The Embraer E-Jets have had a monopoly on the large RJ and right-sized airliner market for the eight or nine years. There are now three new families competing for this market. The cabin features, payload and range performance, and technical features of the contenders are analysed.

Large regional Jets: the C Series, MRJ, Superjet 100 & E-Jet families.

Airlines are always looking to improve aircraft operating efficiencies and costs. The introduction of the Embraer E-Jets caused them to downsize from larger jetliners and upsize from turboprops *(see The economics of downsizing to large RJs, Aircraft Commerce, October/November 2008, page 31)*. Three more large regional jet (RJ) types are now coming on to the market, and these are reviewed here.

The end of this decade will see the development of three new RJs. These will integrate similar advances that have been seen in mainline types such as the A350 and 787, and which have led to savings in direct operating costs (DOC) for fuel and maintenance. Another advantage for RJs is that they have traditionally been operated with lower salary scales for pilots and cabin crew. RJs are often used employed by subsidiaries, franchises or feeder companies of the major airlines *(see The different elements of pilot employment costs, Aircraft Commerce, February/March 2009, page 23)*. All the new RJ families being analysed benefit from cross-crew qualification (CCQ).

New technology and manufacturing methods mean these new aircraft will allow airlines to give a superior cabin and qualitative service index (QSI) to their customers on short-, medium- and long-haul flights, much as the 777 did from 1995. For example, the increased use of composite materials in the structure of the aircraft can lead to larger window size and improved cabin humidity.

The three latest developments are for the Bombardier C Series (C Series), the Mitsubishi Regional Jet (MRJ), and the Sukhoi Civil Aircraft Company Superjet 100 (SSJ100). There are also the Embraer E Jets (E-Jet). All four families have several variants, providing a large number of maximum take-off weights (MTOW) and passenger capacities, and the use of the common type ratings for pilots within the aircraft families.

The smaller E-Jets have been in service since 2002, and the larger ones since 2005. The first of the other three new RJ families are currently planned for delivery from the end of this year: the Sukhoi SSJ100, the Mitsubishi MRJ and Bombardier C Series.

These aircraft will operate in the traditional regional feeder route network to support mainline operators. They are likely to replace older aircraft such as RJs that are reaching the end of their economical usable life, including: the BAE 146 (and its newer replacement the Avro RJ); older Bombardier CRJs; and the Fokker 70 & 100.

The new RJs may also be considered by turboprop operators that want to increase capacity without large increases in frequency, and so operating costs. Large RJs could replace current aircraft or operate alongside turboprops on airlines' longer, busier routes. In another market, major airlines that are looking to save DOCs and reduce capacity may use the large RJs to replace short-haul types like the 737 and A320 family.

The larger RJ variants are comparable in capacity to the smaller 737s and A318/A319s, as well as the BAE146/Avro and Fokker 70/100.

Bombardier C Series

The C Series has had a chequered past, with the project being put on the back burner several times. The aircraft has now had the official go-ahead, and has received some firm orders. Entry into service (EIS) is planned for 2013.

There are two variants: the CS100, with two sub-variants; and the CS300, with three sub-variants. The smaller CS100 will carry 110-125 passengers (32- or 30-inch pitch) in a one-class layout and about 100 (36-/32-inch pitch) in a dual-class configuration. The CS300 will carry 130-145 passengers in a single-class configuration, and 120 seats in a dual-class configuration.

The CS100 will have a maximum take-off weight (MTOW) for the basic (B) model of 120,700lbs, and 127,800lbs for the extended range (ER) model *(see table, page 27)*. The maximum payload is planned for 30,800lbs, and the CS100 also have 819 cubic feet of cargo volume. Range will be 2,200nm for the basic model, and 2,950nm for the ER model.

The CS300 will have an MTOW for the basic and XT models of 131,300lbs, and 139,100lbs for the ER model. The maximum payload is an increased 36,500lbs, with a cargo capacity of 1,058 cubic feet, equivalent to a maximum weight of 10,580lbs.

Both variants will be powered by the Pratt & Whitney (PW) PW1000G geared turbofan, which has a take-off thrust of 21,000lbs for the basic models and 23,300lbs for the ER and XT models. This is comparable to the thrust and MTOW of the smaller 737 Classics. The C Series has improved environmental factors and cabin comfort, and its range, fuel capacity and payload are, in most cases, also better.

