United States General Accounting Office

GAO

Report to the Honorable
Olympia J. Snowe, United States Senate

February 2001

AVIATION COMPETITION

Regional Jet Service Yet to Reach Many Small Communities

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Contents

Abbreviations

AIR-21	Aviation Investment and Reform Act for the 21st Century, P.L. 106-181
DOT	U.S. Department of Transportation
FAA	Federal Aviation Administration
MSA	metropolitan statistical area
O&D	origin and destination
RJ	regional jet

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United States General Accounting Office
Washington, D.C. 20548

February 14, 2001

The Honorable Olympia J. Snowe
United States Senate

Dear Senator Snowe:

Many aviation experts view U.S. airlines' growing use of small "regional jets"[1] as a revolutionary development that is significantly changing the aviation marketplace. Because jets are generally faster, quieter, smoother, and perceived to be safer than turboprop aircraft, the public tends to prefer travel by jet. Additionally, because regional jets (typically seating between 32 and 70 passengers) tend to have lower operating costs than larger "mainline" jets (e.g., the Boeing 737, which may seat 110 passengers or more), expectations rose that air carriers would provide regional jet service to smaller communities that could not profitably support mainline service. And because regional jets can fly farther than turboprop aircraft, their use holds the potential for small communities to obtain new service on longer routes to more distant airports—thereby perhaps offering new service options to those small communities. The Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (AIR-21) further fueled small communities' expectations of improved air service through specific provisions that eased certain restrictions at New York's LaGuardia Airport to encourage air carriers to serve smaller communities with regional jets.[2]

To address your concerns about air service to smaller communities, we examined how U.S. air carriers are using regional jets and what issues surround the carriers' abilities to use these aircraft. Our work focused on the following three questions:

[1] There is no uniformly accepted definition of a regional jet either in the industry or in federal laws and regulations. For example, the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, P.L. 106-181, variously defines a regional jet as having a maximum seating capacity of "not less than 30 nor more than 75" (sec. 210) or "less than 71" (sec. 231). Within the industry, "regional jet" is sometimes used to describe larger aircraft, such as the Fokker F-100 (107 seats) and Boeing 717 (106 seats), and older-technology aircraft, such as the Fokker F-28 (69 seats) and BAe 146-100 (70-82 seats).

[2] Among other things, AIR-21 allows the Department of Transportation to grant exemptions to existing rules at New York's LaGuardia and John F. Kennedy airports and at Chicago's O'Hare airport for carriers that provide service with a regional jet to certain small airports as a replacement for a turboprop aircraft.

- What is the status of regional jet deployment in the United States, and how has this service evolved?
- What factors have affected the airlines' decisions in deploying regional jets?
- What effects have regional jets had on air traffic and airport congestion, according to published studies and experts in the field?

To determine the status of the airlines' regional jet service, we analyzed historical airline service data, as well as current airline schedule information. Our analysis excluded those carriers that do not have regional affiliates that operate regional jets. We defined regional jets as newer jet aircraft that have been placed into service since 1993 and are designed to seat 70 or fewer passengers. In addition, our analysis included only those markets that had a minimum of 20 monthly regional jet departures—the equivalent of 1 departure per business day. To determine the factors that have affected the airlines' deployment of regional jets, we interviewed airline and industry officials and reviewed airline, government, and consultant documents. To ascertain industry experts' views on the effects of regional jets on air traffic and airport congestion, we reviewed studies and consulted with Federal Aviation Administration (FAA) and industry officials. We conducted our work from March 2000 to February 2001 in accordance with generally accepted government auditing standards. Additional information on our scope and methodology appears in appendix I.

Results in Brief

As of October 2000, major airlines provided regional jet service to 157 U.S. cities, only 13 (8 percent) of which were small cities with populations under 100,000. Eight of these small cities received their service in or before 1997; the remaining five received regional jet service between 1998 and October 2000. Larger cities (those with populations over 250,000) represented 74 percent (115) of the total U.S. cities receiving regional jet service. Most of this regional jet service has radiated from the carriers' hubs to spoke cities that the carriers were already serving with either turboprops or mainline jets. Of the markets in which air carriers began regional jet service since May 1997, 41 percent were new markets in which the regional jet carrier had not previously flown. Air carriers used regional jets in these new markets to expand their networks, although another carrier may already have been providing service in some of these locations. For example, service between Denver and Fargo, North Dakota, represented a new market for United Airlines, although Northwest Airlines already served Fargo from Minneapolis. The airlines have tended to use

their regional jets to serve more distant cities (between 350 and 1,200 miles) that previously were beyond their turboprops' practical operating range or had too few passengers to be profitably served by mainline jets. Because those more distant cities may have been served only by other airlines, regional jets have provided passengers in those cities with additional choices among airline networks. Future regional jet deployment patterns may change, however, as carriers begin operating other types of regional jets—both smaller and larger than the 50-seat aircraft predominantly in service today.

According to airline officials, regional jet deployment strategies are driven primarily by efforts to maximize profit, but other carrier-specific factors such as labor agreements and network structures have also influenced the airlines' decisions. The airlines use complex models—which include data on numerous factors such as passenger traffic, operating costs, and various competitive considerations—to help determine the most profitable markets for regional jet service. In addition, industry officials told us that labor contracts—especially those with pilots—have affected the airlines' regional jet deployments. The pilot contract for most major U.S. airlines includes a provision (the "scope clause") that limits the number and/or size of the regional jets that the airlines' affiliates can operate. These scope clauses differ greatly among the airlines. For example, Delta Air Lines' 1996 scope provision is relatively unconstrained, restricting the size but not the number of regional jets that can be operated. Thus, as of October 2000, Delta's affiliates were flying more than 160 regional jets. In contrast, US Airways' 1998 contract with its pilots limited to 35 the number of regional jets that its affiliates could operate. As of October 2000, US Airways' regional affiliates were operating 30 such aircraft. Recent contract agreements at United and US Airways relaxed some scope clause limits on aircraft numbers while generally maintaining limits on aircraft seating capacity.

Regional jets have added to the congestion and delays facing the nation's air traffic system and airports, according to published studies and experts with whom we spoke. At the same time, however, there is little agreement or conclusive evidence as to the extent of their contribution to those problems. The key study we reviewed estimated a 31-percent (compounded yearly) increase in regional jet traffic between February 1998 and December 2003, compared with FAA's forecasted 3-percent (compounded yearly) increase in mainline jet traffic for the same time period. Experts agree that regional jets increase congestion partly because they represent a large infusion of aircraft into an already crowded system,

but opinions vary as to how regional jets' specific flight operating characteristics (e.g., how fast they can climb to cruising altitude) may contribute to congestion and delays. Experts also agree that air traffic congestion often depends on circumstances or procedures in effect at a specific location, including the number of aircraft operating there. For example, according to officials, the influx of regional jets into the Dallas/Fort Worth International Airport has had little impact on the airport's operations to date, but regional jet operations have had a clear effect at New York's LaGuardia Airport. Increased congestion at LaGuardia—an already congested airport within an extremely congested airspace corridor—led FAA to limit aircraft operations there. Given the projected growth in the number of regional jets that will be in service over the next few years and the likely impact of this growth on the already congested air traffic system, experts agree on the need for action to address the nation's broader air traffic congestion concerns.

Background

Regional jets (RJ) carry fewer passengers than mainline jets but generally travel at similar speeds, cruise at similar altitudes, and require runways of about the same length as mainline jets. The most common RJ models in service today are 50-passenger aircraft—the Bombardier CRJ100 and CRJ200 and the Embraer ERJ-145. Most RJs have a maximum flight range between 900 and 1,700 nautical miles.[3] (See app. II for more detailed information about these aircraft.)

Most RJs are operated by regional affiliates of major airlines rather than by the major airlines themselves.[4] The relationship between the major carrier and the regional carrier can take several forms. Some relationships are contractual; for example, United Airlines (United) contracts with Atlantic Coast Airlines to fly passengers to and from United's hub at Washington Dulles International Airport. By contrast, other carriers own all or some of their regional affiliates. For example, American Airlines (American) and Continental Airlines (Continental) own many of the carriers that operate for their regional affiliates, American Eagle and Continental Express. Likewise, Delta Air Lines (Delta) purchased two of its regional affiliates, Comair and Atlantic Southeast Airlines, in 1999. Major carriers may also

[3] According to the air carriers, the practical limit is much less—about 1,200 miles.

[4] In this report, we refer to all RJs and their operations as those of the major airline.

purchase a partial interest in a regional carrier, as Northwest Airlines (Northwest) has done with Mesaba Airlines.

RJs are part of a U.S. air transportation structure dominated by "hub-and-spoke" networks. Since the deregulation of U.S. commercial aviation in 1978, nearly all major carriers have developed such networks. Airline officials state that by bringing passengers from a large number of cities to one central location and redistributing these passengers to their intended destinations, an airline's fleet can serve more cities than it could through direct "point-to-point" service. Airline networks generally have several hub cities. For example, Northwest has hubs in Minneapolis, Detroit, and Memphis, and American has hubs in Chicago, Dallas, and Miami.

Rapid Growth of RJs Has Primarily Increased Service to Larger Cities

With hundreds of aircraft in operation, the airlines were providing RJ service to 157 cities and 482 city-pair markets in October 2000.[5] Seventy-four percent of the cities receiving this service were large and medium-sized; only 8 percent were small, with populations under 100,000.[6] Air carriers have placed almost 60 percent of their RJ service in markets they were already serving ("existing markets") and have expanded their networks by instituting RJ service in markets that they previously were not serving ("new markets"). Much of the service to existing markets supplemented or replaced mainline jet service that the carriers provided in these markets. The airlines chose to establish new service at cities that either were beyond the practical operating range of turboprop aircraft or were perhaps too small to be profitably served by mainline jets, according to airline officials. However, the airlines have ordered hundreds more aircraft, many of which are smaller or larger than the predominantly 50-seat RJs currently in service. In the future, with these aircraft of varying size, the airlines may adjust their RJ deployment strategies to provide service in markets of varying size.

[5] In the airline industry, markets are generally defined in terms of service between a point of origin and a point of destination. This is often, but not always, defined as a city pair. When a metropolitan area is served by more than one airport, a market may be an airport pair. See app. I for additional information on our market definition.

