenger-to-freighter programme could also cannibalize sales from the factory built A330-200F. In May 2012 Airbus announced plans for an A330 passenger to freighter programme. Engineering development will be performed by ST Aerospace and the conversions will be done by EADS-EFW in Dresden. First the A330-300 will be offered as a converted freighter, followed one year later by an A330-200 conversion. In spring 2013 ST Aerospace started engineering work on the A330 P2F conversion programme. The first prototype has been inducted in EFW facilities 2016 and its supplemental type certificate will be obtained in 2017 with entry into service later that year. The conversion will involve replacing the existing passenger cabin fittings with a Class E cargo compartment, and installing a 141in wide by 10in high main deck cargo door. In December 2014 Egypt Air signed an agreement to convert two of its passengers A330-200s to freighter and became the launch customer of the A330 passenger-to-freighter programme. The Egypt Air aircraft will enter production in November 2016 and will enter service with the airline in 2018. Surprising about this is that Airbus-EFW has stated that the first A330 to be converted would be an A330-300 and not A330-200. Probably there were at that time still some orders pending for the larger variant of the A330. At the Farnborough Air Show 2016, DHL indeed placed an order for four A330-300P2F aircraft which will enter service late 2017, so before the Egyptair A330-200 P2F.

Airbus expects a market demand for 900 converted A330s during the next 20 years. According to Airbus, the converted A330 freighter will be complementary to the Airbus factory built A330-200 freighter, as the converted freighter address a different price-point and end-users, based on separate operational requirements. The A330 P2F will appeal more to low-utilisation operators who will benefit from the lower capital costs, while the factory built A330-200 freighter will be more suited to express operators who have higher utilization. Competition would be the 767-300ERSF converted freighter which has a less attractive narrower fuselage and is slightly less capable. If launched, a 777F conversion programme would generate a significantly larger competitor with the same range but much higher operating and conversion costs. The larger and older A330-300s will probably be the first conversion candidates. Although not as capable as the A330-200 from a range perspective, the A330-300's larger fuselage would be attractive, especially for low density cargo integrators or for e.g.

intra-European high volume cargo. A complicating technical issue is the A330's nose down position when on the ground, as the cargo door would be in the front. The converted A330 freighter will not feature an extended nose gear and cargo loading will be facilitated by a powered cargo loading system. For low density cargo this is less of a problem.

BOEING

Boeing 767-200(ER)PC/SF

Class:	Medium Size Short Range Widebody Freighter
First Conversion:	1998
Payload:	84,000 - 101,400 lb
Range:	1,950-3,100 nm
Engine Options:	GE CF6 (93%), PW JT9D (7%)
In Service:	60
On Order:	0
In Storage:	0
Operators:	13
Last Conversion:	October 2012

The 767-200PC ('Package Carrier') conversion was developed for US integrator Airborne Express (ABX). The conversion, performed by IAI/Bedek, involves the removal of the passenger equipment and the installation of a main deck cargo floor and cargo handling system, but not a cargo door as ABX uses cargo containers that fit through standard passenger doors. ABX received 24 767-200PCs between August 1998 and July 2003 and also ordered the first conversion into a 767-200SF which was delivered by IAI/Bedek in 2004. Compared to the-PC, the-SF conversion included a main cargo door and was offered by Boeing/Aeronavali (20 pallets) and still is by IAI/Bedek (19 pallets). Bedek has converted 17 'PCs' to 'SFs' over the last years and there are no more "PC" in active service today. Apart from ABX, the-SF conversion is also used by 16 other airlines of which the majority operates flights on behalf of DHL, UPS and Amazon. Thanks to a higher weight schedule, converted 767-200ER/EMs are more capable in terms of payload and range than converted 767-200s. At this time there are no further conversions on order.

Boeing 767-300F

Class:	Medium Size Medium Range Widebody Freighter
First Flight:	20 June 1995
Payload:	115,700 lb
Range:	3,125 - 3,255 nm
Engine Options:	GE CF6
In Service:	116
On Order:	75
In Storage:	1
Operators:	11
Last Delivery:	N/A

The 767-300F is Boeing's medium capacity factory built freighter based on the passenger 767-300ER technical platform. It competes with Airbus' A300-600F and the larger A330-200F which arrived in 2010 but hasn't gained much traction yet. Compared to the 767-300F, the Airbus products have a slightly larger fuselage cross section which enables them to accommodate standard containers in a transverse position. This maximizes volume and avoids costly re-packaging of containerized freight in interline operations. The 767-300F can hold up to 24 standard "88" x "125" pallets. However, with customized unit load devices, the 767-300F enjoys a significantly better payload/range capability than the A300-600F.

The biggest operator of the 767-300F is currently UPS who operates 59 767-300F aircraft. The UPS aircraft are equipped for specialized package transport and lack a powered cargo handling system and environmental system for livestock/perishables transport. Besides UPS, there had for a long time not been many orders for the 767-300F and other operators of the type only have a marginal fleet of four maximum, with the only exception LAN Cargo which together with its subsidiaries operated 11 aircraft (LAN cargo has been rebranded as LATAM Cargo and has sold 3 767-300 freighters in recent years, so now operates 8 aircraft). The 767-300 Freighter got a big boost in December 2011 when FedEx chose the 767-300F as replacement for their MD-10Fs. So far Fedex has ordered 109 767-300Fs (34 delivered) for-as rumours go-prices which closely resemble the price they have to pay for a second hand converted aircraft. Fedex probably got a good deal from Boeing, as Boeing would like to keep the 767 production line open, before the 767 Pegasus military tanker enters production. Today the only outstanding orders for the 767 freighter are from Fedex. Besides the 75 fixed orders, Fedex also has options for 52 more 767 freighters.