The flightdeck will use advanced systems as well as taking advantage of the well tested technology of Rockwell Collin's Pro-Line Fusion avionics.

The C Series will take advantage of

MRJ, SUPERJET 100 & E-JET SPECIFICATIONS: UP TO 100 SEATS

	Mitsubishi MRJ		Superjet 100		Embraer E-Jet	
	MRJ70	MRJ90	SSJ100/75	SSJ100/95	E170	E175
Single-class seats	70-80	86-96	78	98	70-80	78-88
Dual-class seats			68	86	70-72	78-80
Seating arrangement	2+2	2+2	3+2	3+2	2+2	2+2
Seat width-inches	18	18	18.31	18.31 in	18.25	18.25
Aisle width-inches	18	18	20.08 max.	20.08 max.	19.75	19.75
Cabin width-inches	116.5	116.5	127.48	127.48	107	107
Cabin height at aisle-in	79	79	83	83	80	80
Max. altitude-feet	39,000	39,000	41,000	41,000	41,000	41,000
Cabin altitude-feet	under 8,000	under 8,000	7,920	7,920	8,000	8,000
Av. overhead locker volume/pax-cu.ft.	N/A	N/A	2.4 min	2.4	Averages of 2.0	
Window size-inches	10.6 x 14.5	10.6 x 14.5	10.6 x 15	10.6 x 15		
Engine type	PW1215G	PW1217G	SaM146	SaM146	CF34-8E	CF34-8E
Engine thrust lbs	15,000	17,000	B-15,400 LR-17,500	17,500	14,200	14,200
Engine bypass ratio	8.4:1	8.4:1		4.4:1	5.0:1	5.0:1
Engine-SFC-lb/h/lb	N/A	N/A		0.629	0.684	0.684
MTOW-lb	STD-81,200 ER-84,700 LR-88,600	STD-87,300 ER-91,400 LR-94,400	B-85,585 LR-93,210	B-93,740 LR-101,150	STD-79,344 LR-82,011 AR-85,098	STD-82,673 LR-85,517 AR-89,000
MLW lb	79,800	84,900	77,160	86,860	STD&LR-72,310 AR-73,414	STD&LR-74,957 AR-75,178
Max. fuel capacity-lb	N/A	N/A	B-21,055 LR 27,975	B-21,055 LR-27,976	20,580	20,580
Range-nm	STD-800 ER-1,270 LR-1,800	STD-870 ER-1,400 LR-1,770	B-1,570 LR-2,460	B-1,590 LR-2,390	2,100	2,000
Cruise speed Mach	0.78-0.82	0.78-0.82	0.78 M	0.78 M	0.82	0.82
Take-off field length-ft	STD-4,560 ER-4,920 LR-5,410	STD-4,790 ER-5,220 LR-5,540	B-4,970 LR-4,980	B-5,033 LR-5,915	5,394	7,362
Landing field length ft	4,560	4,760	4,850	4,850	4,177	4,278
Max. payload-lb	20,723	24,250	20,130	26,995	STD&LR-20,062 AR-21,693	STD&LR-22,223 AR-22,840
Max. cargo volume-cu.ft.	618	651	530.07	775.8	508.18	604.59
ICAO landing Category	Cat III	Cat III	Cat IIIA by 2nd stage	Cat IIIA by 2nd stage		
On-board MTCE computer	Yes	Yes			Yes	Yes
Electronic flt. bag	Yes	Yes	Class 2	Class 2		
Avionics			Thales			
NOx margin to CAEPVI	50%	50%	30%+	30%+		
Smoke margin to CAEPVI	90%	90%				
Unburned hydrocarbon margin to CAEPVI	85%	85%				
CO_2 margin to CAEPVI	70%	70%	Up to 10%	Up to 10%		
Noise margin to Stage IV -EPNdB	15.6	17.4	Up to 15% reserve	Up to 15% reserve		
Entry into Service		2013		end 2009/2010	Now	Now
Current list price US$m	N/A N/A	N/A N/A	B-26.4 LR-27.0	B-29.9 LR-30.5	32.9	35.5

advances in technology and use composite materials in its fuselage, 70% of which will comprise advanced materials: 46% advanced lightweight composite, and 24% aluminium lithium. This will increase the intervals between airframe checks, and improve passengers' comfort. The C Series has larger windows than previous RJs, which are also the largest of the new entrants to the market. The C Series cabin width is also the widest of all the four RJs, narrowly beating the Superjet100. This additional cabin width of 1.5-22 inches compared to all other RJs also gives the C Series the widest seats and, in most configurations, the widest aisle and the highest ceiling.