[6] The U.S. Bureau of the Census categorizes metropolitan statistical areas (MSA) into four population categories. We have labeled these four standard MSA categories as follows: "Small cities" are MSAs with populations of less than 100,000, "medium cities" are MSAs with populations between 100,000 and 249,999, "medium-large cities" are MSAs with populations between 250,000 and 999,999, and "large cities" are MSAs with populations of 1 million or more.

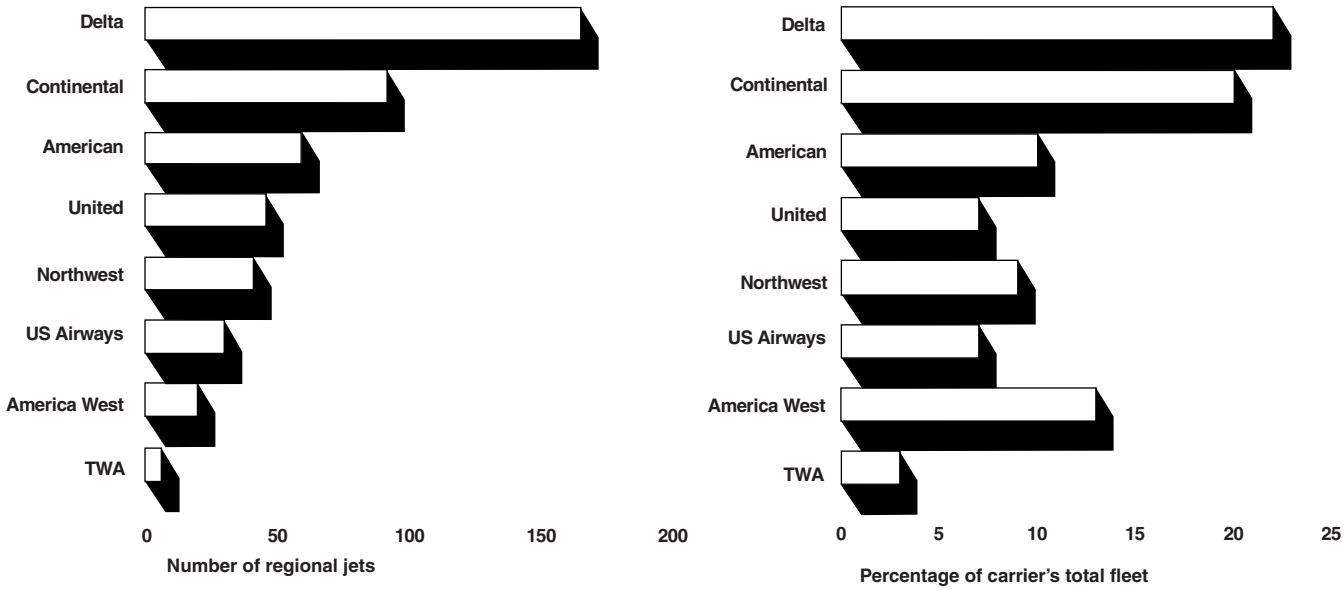
Number of RJs in Operation Has Increased Significantly

As of October 2000, major U.S. passenger airlines and their regional affiliates had deployed almost 500 RJs. This represents a significant increase in RJ aircraft since 1997, when only 89 RJs were in service. Of the 486 RJs in U.S. domestic service in the fourth quarter of 2000, 86 percent were 50-seat Bombardier or Embraer aircraft. The remaining RJs were 32- or 37-seat Fairchild or Embraer RJs, both of which began commercial operations in the United States in 1999.

The number of RJs that each carrier operates varies widely. For example, Delta operates 168 RJs—more than any other major U.S. passenger carrier, largely because of its relationship with Comair (the first regional airline to purchase and begin operating RJs extensively).[7] Other major airlines whose regional affiliates have deployed relatively large numbers of RJs are Continental (92) and American (83). Figure 1 shows the number of RJs operated by major airlines as of October 2000 and the size of their RJ fleet compared with that of their total jet fleet.

[7] While Comair was the first U.S. carrier to begin operating more modern RJs, airlines such as Air Wisconsin and Horizon Air had already been flying older-model RJs, such as the BAe-146 (the predecessor of the Avro RJ) and the Fokker F-28.

Figure 1: Number of RJs Operated by Major U.S. Airlines and Their Regional Affiliates, October 2000



Source: GAO's analysis of data from U.S. airlines.

Just as the number of RJs in service has increased since 1997, so has the number of RJ departures. For example, in May 1997, there were 12,364 scheduled RJ departures, compared with 93,606 scheduled RJ departures in October 2000—an increase of 735 percent in 3-½ years. On average, each RJ in October 2000 made more than six departures per day. By comparison, overall mainline jet departures amounted to 492,331 in May 1997 and 537,697 in September 2000—a 9-percent increase.

RJs Serve 157 Cities, Few of Which Are Small

Although RJs are flying throughout the United States, about two-thirds of the cities with RJ service are located east of the Mississippi River. Figure 2 shows the location of the cities served by RJs as of October 2000. Industry experts believed that this geographic distribution can be explained by differences in population densities and distances between cities that made RJ service well suited for these markets. See appendix III for more detailed information on the U.S. cities with RJ service as of October 2000.[8]

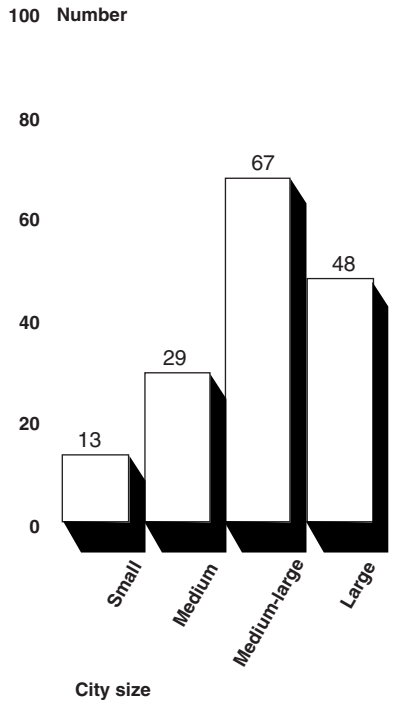
Figure 2: Locations of Cities Served by RJs, October 2000

Source: GAO's presentation of data from the Kiehl Hendrickson Group.

[8] Some carriers use RJs to serve cities in Mexico and Canada as well. For example, Continental uses RJs to serve Ixtapa/Zihuatanejo, Mexico, from its Houston hub and Montreal, Canada, from its Cleveland and Newark hubs.

Of the 157 cities served by RJs as of October 2000, only 13 (or 8 percent) were small cities—those with populations under 100,000. Five carriers—Delta, Continental, American, Northwest, and America West—provide RJ service to those cities.[9] However, only three of these small cities (White Plains, New York; Traverse City, Michigan; and Bozeman, Montana) have RJ service from more than one air carrier. Figure 3 shows the distribution of cities that had received RJ service as of October 2000.

Figure 3: Size of Cities Served by RJs, October 2000



Source: GAO's analysis of data from the Kiehl Hendrickson Group and the U.S. Bureau of the Census.

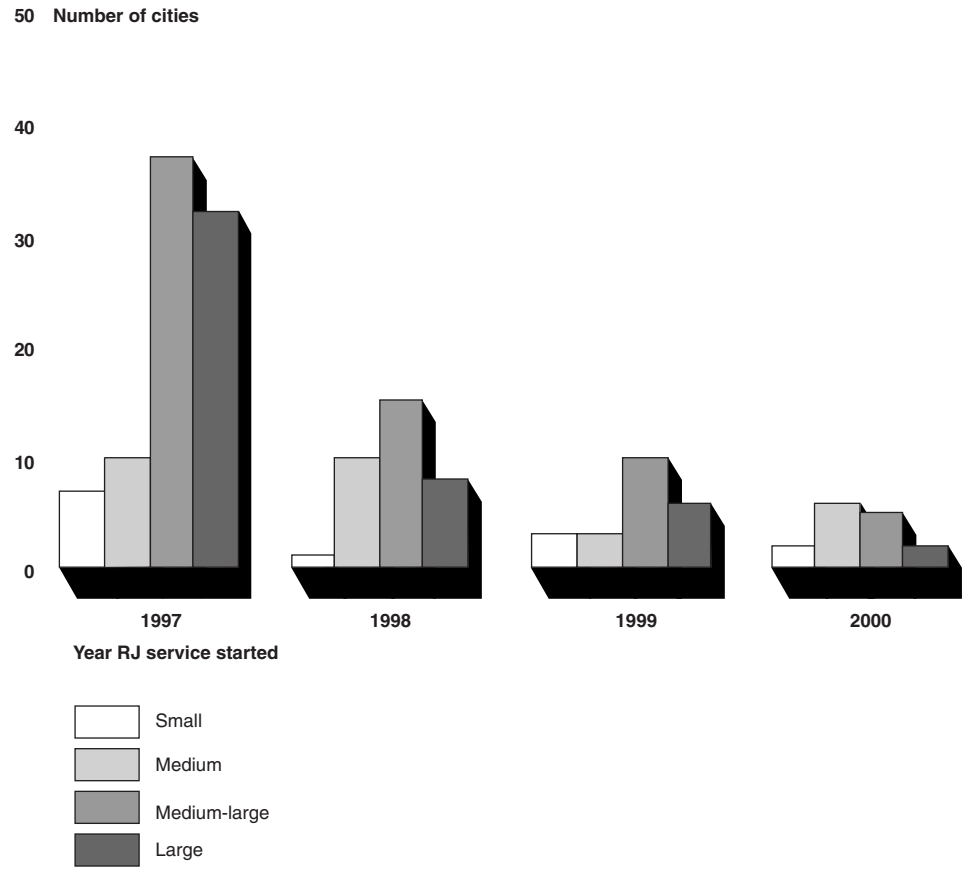
Large and medium-sized cities have received the vast majority of RJ service. The airlines generally introduced RJ service in larger cities before expanding it to smaller cities. For example, of the cities gaining RJ service in or before 1997, 69 (or 79 percent) were cities that had populations over

[9] For our analysis, we included only those city-pair markets that had a minimum threshold of at least 20 RJ departures in Oct. 2000.

250,000 while only 8 (9 percent) were small cities. This deployment pattern—in which airlines have decided to serve larger cities rather than small cities with RJs—remained consistent between 1997 and 2000. Only five additional small cities received RJ service between 1998 and October 2000. Larger cities also more often received RJ service from more than one carrier. Of the 157 cities that received RJ service, 94 received service from multiple carriers. Moreover, 77 of those 94 cities had populations of 250,000 or more.