Boeing 767-300(ER)BCF/SF

Class:	Medium Size Short/ Medium Range Widebody Freighter
First Conversion:	2008
Payload:	113,900 - 116,800 lb
Range:	3,120 - 3,305 nm
Engine Options:	GE CF6 (88%), PW4000 (12%), RR RB211-524H-T (0%)
In Service:	37
On Order:	0
In Storage:	3
Operators:	11
Last Conversion:	N/A

There are currently two freighter conversion programmes offered for the 767-300(ER) by ST Aviation Services (a strategic partnership with Boeing) and by M&B Conversions (IAI/Bedek/Mitsui JV). Initiatives for more programmes stalled or were postponed by lack of demand over the last years such as the Shanghai based Boeing-Shanghai-Aviation-Services initiative. The design and delivery delays of the 787 programme, the anticipated increasing availability of pax 767-300ERs and the consequential drop in values materialized much later than many anticipated. But since 2015 conversions for 767-300s have been picked up, and in the last two years 18 767-300s have been converted and there are many aircraft in the pipeline waiting for a conversion slot. The fact that the 767-300 conversion programmes finally got momentum is largely the result from the decision of e-Commerce giant Amazon to commence its own air express operations under the Prime Air brand with 40 767-300 (converted) freighters. The 40 767-300 Prime Air freighters will be operated by Air Transport Services group and Atlas Air. Also Chinese express carrier SF Airlines has ordered 767-300 converted freighters for its expansion plans. The introduction of an A330 conversion programme impose a threat to the 767-300BCF/SF's future. Like its factory built sister (767-300F), the-BCF/SF has a slightly smaller fuselage cross section than the Airbus products which means that the 767s can only accommodate standard containers in a longitudinal position which is less efficient, especially for integrators that work with standard containers. Thanks to a higher weight schedule, converted 767-300ERs will be more capable (est. 25,000 lb more payload, 44% higher fuel capacity) than converted 767-300s.

McDonnel Douglas MD-11F

Class:	Large Size Medium Range Widebody Freighter
First Flight:	1 March 1990
Payload:	184,685 - 197,505 lb
Range:	3,435 - 3,620 nm
Engine Options:	GE CF6 (92%), PW4000 (8%)
In Service:	35
On Order:	0
In Storage:	13
Operators:	8
Last Delivery:	February 2001

Like the 747, the MD-11 was, from the start, structurally designed to be a freighter as well as a passenger aircraft, making it especially appealing for the large carriers of passenger/cargo traffic. The early end to the production of the MD-11 and subsequent collapse of passenger aircraft values, allowed the passenger to freighter conversion of the MD11 to flourish. The factory built MD-11F had Fedex and Lufthansa as its largest clients (21 and 14 respectively). Compared to the converted MD-11F, the production MD-11F has a slightly higher payload capacity. MD-11 freighters are well-suited for many medium to longer haul routes that have insufficient density of cargo for deployment of a 747-400 freighter. The absence of a same-sized newer technology type should see the MD-11F retained by some operators for the foreseeable future. Others may prefer to introduce 777 freighters if long-range routes, developed with the MD-11F, have grown sufficient traffic. Alternatively, the A330-200F may prove a useful development tool for low-density, long-range cargo routes.

McDonnel Douglas MD-11BCF

Class:	Large Size Medium Range Widebody Freighter
First Conversion:	1995
Payload:	184,700 - 194,700 lb
Range:	3,480 - 3,970 nm
Engine Options:	GE CF6 (51%), PW4000 (49%)
In Service:	86
On Order:	0
In Storage:	20
Operators:	9
Last Conversion:	May 2012

Like the 747, the MD-11 was, from the start, structurally designed to be a freighter as well as a passenger aircraft, making it especially appealing for the large carriers of passenger/cargo traffic. The early end of the production of the MD-11 and subsequent collapse of passenger aircraft values, allowed the passenger to freighter conversion of the MD-11 to flourish. As a result, 123 MD-11 aircraft of the 147 built passenger (incl. 4 Convertibles and 4 Combi) MD-11s had undergone freighter conversion at Aeronavali or SASCO (Singapore). MD-11 freighters are well-suited for many medium to longer haul routes, which have insufficient density of cargo for deployment a 747-400 freighter. Five ex-Combi MD-11s that were converted to freighter are considered "odd-balls" as they are the only airplanes in the MD-11 fleet which have the large cargo door in the rear part of the fuselage (instead of the front part) which makes loading procedures different. Due to the lack of cargo doors which are no longer produced and the fact that the feedstock has dried up, the last MD-11 conversion was completed early 2012.

UPS (37 aircraft in service) and Fedex (36 aircraft in service) are the biggest operators of the type and form a market concentration of 85% of all MD-11 converted freighters currently in service. In recent years, many MD-11 converted freighters have been phased out. Given the weak air cargo market and overcapacity, it is highly unlikely that these parked MD-11s will return in active service again.

Boeing 777 Freighter

Class:	Large Size Long Range Widebody Freighter
First Flight:	14 July 2008
Payload:	224.900 lb
Range:	4,605 - 4,970 nm
Engine Options:	GE90
In Service:	124
On Order:	34
In Storage:	0
Operators:	20
Last Delivery:	N/A

The 777 Freighter is the world's longest range twin-engine freighter. Boeing launched the factory built 777 Freighter in May 2005 (known then as 777-200LRF) with a launch order from Air France. The first delivery took place in the 1H 2009 to Air France. The Boeing 777 Freighter is generally seen by the airlines as a potential replacement for the 747-200F/SF and the MD-11F. It offers only slightly less payload than the 747-200F and superior payload capacity compared to the MD-11F but significantly more range than either. From Boeing's perspective, the 747-400 Freighter production is now discontinued, leaving customers to choose between moving up a capacity class to the 747-8F or choosing the slightly smaller payload option offered by the efficient 777 Freighter. With the 777 Freighter and the 747-8F, Boeing has a virtual monopoly of the large, long haul cargo aircraft market for the unforeseen future, as Airbus after the failed attempt of the A380 freighter, does not offer an alternative capable freighter. Technology wise, the 777 Freighter is based on the highly efficient 777-200LR passenger airplane, equipped with a large side cargo door and solely powered by GE90-110/115 engines. The 777 Freighter main deck can accommodate 27 standard pallets. The aircraft is complementary to the significantly larger 747-8F while there seems to be no contemporary competitor until e.g. an A350XWB-900F would be introduced.