The C Series offers galleys both forward and aft of the aircraft. This will aid passenger service, especially in a two-class configuration, as will having up to three toilets, compared to the maximum of two on the MRJ and E-Jets. The C Series has been configured for the airliner replacement and rightsizing market.

Cabin bag storage is provided by larger overhead lockers with an average volume of 2.4-2.5 cubic feet per passenger. It will also be possible to have up to two wardrobes, which is the same as on short-haul aircraft and some larger RJs. The C Series has a standard seating configuration of three seats on one side of the aisle and two on the other, with 2 + 2 in business. Some airlines may take advantage of the width and request a 3 + 3 configuration in economy. The chances of this increase when the MTOW figures for similar-sized new RJ variants and smaller 737 Classics are considered.

Environmentally the C Series will make large advances, in much the same way as the MRJ, as its engine emissions are within current CAEP VI margins by 50%. The current Stage IV noise regulations are also being met with the CS100 beating it by 21 EPNdB, and the CS300 by 20 EPNdB.

So far the C Series has attracted two customers. Lufthansa has ordered 30 CS100 aircraft with an option for 30

more. Lease Corporation International has 20 firm orders.

With at least four years until delivery, it is unclear how well the C Series will do. Bombardier predicts that it will have 50% of the estimated 6,300 regional aircraft in operation over the next 20 years.

Mitsubishi MRJ

The MRJ is a totally new venture for Mitsubishi, and features the same new geared fan engine as the C Series. The MRJ is currently scheduled for an entry into service in 2013 *(see table, page 26)*.

There will be two variants of the MRJ: the MRJ70 and the MRJ90. Each will have three sub-variants consisting of a standard (STD), extended- range (ER) and long-range (LR) aircraft.

The MRJ70 will have 70-80 seat, and the MRJ90 86-96. The cabin will have 2 + 2 abreast seating and accommodate two toilets, two wardrobes and a forward and a rear galley. Like the C Series, the MRJ is ideal for the rightsizing market.

Neither variant will have overwing exits, but Mitsubishi markets this as an advantage because it will allow an airline to have any configuration it wants without having to take into account exit rows. Mitsubishi also says that the 2 + 2 layout means that no passenger will have to suffer a middle seat, with the added benefit that boarding and disembarking are quicker, thereby reducing turnaround times, increasing the daily utilisation of an aircraft and reducing ground fees.

The MRJ's cabin width is much smaller than that of the C Series and SSJ100, due to a narrower fuselage that means the majority of cargo and bags must be loaded in the forward and rear of the aircraft. Even with the 2 + 2 seating, the MRJ's seats are narrower at 18 inches, but this is still wider than many current short- and long-haul economy seats, where 17- and 17.5-inch seat widths are the norm. The MRJ will also introduce a new, slimmer seat design, featuring 3D-net fabric. It remains to be seen if these are taken up by airlines.

Despite its narrowness, the MRJ has large windows that are almost the same as those of the SSJ100.

The MTOW for the MRJ70 is 81,200lbs for the STD, 84,700lbs for the ER and 88,600lbs for the LR aircraft. The MRJ90 has a larger MTOW of 87,300lbs for the STD, 91,400lbs for the ER and 94,400lbs for the LR. The maximum payload is 20,723lbs for the MRJ70 and 24,250lbs for the MRJ90. Both figures are comparable with similar-sized new RJ aircraft.

The cargo is split between two areas on both variants. The MRJ has 618 cubic feet, and the MRJ90 has 651 cubic feet. The aft cargo is 555 cubic feet for both aircraft, and it is just the forward cargo area that varies.

The range will be 800-1,800 nm for the MRJ70, and 870-1,770nm for the MRJ90, with a fast cruise speed of Mach 0.82. The MRJ lives up to the RJ image by having some of the shortest take-off and landing field lengths of the four RJ families. This is a plus for an operator looking at new routes to smaller airports. The materials used to manufacture the aircraft create this advantage, and should help to reduce maintenance costs. These comprise: 58% aluminium; 28% carbon fibre reinforced polymer (CFRP); 9% titanium; 4% heavy steel; and 1% graphite fibre reinforced polymer (GFRP).