The growth in the number of cities that have received RJ service has been slowing since 1997. Of the 157 cities that were served by RJs in October 2000, 86 had begun to receive their service in or before 1997. Since then, however, air carriers initiated service to 34 cities in 1998, 22 cities in 1999, and 15 cities in 2000. Figure 4 shows the decreasing number of new cities served by RJs over time and further indicates that most of these cities are not small.

Figure 4: Number and Population Category of Cities Receiving RJ Service, by Year



Source: GAO's analysis of data from the Kiehl Hendrickson Group and the U.S. Bureau of the Census.

RJ Service Has Been Split Between New and Existing Markets

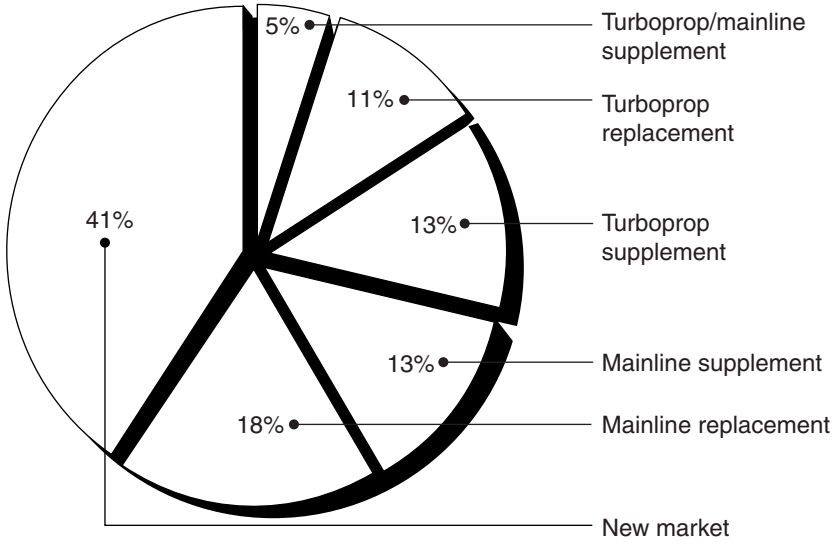
As the total number of cities served by RJs has grown over time, so has the number of city pairs (or markets). As of October 2000, RJs were serving 482 markets.[10] Of these 482 markets, we examined the 432 that received RJ service between January 1997 and October 2000.[11] Air carriers were already serving the majority of these markets with turboprops or mainline jets before they introduced RJs. However, air carriers also used RJs to expand their networks by flying to cities they had not previously served.

Almost 60 percent of the 432 markets were existing markets—that is, they were already receiving either mainline jet or turboprop service from the RJ carrier before it added the RJ operations. Specifically, RJs supplemented existing mainline jet and/or turboprop service in about 36 percent of the markets and replaced mainline jet or turboprop service in 24 percent of the markets. The remaining 41 percent were new markets that had not received service from that RJ carrier for at least 1 year before the carrier introduced RJ operations. Figure 5 breaks down the changes in types of service for the 432 RJ markets that have received RJ service since January 1997.

[10] The total number of markets served is greater than the number of cities because many spoke cities receive service from more than one airline through different hubs. Competing airline networks and hubs create multiple markets.

[11] Because of data limitations, we could not analyze the markets served by Delta before June 1997. As a result, the data for Delta cover only those markets served from June 1997 through Oct. 2000.

Figure 5: RJ Deployment by Service Type Since January 1997



n = 432 markets

Note: Numbers do not add to 100 percent because of rounding.

Source: GAO's analysis of data from BACK Aviation Solutions and the Kiehl Hendrickson Group.

Adding RJ Service to Existing Markets Improved Service Options

Adding RJ operations to existing markets gave RJ carriers opportunities to change their levels of service in various ways. For instance, a carrier could upgrade its service by replacing or supplementing its existing turboprop service with RJs, because jet service is considered to be of higher quality than turboprop service. In other markets, airline officials told us, adding RJs allowed them to "right size" their existing mainline jet service. In other words, the air carrier replaced its existing mainline jet service (which might have been carrying relatively few passengers) with RJs, whose seating capacity better matched the existing passenger traffic.

When air carriers added RJ service to existing markets, they adjusted the total seating capacity. For example, in eight markets where RJs replaced mainline jets between January and October 2000, the carriers decreased the total seating capacity.[12] In five markets, the carriers increased the total seating capacity, even though they "downgraded" these markets to smaller-sized jets. By contrast, in markets where carriers replaced turboprops with RJs, they decreased the total seating capacity in one while increasing it in another nine. As a result, with RJs, the airlines have been able to maintain jet service (albeit with smaller aircraft) but have more often decreased the total seating capacity; where they have upgraded service from turboprop to jet aircraft, they have more often increased total capacity. According to airline officials, both approaches were consistent with the carriers' competitive service goals.

To date, carriers have seldom completely replaced turboprop service with RJ service. This has occurred in only 11 percent of the markets that have received RJ service since January 1997. The carriers continue to fly turboprops in some markets for two fundamental reasons.[13] First, communities served by turboprops are often located within a few hundred miles of a hub airport, and carriers may continue to fly turboprops there because they are generally less expensive to operate on shorter routes than are RJs. Second, those communities also tend to be smaller, and they generate less passenger traffic—especially high-fare business traffic—than larger markets. Consequently, barring other considerations, if alternative markets that may generate more revenue are available, carriers will not deploy their RJs into smaller markets. Industry experts agreed that few turboprop aircraft had been replaced by RJs. So long as major U.S. carriers have turboprops in their fleets, they will use those aircraft as cost- and revenue-efficiently as possible.

[12] We did not examine whether the airlines' decisions to reduce the number of seats in some markets reflect the fact that these markets were competitive but had unnecessary capacity, or whether the airlines were able to increase airfares in some markets by reducing the number of seats available.

[13] One airline official said that if more RJs had been available for deployment, the airlines might have used them to replace more turboprops.

RJs Have Allowed Airlines to Serve New Markets and Expand Their Networks

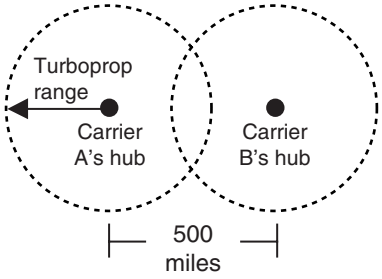
When carriers initiated RJ service in new markets[14] (41 percent of the markets served by RJs), these new city pairs generally were more distant from each other than the city pairs that the carrier had previously served. According to information from airline officials, these new markets typically provided opportunities for the carrier to serve cities that previously were beyond the practical operating range of its turboprop aircraft. For example, in 1999, American initiated RJ service to Grand Rapids, Michigan, from its hub in Dallas (a distance of 931 miles), whereas previously it had served this city only with turboprops from its closer hub in Chicago (a distance of 137 miles). With an RJ—capable of flying farther than a turboprop—American could add this city pair as a new market and expand its network. The average distance (stage length) for all new markets receiving RJ service between 1997 and October 2000 was 563 miles—a distance well beyond the 350-mile range that many view as the practical limit for turboprop service. In other cases, industry officials indicated that airlines saw opportunities to provide RJ service in markets that were unlikely to have generated enough passenger traffic (and revenue) to support profitable mainline jet service.

Providing RJ service to these new, more distant markets thus expanded a carrier's network size or "footprint." One result of this expansion is more overlap among the different carriers' networks. Figure 6 illustrates how using longer-range RJs instead of turboprops creates greater network overlap and effectively expands consumers' choices in some cities. For example, in 1998, Continental initiated RJ service between its Houston hub and Greenville/Spartanburg, South Carolina—a distance of 838 miles. Similarly, United began service in 1999 between Denver and Fargo—a distance of 627 miles. Each of these new markets was too far from those particular hub airports to serve with turboprops and not big enough to serve with mainline jets. The new RJ service increased the flight opportunities for these communities because, for example, until Continental began flying into Greenville/Spartanburg, service to that location was generally provided only by Delta, Northwest, and US Airways. Likewise, Fargo was served only by Northwest until United began RJ service there.

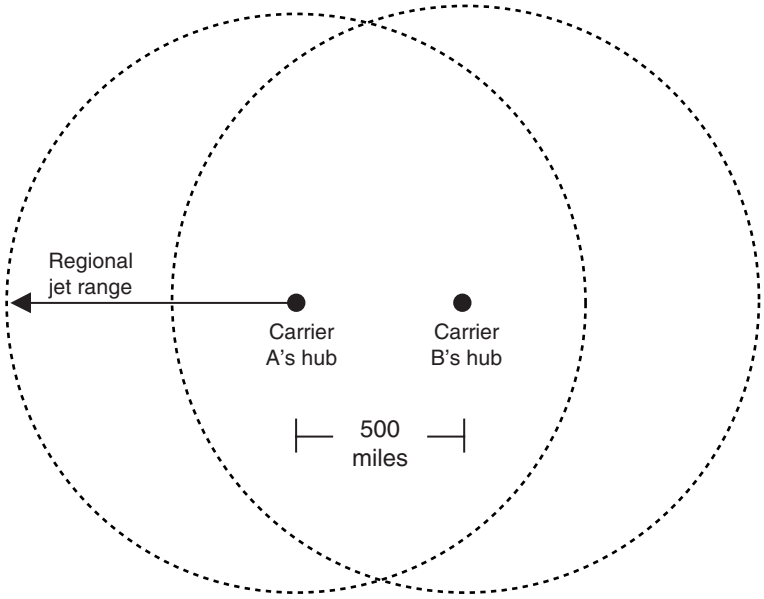
[14] Of the 179 new markets (41 percent of the 432 markets), only 23 involved service to small and medium-sized communities. These markets represented 13 cities—11 medium and 2 small. In addition, each of these cities already had mainline jet service from at least one other carrier.

Figure 6: How RJs Expand the "Footprint" of Carriers' Hubs

With turboprop aircraft, which generally have a maximum range of 350 miles, different air carriers' hubs that are 500 miles apart have little competitive overlap.



With the greater range that regional jets provide, the same two hubs have much greater overlap--and potentially much greater competition for the same passengers.