As the capital investment is significant, the 777 Freighter is mainly operated by larger (cargo) network operators, integrators and dedicated first tier cargo airlines. Biggest operator is Fedex with 27 aircraft in active service and 9 on order and 7 options. The 777 Freighter is received very well as it is highly efficient and even opened up new markets and considerably extends the cargo cut off times of suppliers as it doesn't need fuel stops on long range routes. Potentially, Boeing could develop a freighter conversion programme as well which would extend the life of older 777s, though such aircraft (except an '-LRSF') would lack the range for the truly long-haul markets and might offer too much volume for the US domestic market.

Boeing 777-200(ER)BCF

Class:	Large Size Medium/ Long Range Widebody Freighter
First Conversion:	est. 2017
Payload:	est. 180,000 lb
Range:	est. 4,000 nm
Engine Options:	GE90, PW4000, RR Trent 800
In Service:	0
On Order:	0
In Storage:	0
Operators:	0
Last Conversion:	N/A

The 777 freighter conversion programme by Boeing still has "product development" status. With the ageing of particularly the 777-200(ER) passenger fleet, a 777BCF programme could become more and more attractive. However, due to the complexity of the 777's (cockpit) systems and the significant composite content in its structure, a conversion would probably cost around US$ 30 mln, according to Boeing. From a payload-range point of view, the oldest 777-200s (or-200'A's) are not so attractive as their already limited range would be further compromised by a potential payload increase. Also, there will only be limited availability of this type as even some part-outs have already occurred. The 777-300 more or less has the same problems. As the 777-200LR and 777-300ER are still too young, the 777-200ER remains as a well suited candidate. It's payload range capabilities will quite well match those of the MD-11F which it could replace. Competition could not be excluded as e.g. a future A330-300P2F could be attractive as well, certainly from a cargo volume perspective.

The definitive launch of a 777 conversion programme depends largely on market conditions and the development of feedstock values. For the time being Boeing expects to see the market introduction of the 777BCF in the latter part of the current decade. However there is still a lot of doubt in the market if there will ever be a viable business case for a 777 converted freighter. The high costs involved in the conversion makes that converted aircraft must stay in service for quite some time after the conversion to provide its operator with a healthy return on investment. It is highly unlikely that this will ever be the case, because 777s which can be used as feedstock are already relative old aircraft. Besides that, Boeing is more focussed on selling new freighters.

IAI Bedek from Israel is also considering a conversion programme for the 777-200. It has completed the concept design for this conversion and expects the first conversion could be done in 2017. IAI Bedek believes that the current low fuel prices, will extend the operational lives of older 777, to such extent that a second life of converted freighter could be profitable.

Boeing 747-400(ER)F

Class:	Very Large Size Long Range Widebody Freighter
First Flight:	4 October 1991
Payload:	249,100 - 274,100 lb (400F) 249,400 - 273.400 lb (400ERF)
Range:	2.825 - 4.455 nm (400F) 2.825 - 4.980 nm (400ERF)
Engine Options:	GE CF6-80 (61%), PW4000 (28%), RR RB211-524 (11%)
In Service:	147
On Order:	0
In Storage:	15
Operators:	36
Last Delivery:	May 2009

The Boeing 747-400 Freighter is the successful all-cargo transport member of the 747-400 family which entered service at Cargolux in 1993. The-400F was a major improvement over its predecessor, the 747-200F, carrying an additional 33,000 lb payload or flying an additional 840 nm. Due to its improved engines and larger wings, the 747-400F is about 10-16% more fuel efficient than the earlier version. The two-crew flight deck and reduced maintenance costs for avionics and engines provided further savings in direct operating costs. Besides, the-400(ER)F is equipped with a nose cargo door to enable the transportation of outsized cargo which generates premium pricing. The-400ERF (40 ordered) entered service in 2002 and had a higher MTOW which enabled to either fly an additional 525nm or carry an additional 22,000lb payload.

The-400(ER)F is mostly operated by large network carriers with a cargo division or dedicated (first tier) cargo operators. The last-(ER)Fs were delivered in 2009 and 166 747-400(ER)Fs have been produced. The fragile state of the air cargo market (as it suffers from slow growth and over capacity) and the growing market penetration of the new generation 777 Freighters and 747-8Fs have led to further storage of 747-400 Freighters and a continuing softening of its values and lease rates. Values of used 747-400 series aircraft may get a boost if Boeing will end the 747-8F production due to low demand. This will mean that used 747-400F/ERFs (together with the 747-8F) will remain the only nose loaders available in the market. This might make the 747-400F/ERF a very sought after aircraft for cargo charter airlines, who want to offer nose loading capacity for customers with out-sized cargo.

Boeing 747-400BCF/BDSF

Class:	Very Large Size Medium/Long Range Widebody Freighter
First Conversion:	2005
Payload:	237,750 lb
Range:	4,090 nm
Engine Options:	GE CF6-80 (52%), PW4000 (44%), RR RB211-524 (4%)
In Service:	47
On Order:	
In Storage:	19
Operators:	22
Last Conversion:	N/A

With the launch of a freighter conversion programme, Boeing offered a relatively cheap replacement for the older 747-200 freighters but also extended the economic life of individual passenger/combi/domestic 747-400s. The main features of a conversion are the installation of a side cargo door and cargo loading system and strengthening of the floor structure. In addition to the Boeing Converted Freighter (BCF), IAI/Bedek offers a conversion programme as well (BDSF suffix). The BDSF has a slightly higher MTOW and as from July 2008, offers a higher certified MZFW which brings the payload almost up to the levels of the-400F. For specialized cargo operators, the BCF/BDSF is less attractive as it lacks the nose cargo door (for loads of over 20ft in length) and is less efficient than the 747-400F, the 777 Freighter or the 747-8F. Some 78 Boeing 747-400s have been converted to freighter since the start of the programme in 2005. 30 of those conversions took place after the beginning of the global economic downturn in September 2008, which led to a decline in the amount of cargo being transported by air, resulting in a big dip in freighter demand in the early stages of the crisis. Demand for 747-400 freighter conversion picked up in the later stages of the crisis, because of the availability of cheap feedstock 747-400s and rising fuel prices, making the investment in a converted 747-400 more economical than continuing to fly with a 747 classic freighter. However, world air cargo still remains a difficult market and more and more cargo is carried as belly cargo on passenger aircraft, so demand for large dedicated four engine freighters remains weak. The last 747-400 freighter conversion was completed in the summer of 2012.