The MRJ will be powered by the new PW1000G, whose geared fan has reduced the number of stages and the fuel burn. While sharing the same engine family as the C Series, the MRJ's engine variant will have a lower thrust because it is a smaller aircraft carrying fewer passengers, and is therefore lighter than the C Series. With the more powerful engine available, however, Mitsubishi has the option to further develop the MRJ and produce a longer variant that has a higher MTOW.

Like the other new RJ aircraft, the MRJ will be CATIII approved for landings, making it suitable for all

C SERIES & E-JET SPECIFICATIONS: MORE THAN 100 SEATS

	Bombardier C Series		Embraer E Jet	
	CS100	CS300	E190	E195
Single-class seats	110-125	130-145	98-114	108-122
Dual-class seats	100	120	94-97	104-112
Seating arrangement	3+2	3+2	2+2	2+2
Seat width-inches	18.5-20	18.5-20	18.25	18.25
Aisle width-inches	20-22	21-22	19.75	19.75
Cabin width-inches	129	129	107	107
Cabin height at aisle-in	84	84	80	80
Max. altitude-feet	41,000	41,000	41,000	41,000
Cabin altitude-feet	8,000	8,000	8,000	8,000
Av. overhead locker volume/pax-cu.ft.	2.5	2.4	Averages of 2.0	
Window size-inches	11 x 16	11 x 16		
Engine type	PW1000G	PW1000G	CF34-10E	CF34-10E
Engine thrust lbs	B-21,000 ER-23,300	B-21,000 XT&ER-23,300	20,000	20,000
Engine bypass ratio	12:1	12:1	5.4:1	5.4:1
Engine-SFC-lb/h/lb			0.64	0.64
MTOW-lb	B-120,700 ER-127,800	B&XT-131,300 ER-139,100	STD-105,358 LR-110,892 AR-114,199	STD-107,563 LR-111,972 AR-115,279
MLW lb	110,000	120,000	STD&LR-94,798 AR-97,003	STD&LR-99,208 AR-100,971
Max. fuel capacity-lb	Not disclosed	Not disclosed	28,596	28,596
Range-nm	B-2,200 ER-2,950	B&XT-2,200 ER-2,950	2,400	2,200
Cruise speed Mach	0.78-0.82	0.78-0.82	0.82	0.82
Take-off field length-ft	4,950	B-6,240 XT-5,450 ER-6,200	6,745	7,149
Landing field length ft	4,670	4,990	4,341	4,206
Max. payload-lb	30,800	36,500	28,836	30,093
Max. cargo volume-cu.ft.	819	1,058	799.18	906.17
ICAO landing Category	Cat IIIA/B	Cat IIIA/B		
On-board MTCE computer	Yes	Yes	Yes	Yes
Electronic flt. bag	Yes	Yes		
Avionics	Rockwell Collins Pro-Line Fusion			
NOx margin to CAEPVI	56-58%	56-58%		
Smoke margin to CAEPVI	80%	80%		
Unburned hydrocarbon margin to CAEPVI	85%	85%		
CO_2 margin to CAEPVI	80%	80%		
Noise margin to Stage IV -EPNdB	21	20		
Entry into Service	2013		Now	Now
Current list price US$m	52.65	59.35	39.4	41.6

The C Series is a right-sized jet, rather than a larger regional jet. The aircraft's interior is configured for it to compete in the airliner market, having galleys and toilets forward and aft of the cabin. The C Series also boasts the widest and tallest cabin.

weather conditions in the same way as larger aircraft. The MRJ will also be fully equipped with new avionics and an on-board maintenance computer.

The MRJ is environmentally very promising, with NOx emissions standing at a 50-90% margin to CAEP VI. At the same time the noise emissions are 15.6-17.4EPNdB within stage IV requirements.

All Nippon Airways (ANA) is the launch customer for the MRJ, having placed an order for 15 MRJ90s and options on 10 more. These will be delivered from 2014 onwards, although Mitsubishi says that the aircraft should be ready for delivery from 2013.