According to industry officials, expanding airline networks to include new cities also created opportunities for carriers to increase the number of passengers coming onto their networks—a key competitive goal for them. It is unclear whether RJs stimulate passenger traffic. Some industry observers believe that RJs increase passenger traffic because travelers who are unwilling to fly on turboprop aircraft will use RJs. Others believe that when RJ service is offered, passengers only switch to the carrier operating RJs and away from the carriers operating turboprops.

The airlines have seldom used their RJs to provide direct service between spoke cities. As of October 2000, 82 percent of the major carriers' scheduled RJ flights connected a hub and a spoke city. An additional 14 percent of the RJ flights were between a spoke city and a major airport that is not considered a hub, such as LaGuardia. Only 4 percent of RJ flights were directly between spoke cities. For example, since 1998, Continental has begun RJ service from its Houston and Cleveland hubs to 75 U.S. spoke cities while offering spoke-to-spoke service only among 5 cities. Compared with Continental's RJ deployment pattern, American's is less "hub intensive"—flying RJs in 52 markets through its hubs in Chicago and Dallas while providing spoke-to-spoke service in 11 cities.[15] Airline officials have said that because many smaller cities tend not to have enough passenger traffic to justify direct service between them, their airline can better and more profitably serve small communities by aggregating passengers from many small cities into one hub location and distributing them from there.

RJ Deployment Is Expected to Grow, but Future Patterns Are Unknown

U.S. carriers expect to continue the rapid expansion of their RJ fleets. As of January 2001, 1,255 RJs of varying types and sizes had been ordered and 1,010 were on option.[16] These orders are scheduled to be delivered to the airlines between the fourth quarter of 2000 and 2006. (See app. II for additional information on orders and options.)

Whether the aircraft deployment trends seen so far will continue is unknown. One key reason is that the RJs that are to be placed into service over the next few years differ in size: some are smaller and some are larger than the current models. At one end of the market, carriers have recently begun to place smaller RJs into commercial service. Instead of carrying 50 passengers, these models—such as the Embraer ERJ-135 and the Fairchild Dornier 328Jet—carry 37 and 32 passengers, respectively. Additionally, Embraer is developing a 44-seat RJ, the ERJ-140, which is slated to enter service in the first quarter of 2001. However, so few of these aircraft have

[15] Exceptions to this "hub-feeding" strategy include additional flights offered by Delta to Orlando, Boston, and New York's LaGuardia Airport, and by US Airways to LaGuardia and Reagan National, all of which are nonhub airports for these airlines.

[16] According to an industry expert, an order (or purchase agreement) for an RJ is a contract between the manufacturer and the purchaser that indicates, among other things, the number of aircraft to be delivered, equipment to be installed, delivery dates, purchase price, and financing arrangements. Options, when part of a purchase agreement, allow the purchaser to determine whether to purchase additional aircraft.

been put into service to date that it is difficult to characterize the markets where they are used. As of October 2000, carriers had ordered 304 of these smaller RJs and held options for 114 more.

At the other end of the RJ market, manufacturers are developing 70-seat RJs. By the end of 2000, U.S. carriers had placed orders for 112 and held options for 218 70-seat CRJ700s that are to begin commercial service in 2001. Embraer's ERJ-170 and Fairchild Dornier's 728Jet are scheduled to enter service in 2002 and 2003, respectively. However, since none of these larger aircraft are now in service in the U.S., it is unclear how each will affect air service to small and medium-sized communities.

The possible effect of these developments on air carriers' continued use of turboprops is also unknown. The three carriers with the largest number of RJs—Delta, Continental, and American—are planning to eliminate all turboprop aircraft from some or all of their regional operations.[17] Some industry officials told us that the airlines may reevaluate their service to some smaller communities because the higher cost of operating RJs over short distances—relative to turboprops—may make some markets that are relatively close to carriers' hubs less profitable. One industry report concluded that with some airlines converting to all-RJ fleets, some markets currently served by turboprops could possibly lose all service from their current carriers if the airlines deem the markets to be unprofitable for RJs. However, other analyses indicated that turboprop service, while decreasing, would not be completely eliminated in the foreseeable future.

RJ Deployment Decisions Are Profit Driven but Also Affected by Labor Agreements and Other Factors

The carriers' decisions about where to deploy RJs are primarily profit driven, but according to airline officials, other factors, including pilot labor agreements, have influenced their acquisition and deployment decisions. The goal of profit maximization is common among the carriers we interviewed, but the other factors, such as their labor agreements, reflect each carrier's circumstances. According to industry officials, these agreements greatly restrict the ability of some carriers to acquire and use RJs but give other carriers wide latitude to do so. Airline officials said that these agreements—together with other carrier-specific factors, such as the location of the carrier's hubs in relation to major population centers—affected their RJ deployment strategies.

[17] For example, American Eagle made its hub at O'Hare an all-RJ hub as of Nov. 2000 and Comair made its Cincinnati hub an all-RJ hub as of Dec. 2000.

Need to Maximize Profit Generally Drives RJ Deployment

Without exception, officials with the airlines we contacted told us that the primary factor influencing the airlines' decisions about where to deploy their RJs is the need to maximize profits. The airlines use sophisticated models to help them select potential markets. These models rely on detailed data to estimate whether certain markets can be served profitably. They take into account such considerations as estimated passenger traffic, the carrier's operating costs, and competition in the market (including the type of aircraft competitors used, the number of daily flights they scheduled, and the fares charged).

Industry officials told us that the number and type of passengers that an airline is likely to carry is the cornerstone of its model. A key element to the airline's profit estimates is the availability of high-yield passenger traffic (e.g., business travelers who are more likely to pay higher airfares than leisure travelers) in a particular market. Because some smaller communities may not generate enough of this high-yield business traffic, carriers may not have begun RJ service there yet.

Aircraft operating costs—another key factor affecting profits—also determine whether an airline serves a market. While RJs are less costly to purchase than mainline jets, they are generally costlier than turboprops ($22 million for a CRJ200 versus $14.3 million for a 50-seat Q300 Dash 8 turboprop). Furthermore, crew and fuel costs combined, which tend to be the highest-cost elements for both RJs and mainline jets, are generally higher for RJs than for turboprops. Aircraft operating costs generally decrease (on a per-seat-mile basis) as the distance flown in a given market (the "stage length") increases.[18] According to data from Bombardier, operating costs are higher for its CRJ than for its Q300 for stage lengths up to about 380 miles but are lower for longer stage lengths. That is, RJs are less cost-efficient to operate on shorter-range flights than turboprops. As a result, the revenue requirements that a carrier must meet to operate a route profitably will vary with the stage length and the type of aircraft operated.

[18] Cost per available seat mile is a common measure of an air carrier's costs. This is generally calculated by dividing the total cost of operating an aircraft by the product of the total number of seats on the aircraft that the carrier can sell to paying passengers and the total statute (i.e., straight-line) miles that the aircraft is flown in revenue passenger service.

Pilot Labor Agreements Affect RJ Use

According to industry officials, pilot labor agreements have influenced past RJ deployments. However, as other agreements have been ratified more recently, the potential effect of some aspects of these labor issues appears to be waning for most carriers.[19]

In past labor negotiations, pilots and airline officials have agreed to restrictions on the number and/or size of the RJs the carriers' affiliates can operate. Mainline pilots see these restrictions as job protection mechanisms because they ensure that a carrier cannot replace mainline flights operated by its own pilots with RJ flights operated by a regional affiliate's pilots. These restrictions may be negotiated into the portion of the labor contract generally referred to as the "scope clause."

RJ-related scope clause provisions differ from carrier to carrier (see table 1).[20] For example, the 1998 labor agreement between Continental and its pilots generally did not limit the number of RJs that Continental's affiliates could fly, but it did restrict the size of the aircraft to a maximum of 59 seats. The contract between American and its pilot union also limits the seating capacity of the RJs that American Eagle can operate. By contrast, Northwest's RJ-related scope provisions basically limit the carrier's RJ fleet to a certain portion of its overall fleet.

[19] The impact on the current scope clause agreements of the proposed merger agreement between United and US Airways and of American's proposed purchase of TWA, if approved, is unknown. The impact of these two consolidations on small communities' air service and the likelihood that those communities will be served by RJs are also unknown. For information on the potential impact of the United-US Airways merger on competition in the U.S. domestic airline market, see *Aviation Competition: Issues Related to the Proposed United Airlines—US Airways Merger (*GAO-01-212, Dec. 15, 2000).

[20] Scope clauses are typically one factor in broader labor negotiations on salary, job protection, benefits, and other elements, and the airlines and pilot unions negotiate trade-offs among these elements to determine the best possible agreement for their respective interests.

Table 1: Overview of Restrictions on RJ Operations in Pilot Labor Agreements

Airline	Contract term and main provisions related to RJs	Number of RJs in fleet as of October 2000
America West	1995-2000: There are no RJ-related scope restrictions.[a]	20
American	1997-2001: There is a limit of 67 RJs—with a maximum of 70 seats, a minimum of 45 seats, and an average of 50 seats—that applies to the airline's entire commuter fleet. There is no limit on the number of RJs with fewer than 45 seats.	83
Continental	1998-2002: There is no limit on the number of RJs that can be operated, but their size is limited to 59 seats; if this seat size is exceeded, Continental pilots will be given the opportunity to fly RJs.	92
Delta	1996-2000: There is no limit on the number of RJs, but their size is generally limited to 70 seats.[a]	168
Northwest	1998-2002: There is a limit of 30 RJs until the number of narrow-body jets exceeds 347; then RJs can be added on a one-for-one basis. The carrier may also place its code on 36 additional RJs operated by Mesaba (with less than 70 seats), and utilize other RJs operated by regional affiliates.	41
TWA	1998-2002: There is a limit of 30 RJs. The carrier may also operate 2 additional RJs for each additional aircraft in its fleet above 180 until the fleet reaches 188, and 1 additional RJ for each 2 additional aircraft above 188. RJ size is limited to 70 seats and cruise speed to 400 miles per hour.	6
United	1998-2000: This period's agreement limited the maximum number of RJs to 65, with some provisions for adding more as the overall fleet size increased. 2000-2004: The current agreement allows the carrier to deploy approximately 300 RJs by growing its mainline fleet and replacing 150 turboprops on a one-for-one basis.	46
US Airways	1998-2003: RJs are limited to either 35 total or 9 percent of the aircraft in US Airways' fleet, whichever is larger. On April 7, 2000, the pilots and the airline signed an interim agreement allowing 35 additional 50-seat RJs.	30

[a] America West's pilot contract became amendable in April 2000 and Delta's became amendable in May 2000.