The fragile state of the air cargo market (as it suffers from slow growth and over capacity) and the growing market penetration of the new generation 777 Freighters and 747-8Fs have led to further storage of 747-400 Freighters and a continuing softening of its values and lease rates. The Boeing 747-400 converted freighter is less attractive than a 747-400 factory freighter which has a higher payload and has nose loading capacity. With the 747-400 factory freighter becoming more and more available, the chances of any recovery of the values for 747 converted freighters are minimal.

Four passenger 747-400s have been converted to 747-400 Dreamlifters (aka 400LCF-Large Cargo Freighter). With their outsized fuselage they are exclusively used to transport 787 aircraft parts to Boeing assembly plants from suppliers all over the world.

Boeing 747-8F

Class:	Very Large Size Long Range Widebody Freighter
First Flight:	8 February 2010
Payload:	297,700 - 303,700 lb
Range:	4,100 - 4,265 nm
Engine Options:	GEnx-2B
In Service:	66
On Order:	8
In Storage:	1
Operators:	11
Last Delivery:	N/A

The 747-8F is Boeing's growth replacement successor to the 747-400F. It features a newly designed wing, new engines and a 5.6m or 220in (160in front of the wing, 60in aft) stretch of the fuselage (but not the upper deck) which gives it approximately 16% more cargo volume and approximately 14% lower ton-mile cost when compared to the 747-400F. This translates to the -8F's ability to lift up to 46,000lb (21 tonnes) or 7 pallets more payload and transport it over the same distance. It is equipped with a nose door which enables it to generate a significant price premium if outsized cargo needs to be transported. The Boeing 747-8F is the highest-payload freighter currently on the market. The operator base of the 747-8F is not very large as there are not that many cargo operators which are able to fill such large plane and can afford it. However, Boeing enjoys a virtual monopoly in the large freighter segment. The 747-8F is expected to operate very well complementary to the 777 Freighter and (if filled) will be very efficient. Due to some design problems with particularly the new wing structure and aileron control systems, the 747-8F suffered from some delays.

The first commercial delivery of the 747-8F took place in October 2011 to launch customer Cargolux, whereas the first -8F was initially scheduled for delivery in 2009. The first years in service were not trouble free, as Boeing had to deal with some unsatisfied customers as the early 747-8Fs fell short of their promised payload/range capability. In December 2013 Boeing delivered the first 747-8F with the "performance Improvement Package" version of the GEnx-2B engines. The upgraded engine is the core of a broader set of improvements, which also features Flight Management Computer (FMC) software upgrades and reactivation of the horizontal tank fuel system. Those other improvements were scheduled to enter service early 2014, according to Boeing. All modifications combined improve the fuel efficiency by 3.5% and can be retrofitted on existing aircraft.

The back log of the 747-8F in September 2016 was very limited with only 8 outstanding fixed orders and 35 747-8Fs on option. At the Farnborough Air Show 2016 AirBridgeCargo signed a letter of intent confirming a year old agreement (agreed at the Paris Air Show 2015) to purchase 20 747-8Fs. Due to lack of backlog and any new orders, Boeing had already reduced the pace of the production of the 747-8I/8F from 1.75 aircraft a month to 1 a month in March 2016 and to 0.5 a month in September 2016 (freighter and passenger aircraft combined). In the summer of 2016 Boeing itself acknowledged that the production of the iconic 747 may come to an end. However, the 20 AirBridgeCargo options may, if these LoI will ever materialize, give Boeing a backlog big enough to keep the 747-8F in production (with a production rate of 0.5 aircraft a month) until 2019 and further. However to everyone's surprise the 747-8F received a big order late October 2016, when UPS Airlines ordered 14 747-8Fs (with options for 14 more). This UPS' order was a very welcome one for Boeing and obviously breathed some much needed new life in the 747-8 programme. Boeing expects another sales boost after 2019, because by that time enough orders will be placed for the 747-8F as a replacement for older 747-400 and MD-11 freighters. If this will not happen, it is very likely that the two US Presidential VVIP 747-8s (the new Air Force One), may be the last 747s to leave the Everett Factory.

Payload-Range Diagrams

Payload-Range Diagrams
In the following section of the commercial jet aircraft overview, the payload-range characteristics of the individual narrowbody, widebody, freighter and regional jet aircraft types have been expressed in diagrammatical form.

For the narrowbody (or 'single-aisle') aircraft, a distinction has been made between dual-class and single-class cabin configurations. For the widebody (or 'twin-aisle') aircraft, a similar distinction has been made between tri-class and dual-class cabin configurations.

Aircraft operators have many cabin arrangement options available. Apart from the number of classes (first, business, economy) the passenger capacity is influenced by the seat pitch, the number of seats per row (how many 'abreast'), as well as the number (and type and location) of lavatories and/or galleys, emergency exits and the number of cabin crew on the plane.

The maximum range of a specific aircraft is logically limited by the fuel capacity. However, restricted by the Maximum Take Off Weight (MTOW), it is frequently not possible to lift the weight of the maximum payload and the weight associated with the maximum fuel capacity. Apart from fuel saving 'technical measures' like winglets, trim optimization or engine optimization, the only way to increase the range is by decreasing the weight that has to be carried (i.e. reducing the payload). Particularly in cargo operations, the maximum weight of payload is often not fully used as the volume of the cargo bay becomes the restricting factor, due to the payload density and/or load restrictions for the various container/pallet positions. Such sub-optimal loading in terms of weight could result in additional range capability.

The abovementioned issues complicate the comparison of the various aircraft types in terms of payload-range. In the diagrams, AR has used the payload and range data which it deems as most typical for the individual aircraft types. For the aircraft types that are not yet in production, it remains to be seen whether the future aircraft will be able to meet the payload-range characteristics that are being marketed by the aircraft manufacturers. Nevertheless, AR hopes these diagrams will provide some insight to the payload-range performance of the various aircraft.