Mitsubishi predicts a market of 5,000 70- to 90-seat aircraft over the next 20 years. This is smaller than Bombardier's prediction, since it excludes the right-sized aircraft such as the C Series, that seat more than 100 passengers.

Superjet 100

Developed and manufactured by the Sukhoi Civil Aircraft Company (SCAC), the SSJ100 is a new design that uses new engines produced by PowerJet. The first SSJ100 variant should be certified by the end of 2009, with the first delivery shortly after. The SSJ100 is therefore the first of the new RJ families to go into operation. The second, smaller variant will be further developed and certified once it has received some orders, and the first variant is delivered.

The two variants are the SSJ100/75 and the SSJ100/95, which will each have two sub-variants comprising a basic (B) and a long-range (LR) model *(see table, page 26)*. The smaller SSJ100/75 will have 78 seats in a one-class configuration and 68 in a two-class layout. The larger SSJ100/95 will carry 98 passengers in a one-class configuration and 86 in a two-class one. The typical airline two-class layouts that have so far been requested are 12/75, 8/78 and 10/80.

The SSJ100/75 has an MTOW of 85,585lbs and 93,210lbs for the B and LR models and a maximum payload of 20,130lbs. The range is 1,570-2,460nm and the cargo volume is 530 cubic feet, the second smallest cargo area of all RJ aircraft after the E-170.

The SSJ100/95 has an MTOW of 93,740lbs for the basic model and 101,150lbs for the LR model with a maximum payload of 26,995lbs *(see table, page 26)*. The range is 1,590nm for the B model and 2,390nm for the LR model. The cargo volume is 776 cubic feet for the larger SSJ100 variant, which is average for its size, compared to the other three main types.

Both variants will be powered by the SaM146, produced by Powerjet, a new joint venture (JV) between Snecma and NPO Saturn. The SSJ100/75B will have a maximum take-off thrust of 15,400lbs, while the LR and SSJ100/95 will have a take-off thrust of 17,500lbs. This new engine will have a three-stage low-pressure compressor (LPC), six-stage high-pressure compressor (HPC), single-stage high-pressure turbine (HPT) and three-stage low-pressure turbine (LPT). The bypass ratio will be 4.4:1, with the engine having a specific fuel consumption (SFC) of 0.629lbs per hour per lb of thrust.

Like the other new RJs, the SSJ100's design will include new technology to enable it to offer new, cost-effective maintenance programmes and improved passenger comfort. The windows will be larger than those of many aircraft in current operation, but fractionally smaller (at 10.6 inches x 15 inches) than those on the C Series.

The SSJ100 will have a maximum altitude of 41,000ft, while its internal air-conditioning system will allow a cabin altitude of no more than 7,920 feet. This is fractionally better than the E-Jets and MRJs. The cabin will consist of 3 + 2 seating. Cabin, seat and aisle widths, and cabin height, are some of the most generous of the four types analysed, with only the C Series being better.

The SSJ100's passenger stowage areas will consist of large overhead lockers that match the average volume per passenger figures (2.4 cubic feet) on the C Series. Only one wardrobe is included in optional configurations, which is equal to most of the E-Jets, although the C Series, MRJ and the E-195 offer up to two wardrobes forward and aft of the cabin.

All the aircraft being analysed offer up to two toilets, but the SSJ100 (and C Series) also offer a configuration with three. Although this reduces galley, storage and passenger space, it increases the level of passenger comfort, especially on longer flights. It will also assist cabin crew during service, with toilet queues being reduced. Galleys can be fitted both at the forward and the rear of the aircraft. The SSJ100 has four full-size doors (two passenger and two service), which are marketed in the same way as the MRJ, in that they give operators a lot more flexibility with cabin configuration.

The SSJ100 will have NOx emissions with 30% margins relative to CAEP VI standards, and up to a 10% margin for CO2 emissions. The noise emissions have up to a 15% margin relative to stage IV noise regulations.

The SSJ100 is the most successful of the large RJs yet to be delivered. The SSJ100/95 has won 113 firm orders, with an additional 61 options placed. Its nine customers are mostly Russian airlines and aircraft lessors. Aeroflot has ordered 30 aircraft.

SCAC has similar market forecasts to Bombardier's, and says that there will be 6,100 aircraft in the regional market over the next 20 years. It aims to have 17% of the market.