Sources: GAO's presentation of information from the airlines, the Air Line Pilots Association, and the PA Consulting Group.

RJ-related scope provisions in mainline pilot contracts continue to be a part of recent and ongoing negotiations between carriers and pilots. Scope clause agreements adopted in recent negotiations have generally allowed for significant increases in the number, but not in the seating capacity, of the RJs that a carrier can operate with pilots not on that carrier's seniority list. For example, the agreements between United and US Airways and their respective pilot unions have increased the number of aircraft the carriers can deploy. United's limit increased from about 65 to about 300, and US Airways' limit rose from 35 to 70. As of January 2001, America West and Delta were renegotiating contracts or contract extensions with their pilots, and in each case, the new agreement could alter the scope clause provisions.

American and Continental intend to begin renegotiating the contracts with their pilot unions in 2001. For example, American and its pilot union plan to begin contract negotiations in June 2001. This agreement followed the union's September 2000 rejection of a proposed contract extension that, among other things, would have increased the number of 50-seat RJs that American Eagle pilots could fly, but would have given mainline pilots the right to fly 70-seat RJs. According to former union leaders, the union's membership rejected the proposed contract extension not because of the scope provisions, but because the pay increase proposed by American was not high enough compared with the increase that pilots at United had secured in a contract negotiated in August 2000.

Other Factors May Affect RJ Deployment Decisions

Another factor that may affect a carrier's RJ deployment decisions is the carrier's position in the manufacturing queue. The three primary RJ manufacturers—Bombardier, Embraer, and Fairchild Dornier—all have substantial backlogs of RJ aircraft orders and options. As of late 2000/early 2001, the manufacturers had not delivered 61 percent of U.S. carriers' total outstanding orders for RJs (including 50 percent of the orders for 50-seat RJs).[21] According to Bombardier, a new order for a CRJ200 would take at least 24 months to be filled. A Delta official said that its early RJ order gave Delta a competitive advantage because it is ahead of many other airlines in the manufacturing queue. A US Airways official confirmed the importance of a carrier's place in the RJ manufacturing queue by telling us that, other things being equal, US Airways would probably order RJs from the manufacturer that could deliver them most quickly.

One carrier employed a different strategy to improve its place in the manufacturing queue and acquire RJs sooner than originally planned. In June 2000, Horizon Air (the sister company of Alaska Airlines) swapped CRJ700 delivery positions with American to get these planes sooner than originally contracted. This agreement will allow Horizon to take possession of its first 14 CRJ700s by October 2001, well ahead of the original 2002-2003 schedule.

Whether a carrier's hubs can accommodate increased aircraft arrivals and departures and how close these hubs are to target markets are also

[21] RJ manufacturers are increasing their production capability to address the current backlog in RJ orders. App. II contains each manufacturer's firm orders, options, deliveries, and backlog by type of aircraft.

considerations that could influence a carrier's RJ deployment strategy. For example, although Continental's Newark hub is relatively close to a large number of potential markets for Continental's RJ operations, the airport's high rate of delays and physical constraints limit its capacity to expand. Continental officials told us that the airline might be forced to completely abandon its RJ operations at Newark to protect its mainline service there and to shift many of its RJ operations to its Cleveland hub, which has neither the physical constraints nor the problems with congestion and delay found at Newark. Similarly, the geographic location of some hubs may limit the number of potentially profitable spoke cities—even with the added range of RJs. For example, compared with hubs in some eastern or midwestern cities, America West's Phoenix hub is located near fewer large cities that could be attractive RJ markets. On the other hand, Delta has developed an RJ hub in Cincinnati (in conjunction with its mainline operation there), and Northwest has begun to build a similar operation at Memphis. According to FAA officials, both of those airports are relatively uncongested and are within RJ operating distance of large numbers of potential RJ markets.

Responses of Two Carriers to Factors Affecting RJ Deployment Produced Different Results

The experiences of Delta and US Airways illustrate how the various factors influencing RJ deployment have affected their ability to deploy RJs and their strategies for doing so. The two carriers differ greatly in the size of their current RJ fleets and thus adopted markedly different strategies for using RJs to compete in various markets. Table 2 summarizes the differences in these carriers' RJ deployment positions.

Table 2: Comparison of Delta's and US Airways' RJ Deployment, October 2000

Factor affecting deployment	Delta	US Airways
Year RJ service initiated	1993	1998
Number of RJs in fleet	168	30
Number of domestic markets served by RJs	178	41
Number of new markets served by RJs	62	20

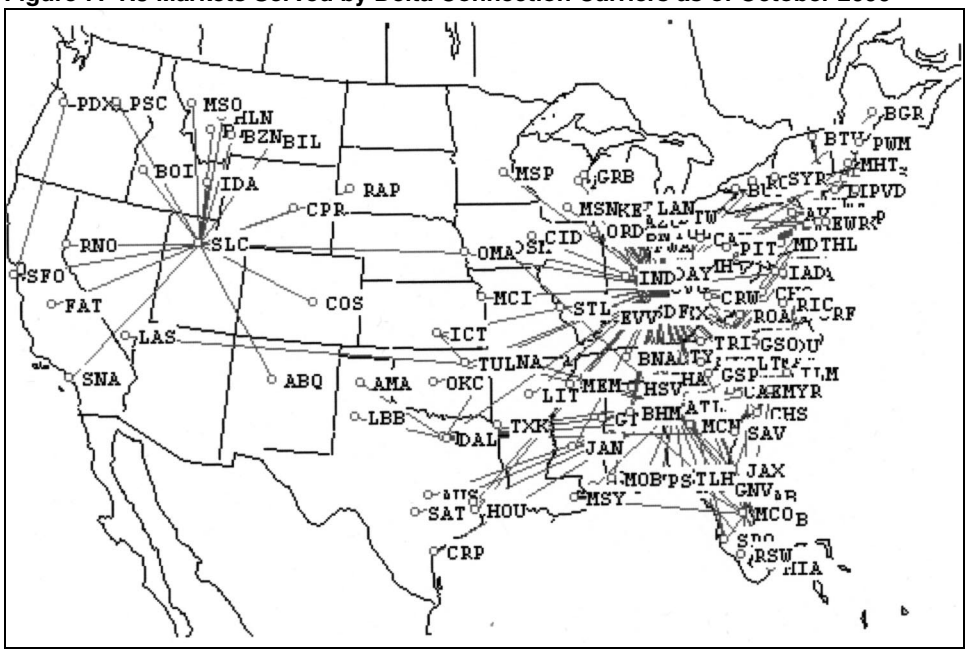
Source: Airlines.

Delta Makes Extensive Use of RJs

Operating within the parameters of its labor contract, Delta has deployed more RJs than any other carrier, greatly expanding its network between 1993 and 2000. Its relationship with Comair—once an independently owned

airline operating as a code-sharing partner with Delta out of Cincinnati—facilitated this expansion. Comair was the first U.S. regional carrier to deploy RJs widely. By 1996, it and two other Delta affiliates were operating 48 RJs—the only ones in service in the United States at the time. As of October 2000, Delta's affiliates were operating 168 RJs. These aircraft served 178 U.S. markets, 76 percent of which included Delta's hubs in Atlanta, Cincinnati, Dallas, and Salt Lake City (see fig. 7). Delta's 1996 labor contract contained no scope clause restrictions on the number of RJs Delta could operate. Additionally, the location of its hubs in Cincinnati and Atlanta, which are within range of numerous profitable markets, has given it a tremendous opportunity to expand RJ service to additional spoke cities.

Figure 7: RJ Markets Served by Delta Connection Carriers as of October 2000



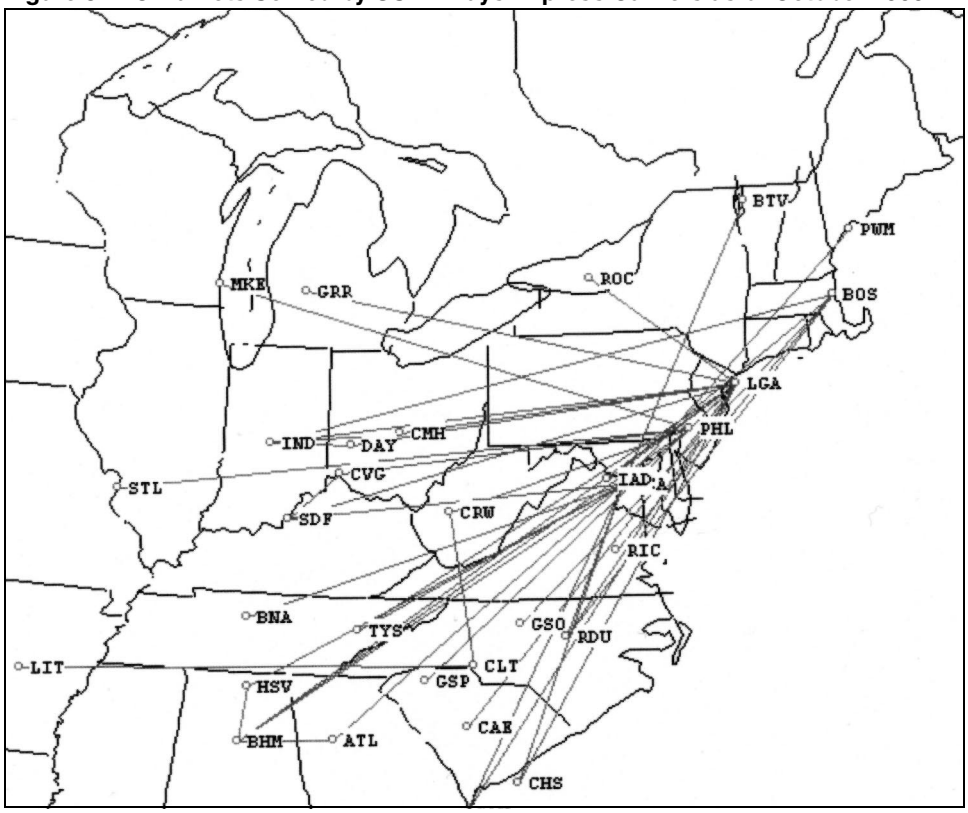
Source: GAO's presentation of data from the Kiehl Hendrickson Group.