Aviation Research
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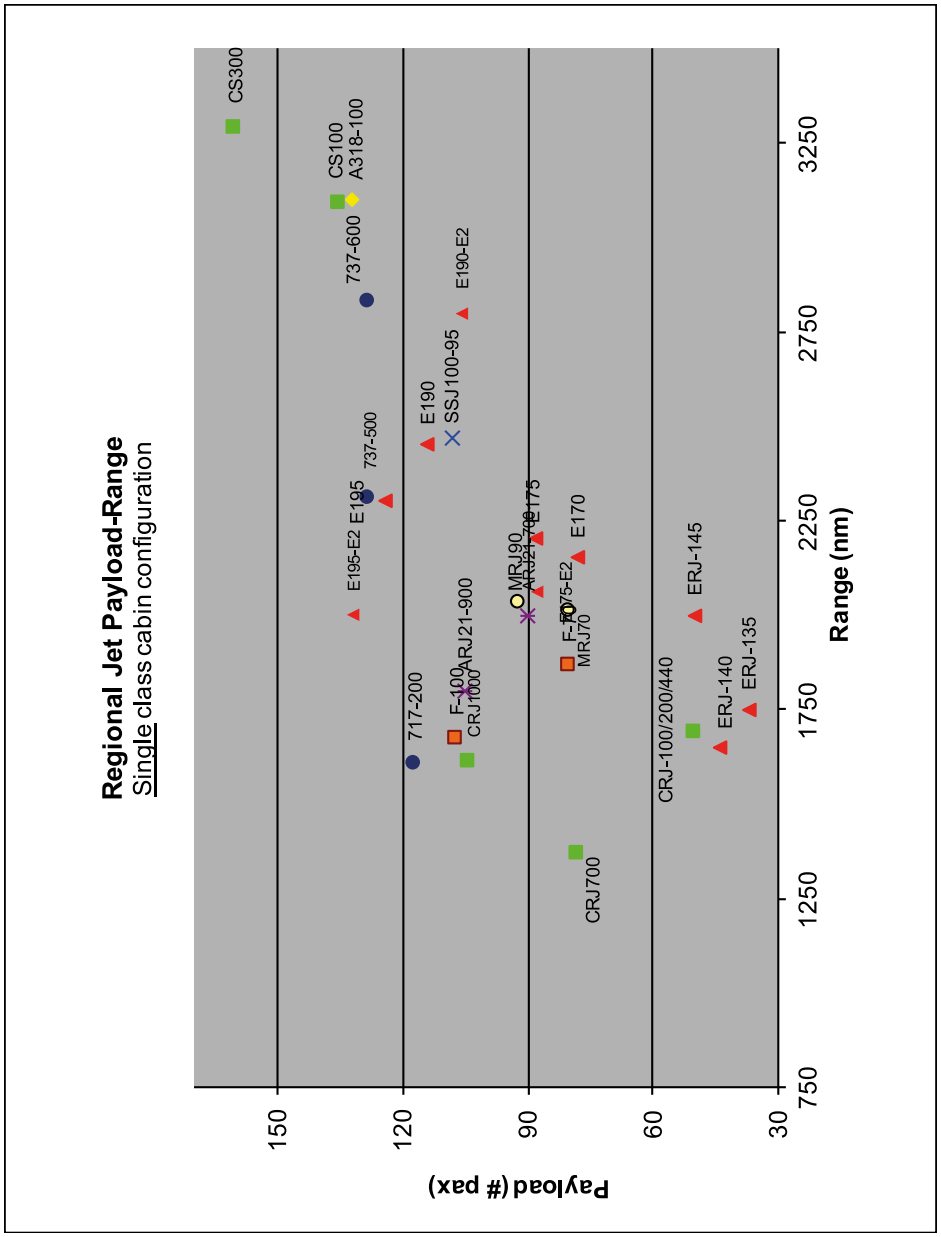