If the SSJ100/95 and SSJ100/75 are successful, then further derivatives will be developed. SCAC has joined with Alenia to form Superjet International, which will deal with the aircraft's aftersales support, as well as the development of a VIP/business and freighter variant of the

The MRJ has the same four abreast configuration of the Embraer E-Jets. Mitsubishi has introduced a new slim seat design, which features 3D-net fabric. One of the MRJ's most notable features is that it is powered by the PW1000G; Pratt & Whitney's geared turbofan.

aircraft. SCAC may develop one smaller and two or three larger variants of the SSJ100, which would make it a very versatile aircraft family.

Embraer E Jets

The E-Jets entered service in 2004. They have almost had a monopoly on the large RJ market during this period, and firm orders for the four airliner models exceed 850.

There are two pairs of variants: the E-170 & E-175; and the E-190 & E-195. With four variants, the E-Jets offer the widest range of size options for operators of 70-122 seats, compared to the two variants offered by the three other manufacturers *(see tables, pages 26 & 27)*. All four E-Jet models have three sub-variants: the standard model (STD), a long-range model (LR) and an extended range model (AR). There are also executive jet versions. The E-170 can accommodate 70-80 passengers (29- to 32-inch pitch) in a one-class layout, and 70-72 seats in a two-class configuration, depending on the seat pitch used. The E-175 has 78-88 seats (30- to 32-inch pitch) in a single-class layout and can seat 78-80 passengers in a dual-class configuration *(see table, page 26)*.

The E-190 carries 98-114 passengers with a pitch ranging from 28- to 33 inches in an all-economy layout. It can also seat 94-100 passengers in a two-class configuration. The biggest E-Jet, the E-195, has an all-economy capacity of 108-122 (30- to 33-inch pitch), and it can seat 104-112 passengers in a two-class layout.

The E-170 has an MTOW of 79,344-85,098lbs depending on the sub-variant, with a maximum payload of 20,062lbs for the STD & AR and 21,693lbs for the AR model. Range is 2,100nm for all three sub-variants, and cargo capacity is 508 cubic feet. This is competitive compared with the MRJ and some SSJ100 models, but the cargo capacity is the lowest of the four aircraft types. The E-170 is one of the smallest variants of the four aircraft being analysed *(see table, page 26)*.

The E-175 has an MTOW of 82,673lbs, 85,517lbs & 89,000lbs for the STD, LR and AR models with a 2,000nm range. Maximum payload is 22,223lbs for the STD and LR and 22,840lbs for the AR models, with an improved cargo capacity of 604 cubic feet.

The E-190 has an MTOW of 105,358lbs (STD), 110,892lbs (LR) and 114,199lbs (AR) with a range of 2,400nm. The maximum payload is 28,836lbs, and cargo capacity is 799 cubic feet *(see table, page 27)*.

With a range of 2,200nm, the largest variant, the E-195, has MTOWs of 107,563lbs (STD), 111,972lbs (LR) and 115,279lbs. The maximum payload is 30,093lbs, exceeded only by the C Series, and the cargo capacity is 906 cubic feet, which only the larger CS300 can better.

All E-Jets are powered by the General Electric (GE) CF34, with the E-170/-175 using the CF34-8E version, with a maximum take-off thrust of 14,200lbs. The CF34-10E engine, fitted to the E-190/-195, has a maximum take-off thrust of 20,000lbs. The CF34-8E has a bypass ratio of 5:1 and an SFC of 0.684lbs/h/lb.

The CF34-10E, powering the E-190 and -195, has a bypass ratio of 5.4:1 and a slightly better SFC of 0.64lb/h/lb.

While the E-Jets do not have the high MTOWs of the C Series, they offer a wide variety of configurations and applications, and are seen as potential replacements for smaller mainline short-haul jets. This is helped by the fact that the E-Jets have the shortest landing field length of all the four aircraft families being analysed, although the take-off field length is on average longer than similar-sized RJs. The landing length was one of the deciding factors in British Airways (BA) placing an order for 11 E-170s/-190s to replace the BAE146/RJ100 fleet it operates from London City Airport.