US Airways Makes Limited Use of RJs

In part because of limitations in its pilot scope clause, US Airways has been slower to acquire and has deployed far fewer RJs than Delta. As of October 2000, US Airways operated 30 RJs that are owned by its code-sharing partners Chautauqua and Mesa airlines. These jets were serving 41 markets out of locations such as Boston, Charlotte, New York (LaGuardia),

Philadelphia, and Reagan National (see fig. 8). US Airways officials said that the airline's management was aware that competitors were using RJs to make inroads into US Airways' network when the airline renegotiated its pilot contract in 1997, but was unsuccessful in negotiating for more liberal RJ rights with its pilot union. Because of the relatively slow development of its RJ fleet, US Airways has tried to defend its markets by offering more turboprop flights in the hope that more frequent turboprop service could compete favorably against other carriers' less frequent RJ service. At LaGuardia, in particular, US Airways is trying to counter a large influx of RJs from carriers such as Delta.

Figure 8: RJ Markets Served by US Airways Express Carriers as of October 2000



Source: GAO's presentation of data from the Kiehl Hendrickson Group.

Experts Believe That RJ Growth Has Increased Congestion, but Extent Is Unclear

There is consensus among the studies we reviewed and the industry experts we interviewed that RJs have contributed to congestion in our national airspace, but there is less agreement about the nature or extent of these effects. The experts we spoke with agreed that the growing number of RJs was increasing congestion at already crowded hub airports, but they varied in their views on whether specific characteristics of these jets, such as their cruising speed or climbing ability relative to that of mainline jets, were having a compounding effect.

Few Studies Identify RJs' Role in Airspace Congestion

To date, only one comprehensive study[22] has focused on how RJs may affect congestion in the United States.[23] Issued in 1999 by the MITRE Corporation, the study focused primarily on congestion in en route airspace and secondarily on airport congestion and infrastructure concerns.[24] A January 2000 update to the MITRE study estimated that if the current scope clause limitations remained unchanged, up to 1,100 RJs would be in service in the continental United States by the end of 2003 (an increase from the 800 RJs estimated in the original 1999 study). The key study we reviewed estimated a 31-percent (compounded yearly) increase in RJ traffic between February 1998 and December 2003, compared with FAA's forecasted 3-percent (compounded yearly) increase in mainline jet traffic for the same time period. This is equivalent to an increase of about

[22] William W. Trigeiro, *The Impacts of Regional Jets on Congestion in the NAS,* MITRE: Center for Advanced Aviation System Development, MP 98W0000256V3 (McLean, VA, Feb. 1999).

[23] Another study, conducted by FAA, focused on airport and infrastructure design concerns that could become increasingly relevant with the growing deployment of RJs. This study concluded that RJs will change the character of airports and passenger air transportation but that it is too early to predict their specific impact. It indicated that small airports (such as small nonhub airports that previously accommodated 727s and DC-9s) may be able to accommodate RJs if they were originally designed for commercial jet operations (i.e., if those airports have sufficiently long runways). Large, congested airports may be limited in their ability to add RJs, particularly if they have historically relied on shorter "commuter" runways that may not be long enough to accommodate RJs. For more information see Kenneth C. Jacobs, *The Impact of Regional Jets on Airport Design,* FAA (Apr. 20, 2000). One additional study reviews a variety of issues related to RJs, including the effects of scope clauses and the impact of RJs on mainline carriers' employees. This report also includes information on RJs and congestion. For more information see: Robert W. Mann, *Small Jet Issues* (1996).

[24] The MITRE Corporation describes itself in its mission statement as a not-for-profit corporation, working in the public interest in partnership with government clients on issues of national importance.

4,000 RJ flights per day over a 70-month period compared with an increase of about 3,000 mainline jet flights per day over the same time period.

MITRE's study generally concluded that the rapid growth of RJs operating in U.S. airspace is likely to contribute to increased congestion in different areas of the national airspace system. However, RJs represent an emerging technology (compared to turboprops) that is allowing airlines to change their service approaches and is increasing the competition between their respective hubs for spoke-city traffic. As a result, the effects that RJs will have on the structure and operations of the air transportation industry will become clear only over time. Key points in the study include the following:

- Currently, RJs fly mostly where airspace is already congested—at high altitudes traditionally used by mainline jets, not at the lower altitudes typically used by turboprops. Because the number of aircraft operating at higher altitudes is increasing, congestion at high altitudes is likely to worsen.
- RJs perform similarly to older narrow-body jet aircraft (e.g., Boeing 737s) except that they climb at a slower rate. Thus, transition airspace (used for climbing and descending) may become more congested and include more types of aircraft (although MITRE did not specifically include an analysis of transition airspace in its investigation).
- Increased air traffic from RJs would create the highest levels of congestion in the northeastern United States. There is no reasonable way for air traffic to avoid this congested airspace, and congestion in this region is expected to be a major concern by 2003.
- Competition for passenger traffic onto different airline networks may provide an opportunity to shift some traffic from badly congested hubs to other locations, but the overall change in traffic patterns is unclear as yet.
- New runway capacity is predicted to relieve potential airport congestion in some hub locations by 2003. These locations include Detroit/Wayne County, Houston (Bush Intercontinental), and Minneapolis/St. Paul. However, other hub airports with high RJ traffic are not likely to have new runways by 2003. Similarly, other hub airports that have runways unsuitable for RJs (i.e., those that are long enough for turboprops but too short for RJs) are not likely to have those runways lengthened by 2003.

Industry Experts' Opinions Supported Many of the Study's Conclusions

Our discussions with a cross section of aviation industry experts consistently confirmed many of the key issues identified in the MITRE study. Among the experts' key points were the following:

- *Increased number of RJs inevitably affects congestion.* The industry experts repeatedly expressed concern about the impact of adding so many aircraft so quickly to airspace whose capacity is already constrained. Because hundreds of new aircraft have been added to already congested airspace while comparatively few turboprops have been taken out of service, many of the experts believed it was inevitable that congestion and delays would increase. They also noted that with many more RJs on order, congestion and delays are not likely to diminish in the near future. The number of daily RJ flights further contributes to crowded skies.
- *RJs are flying into already congested airports.* Industry experts also stated that the effect of such a large infusion of aircraft was exacerbated because these new aircraft were usually flying into already congested airports. For example, after the enactment of AIR-21, air carriers filed requests to add more than 600 new flights per day at New York's LaGuardia Airport—an increase of more than 50 percent in the number of daily flights at what is considered to be one of the nation's most congested airports. The vast majority of those flight requests were for RJ service. While action by FAA has since limited airport operations (take-offs and landings) to a maximum of 75 per hour (allowing a total increase of approximately 159 operations per day), the air carriers' desire to serve this airport with RJs remains high. In October 2000, RJ carriers had 120 daily departures scheduled from LaGuardia.
- *Effect of RJ flight characteristics is unclear.* The experts we spoke with varied widely in their views on how or whether RJs' operating or flight characteristics contributed significantly to congestion. Some believed that transition airspace was a problem area while others were more concerned about situations that might occur at cruise altitude when faster mainline jets—especially large, widebody aircraft—overtook slower RJs. Others believe that these different opinions reflect the lack of a common understanding about how most RJs operate. Many also thought that the congestion problems were not solely related to RJs' operations or characteristics. Rather, congestion was associated more broadly with constraints at individual airports—such as unique design features (e.g., runway lengths) or particular air traffic control procedures. For example, Dallas air traffic officials had some concerns about fitting RJs into departure patterns and arrival sequences under certain conditions.

According to data provided by industry experts, the characteristics of RJs and mainline jets may differ somewhat during certain flight phases, but RJ cruise speeds are highly compatible with those of older, narrow-body mainline jets. This information was generally confirmed by other experts' experiences. For example, when operating in transition airspace, some RJs do not climb out at the same rate as some other aircraft. According to air traffic officials, this can cause congestion and delay by forcing other, faster jets to "stack up" behind the slower RJs. One facility has addressed this issue by restricting RJs to lower altitudes on departure and allowing other, larger jets to climb faster above the RJs. Other air traffic control officials believed that the RJs' cruise speeds were compatible with those of other jets and did not find that managing RJs posed any special challenge during this flight phase.

Congestion at high altitudes is also a concern because RJs are designed to fly at the same altitudes as mainline jets. As their numbers grow, RJs are increasingly competing for airspace that is already frequented by many other aircraft, whereas turboprop aircraft typically fly in lower, less congested airspace. According to FAA, this problem seems to be particularly acute in the Northeast corridor, where air traffic is particularly heavy.

- *Runway space may become more of a problem with more RJs.* RJs generally cannot use the shorter commuter runways that turboprops typically use, but instead require the same longer runways that mainline jets use. This is problematic in locations where runway space is already at a premium. For example, at Washington's Reagan National Airport, only one of three runways is long enough to routinely accommodate most jet aircraft. FAA and airport officials observed that the use of this longest runway is increasing because regional airlines are replacing traditional turboprop aircraft, which can use the shorter runways, with RJs, which must use the longest runway.[25] Some experts suggested that this infrastructure constraint could become an even greater concern as more and more RJs are deployed and increasingly compete with mainline jets for limited runway space. This is significant because few airports have additional runways under development, and according to an FAA official, the time needed to add a new runway can be between 5 and 10 years.

[25] See *Reagan National Airport: Capacity to Handle Additional Flights and Impact on Other Area Airports* (GAO/RCED-99-234, Sept. 17, 1999.)

Some Interim Solutions Have Been Developed to Ease Congestion and Delays, but the Industry Is Concerned About Developing Long-term Solutions

Given the projected growth in the fleet of RJs and the capacity constraints of the current airspace system, industry experts agreed on the need for crafting solutions. Some interim solutions that have been implemented or are under consideration include the following:

- *Low-Altitude Alternative Departure Routes*. This procedure allows an aircraft to depart in certain situations—such as when higher altitudes are congested—provided that the aircraft initially flies at a lower altitude. As a result, aircraft are more often able to depart on time, but they incur higher fuel costs by flying at lower altitudes. This procedure involves RJs as well as other aircraft. Industry officials told us that the airlines are generally willing to make this trade-off to maintain their schedules.
- *Tactical Altitude Assignment Program*. Under this pilot program, set to begin officially in February 2001, certain short stage lengths between city pairs are identified as low-altitude routes, and aircraft are allowed to depart on these routes with potentially less delay provided that they fly the entire route at the predetermined, lower-than-optimum altitude. Because the program is voluntary, carriers can decide whether they want to incur extra fuel costs to maintain their schedules. Many of the selected city pairs included in this program are RJ routes, although this program is not specifically directed toward RJs, according to an FAA official.