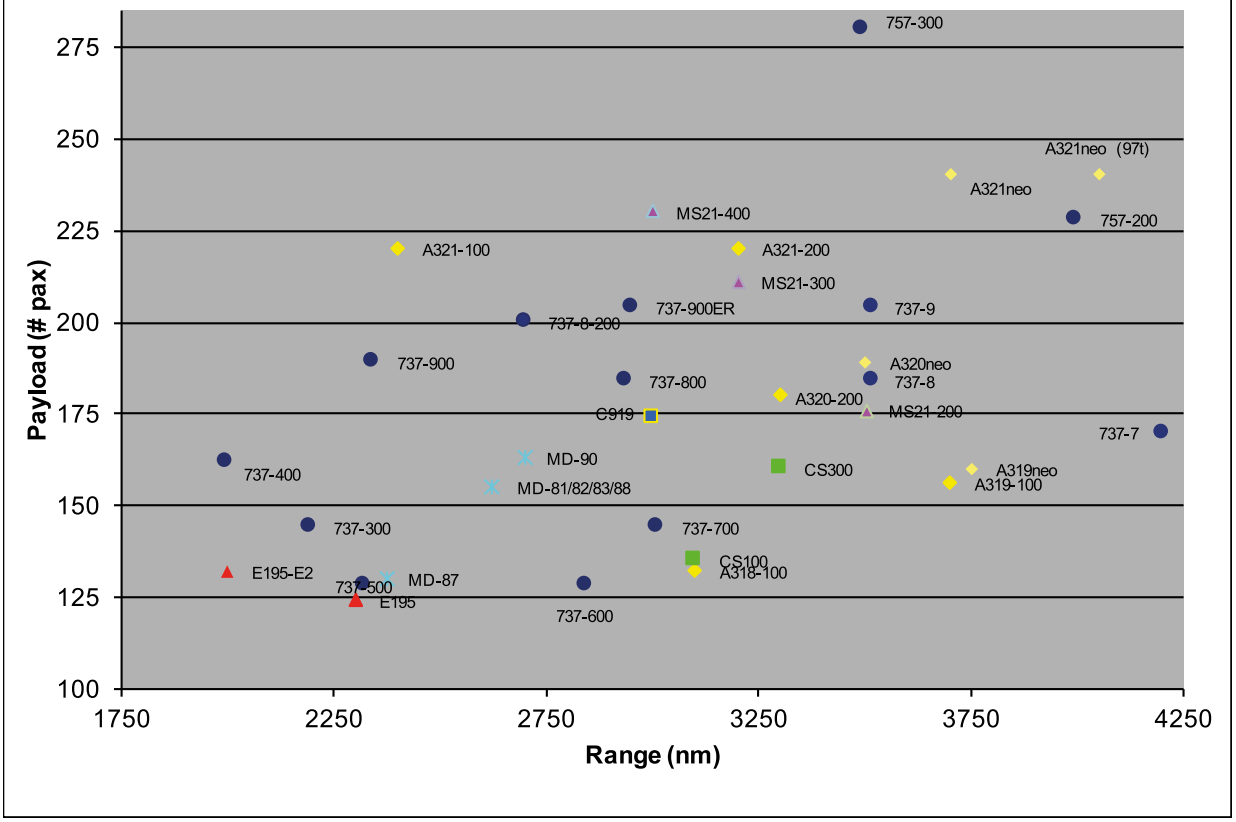
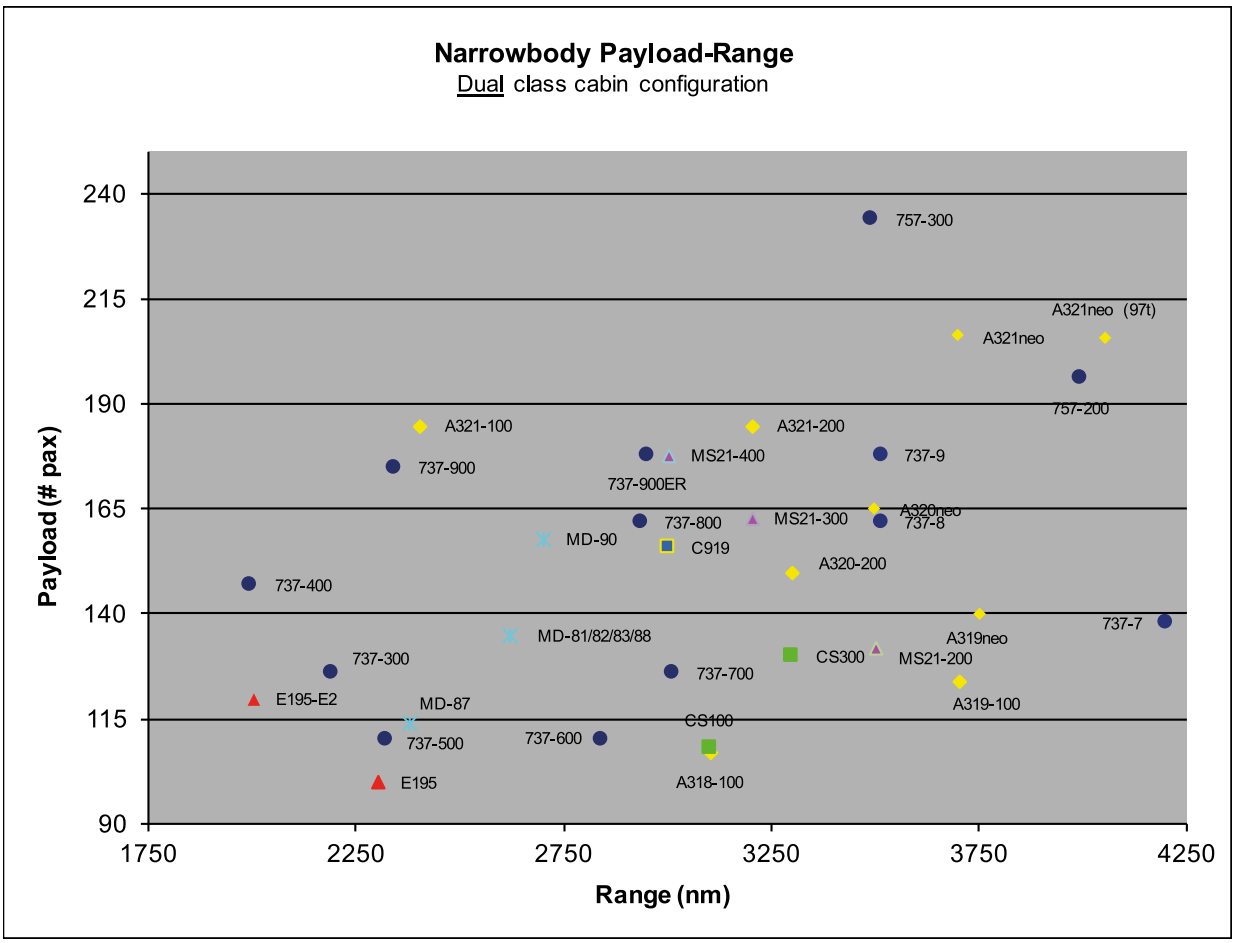
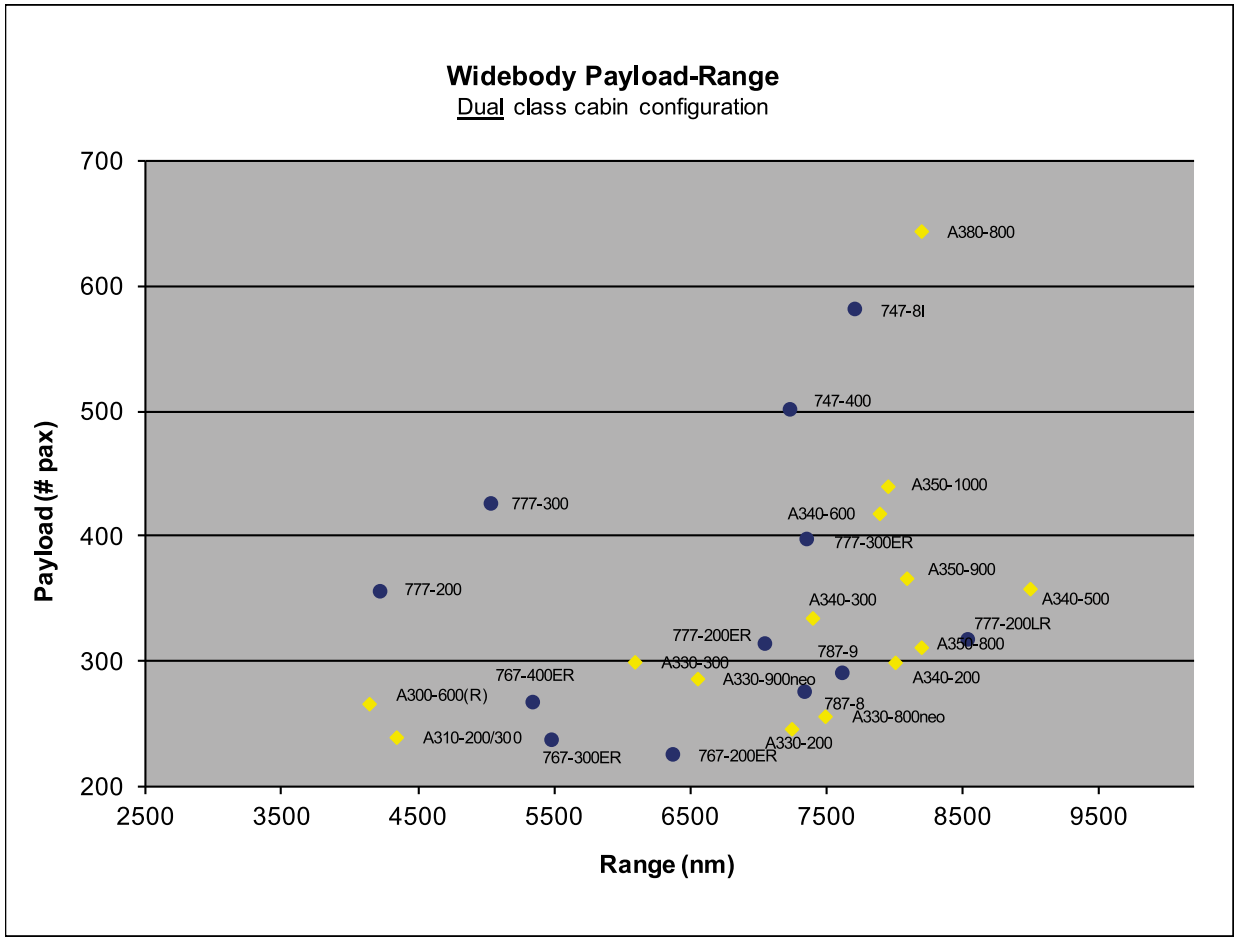