The E-Jets use new technology in manufacturing and maintenance, and have been designed to facilitate their turnaround between missions. This can take as little as 20 minutes, which is a good result for an aircraft carrying more than 70 passengers and an excellent result for one with over 100 passengers. This reduces costly time on ground, and allows higher rates of aircraft utilisation.

The design also includes larger windows, and a spacious 2 + 2 seating layout. While not as wide as some of the other new RJ aircraft, the E-Jets have greatly improved aisle and seat widths. The seat width is more than 18 inches compared to current popular airline widths of 17-17.5 inches.

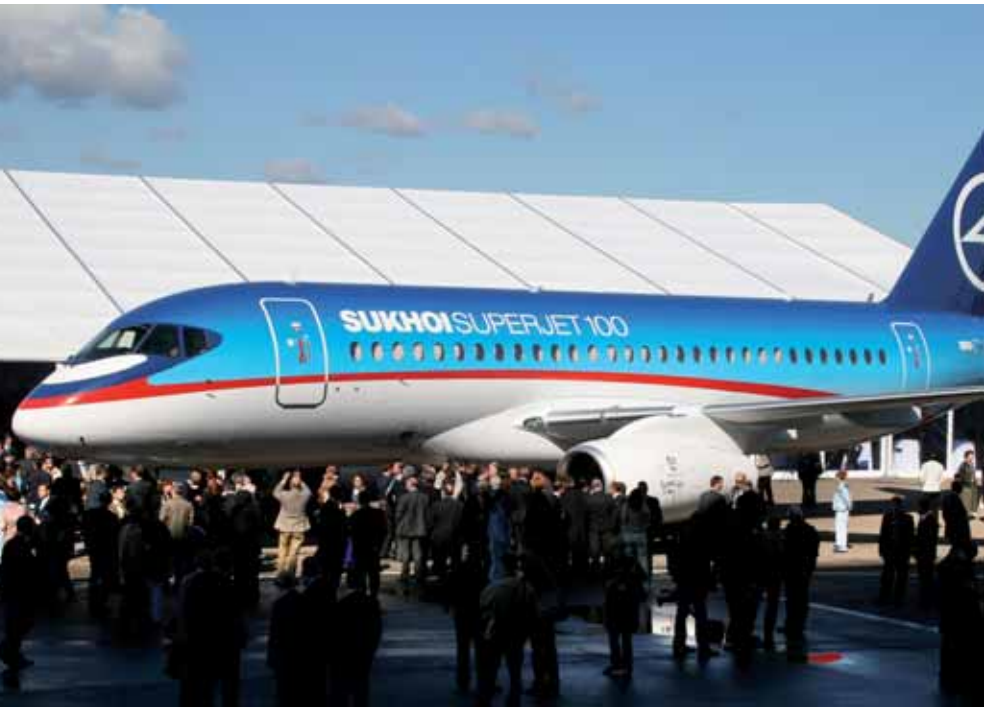
Galleys can be fitted at both the forward and rear ends of the cabin, and there is an option on the E-170/-175 to have just one galley at the rear, thereby increasing passenger space. There are two toilets as standard, at the front and rear, and up to two wardrobes. An option for no wardrobes gives more passenger space. The large overhead lockers average at 2 cubic feet per passenger.

The two smaller variants, the E-170/-175, have just two exits at both the rear and forward, while the larger E190/195 also have two TypeIII / overwing exits.

So far 875 E-Jets have been ordered, with 521 already delivered. The backlog stands at 354 aircraft, with options for another 792. Major customers worldwide include: Air Canada (60), jetBlue (100), Lufthansa (44;)Air France for KLM Cityhopper and Regional (25), Azul Linhas Aereas (41), Air Canada (60), Hainan Airlines (50), jetBlue (89).

Maintenance programme

All four of the aircraft families have used composite materials and new technologies to provide more flexible and cost-effective maintenance programmes. Check intervals should be increased compared to previous RJs, as well as current and older mainline aircraft.



The SSJ100 is the most successful of the new large RJs, having won 113 firm orders. The aircraft is due to enter service in early 2010.

Line maintenance involves the daily, weekly and non-routine checks of the aircraft and its systems. The SSJ100 is currently finalising its certification prior to delivery at the end of the year, but aims for daily checks to be completed every 48 hours, and weekly checks every eight calendar days.