Trade association representatives generally supported these and other efforts to mitigate congestion, but expressed concern about initiatives that specifically targeted regional aircraft. They believed that solutions to congestion should be based on an aircraft's operating and performance characteristics, not on its type. They believed that equal access to the air traffic control system and national airspace was important to the carriers flying RJs and, in particular, to their passengers.

The experts we interviewed agreed that interim solutions are important, given the projected growth in air traffic. In addition, these experts pointed to the need for action on larger, long-standing issues. They said that air traffic may not be able to grow as projected unless some of those needs (e.g., for enhancements to airport infrastructure and improvements to the air traffic control system) are addressed.

Conclusions

The increasing numbers of RJs in operation have provided U.S. air carriers with opportunities to serve new and existing markets. As we have noted, with predominantly 50-seat aircraft, the carriers have initiated service to many large and medium-large communities but have provided less service to smaller communities. Service to small communities—to which the airlines now mostly operate turboprop aircraft—continues to be an important concern, because of the uncertainty about whether those markets may generate enough passenger traffic and revenue to be financially viable to sustain RJ operations. Eventually, smaller RJs (i.e., 32- or 37-seat aircraft) may let carriers serve those smaller communities economically.

Other questions also emerge about the impact of how the carriers will use their RJs. For example, the airlines could restrict capacity in a market by reducing service with larger mainline jets but increasing the number of RJ flights in a way that may inhibit entry by new competitors, allowing the airlines to charge fares higher than might exist in a more competitive market. Additionally, the growth in RJs has clearly contributed to an increasing problem with congestion, particularly in some locations like New York's LaGuardia Airport. But how the expected growth in RJs may continue to contribute to congestion and delay remains to be seen. Depending on how events unfold in the near future, these and other potential impacts of the airlines' RJ strategies may warrant continued oversight.

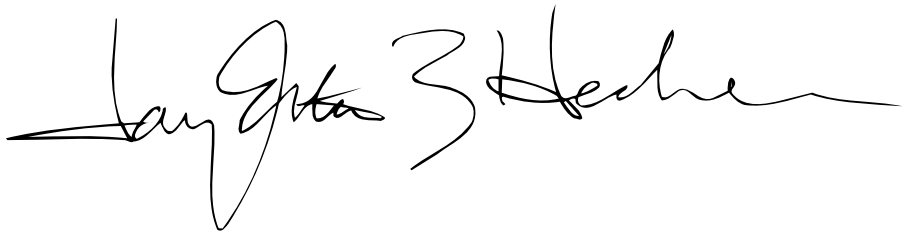
Comments

We provided representatives from the eight carriers whose regional affiliates or code-sharing partners operate RJs (America West, American, Continental, Delta, Northwest, TWA, United, and US Airways) with draft copies of the sections of the report describing RJ deployment information and other factual descriptions of their historical and existing RJ service. We also provided draft copies of report sections to the Department of Transportation (DOT) and other interested parties, such as the Air Line Pilots Association, Allied Pilots Association, Regional Airline Association, Horizon Air, and the three RJ manufacturers—Bombardier, Embraer, and Fairchild Dornier. Representatives of the airlines and officials from DOT and the various industry groups offered technical comments, which we incorporated into the report as appropriate.

As arranged with your office, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will provide copies to the Honorable Norman Mineta, Secretary of Transportation; the Honorable Jane Garvey, FAA Administrator; major U.S. airlines; the Air Line Pilots Association; the Allied Pilots Association; the Regional Airline Association; the RJ manufacturers; and other interested parties. We will also send copies to others upon request.

If you or your staff have any questions about this report, please call me or Steve Martin at (202) 512-2834. Other key contributors to this report are listed in appendix IV.

Sincerely yours,



JayEtta Z. Hecker
Director, Physical Infrastructure Issues

Objectives, Scope, and Methodology

This report examined how U.S. air carriers are using regional jets and what issues surround the carriers' abilities to use these aircraft. Our work focused on three questions: (1) What is the status of regional jet deployment in the United States and how has this service evolved since 1997? (2) What factors have affected the airlines' decisions in deploying regional jets? (3) What effect have regional jets had on air traffic and airport congestion, according to published studies and experts in the field?

To determine the current status of regional jet (RJ) deployment within the United States, we first needed to define this class of aircraft. There is no uniformly accepted definition of an RJ either in the industry or in federal laws and regulations. For example, the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, P.L. 106-181 (AIR-21), variously defines an RJ as having a maximum seating capacity of "not less than 30 nor more than 75" (sec. 210) or "less than 71" (sec. 231). Within the industry, the term "regional jet" is sometimes used to describe larger aircraft, such as the Fokker F-100 (100 seats) and Boeing 717 (106 seats), and older-technology aircraft, such as the Fokker F-28 (69 seats) and BAe 146-100 (70-82 seats). In this report, we defined RJs as newer aircraft that have been placed into service since 1993 and are designed to seat 70 or fewer passengers.

We generally limited our analyses of RJ deployment to major network air carriers: America West Airlines, American Airlines, Continental Airlines, Delta Air Lines, Northwest Airlines, Trans World Airlines, United Airlines, and US Airways. We excluded Alaska Airlines, Southwest Airlines, and American Trans Air because they or their regional affiliates do not operate RJs (as defined above).

To determine where those carriers operated their RJs, we analyzed historical data on airline traffic and current data on airline schedules. To obtain historical airline traffic data, we contracted with BACK Aviation Solutions (BACK), an aviation consulting firm, which obtains operational and financial information submitted by all U.S. airlines to the Department of Transportation (DOT). These data include the Origin and Destination Survey (O&D), based on a 10-percent sample of tickets containing itinerary and pricing information; T-100 on-flight data;[1] and 298C T-1 data, which supplement the T-100 data with data on commuter and small certified air carriers. BACK makes certain adjustments to these data, such as correcting recognized deficiencies in the air carriers' O&D data submissions, when these submissions have not met DOT's standard of 95-percent accuracy. To determine the carriers' scheduled use of RJs, we analyzed airline flight schedule information that we purchased from the Kiehl Hendrickson Group, an aviation consulting firm. We did not independently assess the reliability of the data we purchased from either BACK or the Kiehl Hendrickson Group. Finally, to determine the size of communities that have received or are scheduled to receive RJ service, we obtained information on the populations of metropolitan statistical areas from the U.S. Bureau of the Census. We used the latest available Census data, which at the time we did our work were estimates for 1998. We used the Bureau's definitions to assign each city to one of four population levels: "Small cities" are those with populations of less than 100,000. "Medium cities" are those with populations between 100,000 and 249,999. "Medium-large cities" are those with populations between 250,000 and 999,999. "Large cities" are those with populations of 1 million or more.

We determined the total number of cities to which airlines operated RJs, as well as the total number of markets. In the airline industry, markets are generally defined in terms of service between a point of origin and a point of destination. Thus, a market is often, but not always, defined as a city pair. Some cities, however, are served by more than one airport. In our counts of the number of markets served by RJs, we adopted the definition of a market as a city pair and included all airports that served a metropolitan area as serving that city. Thus, for example, in locations such as Chicago, we counted RJ service from some other city to both O'Hare

[1] 14 C.F.R. 241 prescribes the collection of scheduled service data from the domestic operations of large, certificated U.S. air carriers. The schedules submitted by the air carriers to DOT under this requirement collect nonstop segment data and on-flight market information by equipment type and by service class. This report is known as the "T-100" report.

International and Midway airports as RJ service to the Chicago market. The total number of markets served is greater than the number of cities because many spoke cities receive service from more than one airline—through different hubs. Competing airline networks and hubs create multiple markets. To eliminate markets that might receive less service than one flight per day for business days, we included only those that had a minimum of 20 RJ departures in October 2000. The definitions we used in our analysis are generally consistent with those used by other industry experts.

As part of our effort to determine the status of RJ deployments, we also determined how the type of service provided by carriers changed over time. Prior research had established six main categories for how service in markets may change with the introduction of RJs: establishment of new markets, mainline jet replacement, mainline jet supplement, turboprop replacement, turboprop supplement, and both mainline jet and turboprop supplement. Table 3 shows how each of those categories is defined.

Table 3: Categories of Service Change

Category of service change by RJ	Definition
New market	Airline had no RJ service within the last year.
Mainline jet replacement	Airline replaced all mainline jet service with RJ service.
Mainline jet supplement	Airline added RJ service to existing mainline jet operations, regardless of whether the airline maintained the previous level of mainline operations.
Turboprop replacement	Airline replaced turboprop service with RJ service.
Turboprop supplement	Airline added RJ service to existing turboprop operations, regardless of whether the airline maintained the previous level of turboprop operations.
Mainline jet and turboprop supplement	Airline added RJ service to existing mainline jet and turboprop operations, regardless of whether the airline maintained the previous level of operations.

Using these same categories, we examined RJ deployment in city-pair markets where carriers introduced RJs between January 1997 and October 2000,[2] and those RJs were still scheduled for service in October 2000.

To determine what factors have affected airlines' deployment of RJs, we interviewed officials from aircraft manufacturers, pilot unions, major airlines, and the Federal Aviation Administration (FAA) as well as industry experts and consultants. We interviewed airline officials to determine what criteria and processes they use in making deployment decisions. These officials also helped us understand the airlines' perspectives in pilot contract negotiations. Union officials provided the labor perspective on scope issues, as well as data on the airlines' uses of RJs. We interviewed FAA officials to determine whether infrastructure issues (e.g., airport runways and capacity) might have played a role in the airlines' deployment of RJs. Industry experts and consultants provided a third perspective on RJ deployment and pilot labor issues. In addition, we reviewed studies and documents provided by these officials, as well as documents and studies obtained through literature and Internet searches.

To determine the effect of RJs on congestion, we reviewed the limited number of available studies and consulted with a wide range of industry officials. To develop a list of relevant, comprehensive reports on RJs and congestion, we conducted a literature search and contacted industry officials. To identify industry experts, we relied on the recommendations of many knowledgeable industry officials. We interviewed officials from various sources, including the airlines, FAA (both headquarters staff and air traffic controllers in certain field locations), aviation industry consulting firms, and industry trade associations.