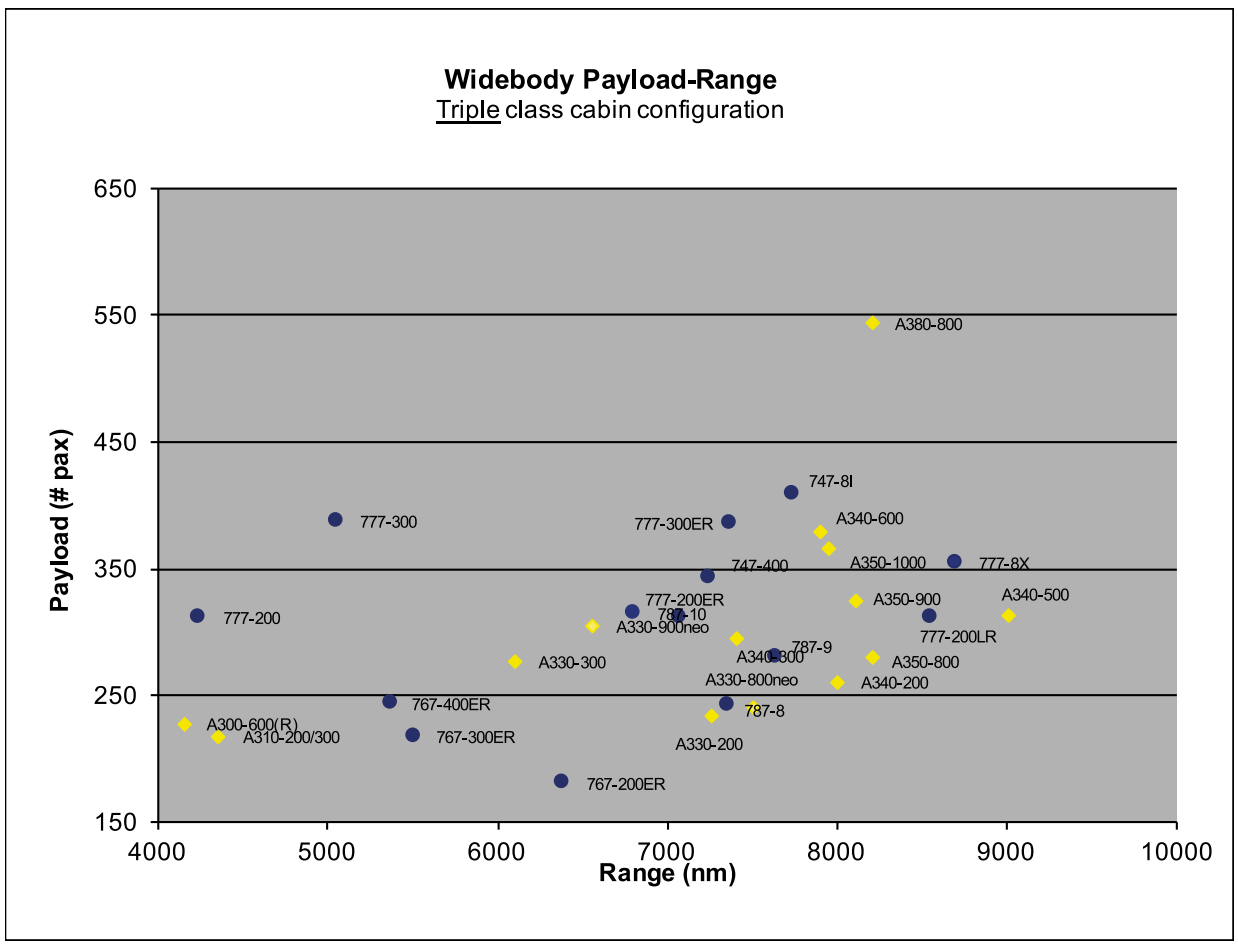
Narrowbody Payload-Range
Single class cabin configuration