Data are not yet available for the MRJ's maintenance programme, but intervals are expected to be longer than those on current RJ aircraft. The MRJ is also expected to have fewer maintenance tasks and a higher reliability rate than older RJs, because of its structural materials, newer technology and better health monitoring. There will be almost 100% commonality between the MRJ variants when it comes to maintenance.

The C Series is intended to have a service check every 100 flight hours (FH) instead of a daily or weekly check.

The SSJ100 and C Series will both have A check intervals of 750FH, and C checks every 7,500FH. The SSJ100 will also have a detailed and general visual inspection at 6,000 flight cycles (FC) / 24 months. The SSJ100/95B will have structural checks every 33,000FC, and the SSJ100/95LR every 27,000FC.

The C Series will have structural checks every 12 years with a smaller calendar check every three years.

The SSJ100 has a life expectancy of 70,000FC compared to 80,000FC on the E-Jets and C Series (who also state 30 years). This compares favourably with the older Avro RJ family, which also has an airframe life expectancy of 80,000FC.

Operating costs

All newly-designed aircraft claim reductions in fuel consumption, which is a large part of reducing operating costs generally.

An additional DOC reduction could come from the salaries that the crew are paid. Traditionally, regional operators paid both flightdeck and cabin crew lower salaries than their mainline colleagues. An operator replacing an old RJ with a new generation RJ would not see any salary cost savings, and neither would a mainline operator choosing to exchange smaller 737/A320 aircraft for new RJ fleets, however.

Both the MRJ and C Series claim a reduction of more than 20% in fuel consumption compared to older RJ aircraft. Bombardier even believe that the larger E Jets will consume 16-21% more fuel than the C Series on a 500nm route.

The MRJ70 and MRJ90 both claim to be 21% more efficient in block fuel burn per passenger seat than an equivalent-sized E-Jet, although no SFC figures are available yet. If 20% is realistic, then an SFC of 0.55lbs/h/lb for the MRJ70 and 0.51lbs/h/lb for the MRJ90 is likely. The MRJ and C series are the only aircraft to use the new PW geared engine, which will have a large effect on their DOCs. The PW1000G can reduce fuel burn by 12-15% compared to similar engines.

Bombardier says the C Series will have a cash operating cost advantage of 15% compared to similar-sized aircraft.

Summary

The main criteria for an airline to consider in choosing between the C Series, MRJ, SSJ100 or E-Jet families are: seat capacities; cabin comfort; range performance; fuel burn; maintenance costs; and levels of commonality.

If an airline considers a new RJ family on just passenger capacity, then the E-Jets, with the widest range of 70-120 seats, would win. Airlines will, however, also seek to improve DOCs and even change seat capacity, and so will consider the SSJ100, MRJ and C Series.

An example could be BA, which has two 737-300s seating 126 passengers, 19 -400s seating 147 and two -500s seating just 110. Most are used on short-haul operations from London Gatwick (LGW). BA is looking to upgrade its LGW short-haul fleet over the next few years. It is unlikely that passengers would object to RJs. BA's 737s are more than 15 years old, and they are steadily losing the battle with passenger QSI levels. BA could find a comparable capacity to the 737-300s and -500s with the C Series or E-Jets, with a slight drop in capacity when compared to the 737-400.

Such a fleet upgrade would improve DOCs due to lower maintenance and fuel costs, as well as shorter turnaround times than old generation aircraft like the 737 Classic. The small drop in capacity could suit many airlines seeking to reduce this. The added advantage of new generation RJs is that previously unprofitable routes can be operated again. LOT Polish Airlines and Lufthansa are airlines with older 737s that could go down this route. LOT has 12 E-175s on order, and Lufthansa has 27 E-190/-195s on order, with options for 50 more, as well as 30 firm orders for the C Series.

An operator wanting to upgrade its current RJ fleet would be spoilt for choice over the coming years with 10 variants of the four new RJ families available. Flybe is currently phasing out its BAe146 fleet, and replacing it with the E-Jet family.

The lower emissions of the newer jets will give them an advantage, as will their quieter designs, which will mean longer operating windows each day. Both these benefits will result in airlines incurring fewer and lower charges.

Since only one of the families has entered service so far, much of the analysis is only theoretical. But, as they come on line, it will be interesting to see if they live up to expectations and bring operators the DOC savings they want, and passengers the modern cabin comfort that they demand. AC