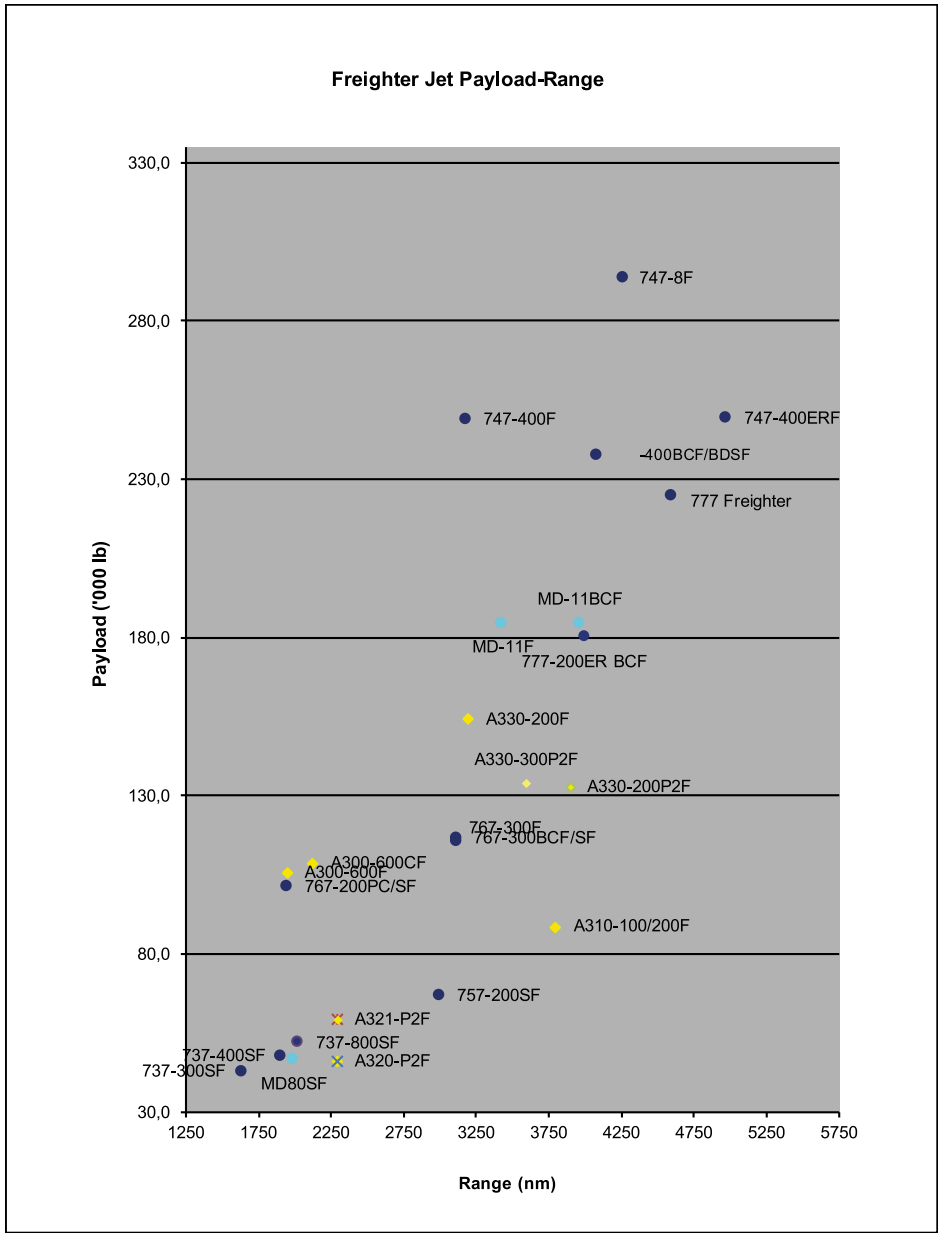


Narrowbody Payload-Range
Dual class cabin configuration




Widebody Payload-Range
Dual class cabin configuration
Payload (# pax)
Range (nm)
700
600
500
400
300
200
2500
3500
4500
5500
6500
7500
8500
9500
A380-800
747-8I
747-400
A350-1000
777-300
A340-600
777-300ER
A350-900
777-200
A340-300
A340-500
777-200LR
777-200ER
A350-800
787-9
A330-300
A330-900neo
A340-200
767-400ER
787-8
A300-600(R)
A330-800neo
A310-200/300
A330-200
767-300ER
767-200ER


Widebody Payload-Range
Triple class cabin configuration
Payload (# pax)
Range (nm)
650
550
450
350
250
150
4000
5000
6000
7000
8000
9000
10000
A380-800
747-8I
777-300
777-300ER
A340-600
747-400
A350-1000
777-8X
777-200ER
A350-900
A340-500
777-200
787-10
A330-900neo
777-200LR
A330-300
A340-800
787-9
A350-800
A330-800neo
A340-200
767-400ER
787-8
A300-600(R)
A310-200/300
767-300ER
A330-200
767-200ER



Picture gallery

Pictures by Bert van Leeuwen and Coen Capelle


QATAR


IRON MAIDEN


QATAR
A350


KLM


Polar


KLM
KLM
ASIA


ATLAS AIR


NAC


EVERTS AIR CARGO


Lufthansa
Alitalia


AIR DO
AIR DO


SOUTHWEST


American


HAWAIIAN


DELTA


Southwest


Southwest


ETIHAD


ANA
25R


KLM


UNITED


EVA AIR Cargo


Southwest


Air Tahiti Nui


spirit


Travel is our deal.
allegiant


UNITED


UNITED


Emirates


AeroLogic


737
EASTERN


American
25R-7L


FRONTIER


American


SOUTHERN AIR

Notes

Notes

For Each Aircraft Type:
- Type Description
- Performance Data
- World Fleet Data
- Engine Split

For Each Aircraft Category:
- Payload-Range Diagrams

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