We conducted our work from March 2000 through February 2001 in Washington, D.C.; Seattle, Washington; and Dallas and Houston, Texas, in accordance with generally accepted government auditing standards.

[2] Because of data limitations, we could include information on Delta's RJ deployment only between June 1997 and Oct. 2000.

Regional Jets: Manufacturers, Characteristics, and Demand

The regional jets (RJ) primarily in service in the United States are manufactured by three companies: Bombardier, Embraer, and Fairchild Dornier.[1] Bombardier, a Canadian company, was the first to enter the U.S. market in 1993 with its 50-seat Canadair Regional Jet (CRJ). Embraer, which is headquartered in Brazil, entered the U.S. market in 1997 with its 50-seat ERJ-145 and in 1999 with its ERJ-135. Embraer is also developing the 44-seat ERJ-140. This plane is slated to enter service in the first quarter of 2001. Fairchild Dornier, which is based in Germany, first entered the market in 1999 with its 328Jet, the first 32-seat jet. Each of these companies also manufactures turboprops and is developing 70-seat RJs. These 70-seat aircraft are scheduled to go into service within the next 3 years. Table 4 lists some operating characteristics of these RJs. Figures 9 through 15 are photographs of the Bombardier, Embraer, and Fairchild Dornier RJs that are either now in service or proposed for U.S. commercial service.

[1] Boeing is considering building large (i.e., 70 seats or more) RJs by altering its 106-seat B-717 to accommodate 70 to 86 passengers. BAE Systems manufactures the Avro aircraft that the company describes as an RJ. These jets are designed to seat 70 to 112 passengers, and only one U.S. carrier—Northwest Airlines—is a customer. Northwest operates a 69-seat version of the Avro RJ85.

Table 4: RJ Operating Characteristics

Manufacturer and RJ model	Seating capacity	Range (fully loaded, in nautical miles)	Maximum operating altitude (in feet)[a]	Maximum cruise speed (in knots)	Take-off distance at sea level (in feet)
BAE Systems					
Avro RJ85	85-100	1,510	35,000	440	3,796
Bombardier					
CRJ200 ER	50	1,645	41,000	464	6,290
CRJ700	*70*	*1,685*	*41,000*	*473*	*5,130*
Embraer					
ERJ-135	37	1,700	37,000	450	5,577
ERJ-140	*44*	*1,630*	*37,000*	*450*	*6,463*
ERJ-145	50	1,550	37,000	450	7,448
ERJ-170	*70*	*1,800*	*41,000*	*470*	*5,500*
Fairchild Dornier					
328Jet	32-34	900	31,000	400	4,530
728Jet	*70-85*	*1,600*	*41,000*	*464*	*5,009*

[a]Embraer terms this operating characteristic the “service ceiling.”

Note: The information for the ERJ-140, CRJ700, ERJ-170, and 728Jet is italicized because these models are not yet in service in the U.S. and their specifications may therefore be preliminary.

Source: Manufacturers.

Figure 9: Bombardier CRJ200

Source: Bombardier.

Figure 10: Bombardier CRJ700

Source: Bombardier.

Figure 11: Embraer ERJ-135

Source: Embraer.

Figure 12: Embraer ERJ-145

Source: Embraer.

Figure 13: Embraer ERJ-170

Source: Embraer.

Figure 14: Fairchild Dornier 328Jet

Source: Fairchild Dornier.

Figure 15: Fairchild Dornier 728Jet

Source: Fairchild Dornier.

These manufacturers have significant backlogs for U.S. orders. For example, Bombardier has not yet delivered 47 percent of the U.S. orders for its 50-seat CRJ. Embraer has not yet delivered 54 percent of the U.S. orders for its 50-seat ERJ and 51 percent of the U.S. orders for its ERJ-135. Fairchild Dornier has not delivered 69 percent of the U.S. orders for its 328Jet. Table 5 presents the number of orders, options, and deliveries, together with the backlog for each aircraft type.

Table 5: U.S. RJ Orders, Options, Deliveries, and Backlog, by Aircraft Type

Manufacturer	Aircraft type	Seating capacity	Orders	Options	Deliveries	Backlog
Bombardier[a]	CRJ100/200	50	516	497	272	244
	CRJ700	70	112	218	0	112
Embraer[b]	ERJ-135	37	100	0	49	51
	ERJ-140	44	129	31	0	129
	ERJ-145	50	323	181	147	176
	ERJ-170	70	0	0	0	0
Fairchild Dornier[c]	328Jet	32-34	75	83	23	52
	728Jet	70-85	0	0	0	0
Total			**1,255**	**1,010**	**491**	**764**

Note: Orders, options, deliveries, and backlog are for orders placed by U.S. carriers only, including some airlines that are not flying RJs as code-sharing partners for major carriers. Orders by U.S.-based aircraft-leasing companies are not included. The ERJ-140 and the 70-seat RJs are not yet in service in the United States.

[a] Data for Bombardier are as of January 2001.

[b] Data for Embraer are as of November 2000.

[c] Data for Fairchild Dornier are as of January 2001.

Sources: Manufacturers.

To address their backlogs, Bombardier and Embraer planned to increase production of their aircraft. Bombardier planned to increase its CRJ100/200 production from 9.5 per month to 12.5 per month in the fall of 2001. This will allow the company to produce 135 aircraft in 2001-2002 and 150 aircraft in 2002-2003. Bombardier is building a new plant at Montreal's Mirabel airport to handle the final assembly of the CRJ700 as well as of the CRJ900 (a planned 86- to 90-seat jet). Embraer also planned to increase production of its RJs. The company expected to deliver 150 RJs in 2000 and nearly 200 in 2001.

U.S. Cities With Regional Jet Service as of October 2000

Cities	State	Airline and year RJ service started
Large cities		
Atlanta	GA	DL (1997), CO (1998), US (1999)
Austin	TX	DL (1999)
Baltimore	MD	HP (1998), CO (2000)
Boston	MA	DL (1997), US (1998), CO (1999), AA (2000), HP (2000)
Buffalo	NY	DL (1998), CO (2000), NW (2000)
Charlotte	NC	DL (1997), CO (1998), US (1998), NW (2000)
Chicago	IL	AA (1998), DL (1998), UA (1998), CO (1999), HP (1999)
Cincinnati	OH	DL (1997), AA (1998), CO (1998), NW (1998), US (1998), TW (2000)
Cleveland	OH	DL (1997), AA (1998), CO (1998), NW (1998), UA (2000)
Columbus	OH	DL (1997), AA (1998), HP (1998), UA (1999), US (2000)
Dallas	TX	AA (1998), CO (1998), NW (1999), DL (2000)
Denver	CO	UA (1999)
Detroit	MI	DL (1997), NW (1998)
Ft. Lauderdale	FL	DL (2000)
Grand Rapids	MI	DL (1997), AA (1999), NW (1999), US (1999), CO (2000)
Greensboro	NC	DL (1997), CO (1998), NW (1999)[a], AA (2000), UA (2000), US (2000)
Hartford	CT	CO (1998), HP (2000)
Houston	TX	CO (1998), DL (1998), AA (1999)
Indianapolis	IN	DL (1997), AA (1998), CO (1998), UA (1998), US (1999)
Jacksonville	FL	UA (1998), CO (1999), DL (1999)
Kansas City	MO	DL (1997), CO (1999)
Las Vegas	NV	DL (1997), HP (1999)
Long Island	NY	DL (1998), CO (1999)
Memphis	TN	DL (1997), AA (1999), CO (1999), NW (2000)
Miami	FL	DL (1997)
Midland/Odessa	TX	CO (1999), AA (2000)
Milwaukee	WI	DL (1997), AA (1998), CO (1998), US (1998), UA (2000)
Minneapolis	MN	DL (1997), CO (1998), NW (1998)
Nashville	TN	DL (1997), CO (1998), UA (1998), US (1999), AA (2000), NW (2000)
New Orleans	LA	DL (1997)
New York Metro	NY	DL (1997), CO (1998), HP (1998), AA (1999), UA (1999), US (1999)
Norfolk	VA	AA (2000), CO (2000), DL (2000), UA (2000)
Oklahoma City	OK	AA (2000), CO (2000), DL (2000), UA (2000)
Santa Ana (Orange County)	CA	DL (1997)

(Continued From Previous Page)

Cities	State	Airline and year RJ service started
Orlando	FL	DL (1997), CO (2000)[a]
Philadelphia	PA	DL (1997), HP (1998), US (1998), CO (1999), AA (2000)
Phoenix	AZ	HP (1997)
Pittsburgh	PA	DL (1997), CO (1998), NW (1998), AA (1999)
Portland	OR	DL (1997)
Providence	RI	CO (1999), DL (2000), UA (2000)
Raleigh/Durham	NC	DL (1997), CO (1998), UA (1998), US (1998)
Rochester	NY	DL (1997), US (1999), CO (2000), NW (2000)
Salt Lake City	UT	DL (1997)
San Antonio	TX	DL (1999)
San Francisco	CA	DL (1997)
St. Louis	MO	DL (1997), CO (1998), US (1998), NW (1999), TW (2000)
Tampa	FL	CO (2000)[a]
Washington	DC	DL (1997), UA (1998), US (1998), CO (1999), HP (1999)
Medium-large cities		
Akron/Canton	OH	DL (1997), UA (2000)
Albany	NY	CO (1999), UA (1999)
Albuquerque	NM	DL (1997)
Allentown	PA	DL (1997)
Appleton	WI	DL (1997), UA (1999), NW (2000)
Bakersfield	CA	HP (1999)
Baton Rouge	LA	AA (1999), CO (1999), NW (2000)
Birmingham	AL	DL (1997), US (1998), CO (1999), NW (2000), UA (2000)
Boise	ID	DL (1997)
Brownsville	TX	CO (1999)
Charleston	SC	UA (1998), CO (1999), DL (1999), US (1999), NW (2000), TW (2000)
Charleston	WV	DL (1998), UA (1998), US (1998)
Chattanooga	TN	DL (1997), AA (2000), NW (2000)
Colorado Springs	CO	DL (1997), CO (1999), HP (1999)
Columbia	SC	DL (1997), CO (1998), UA (1999), US (1999)
Corpus Christi	TX	CO (1998), DL (1999), AA (2000)
Dayton	OH	DL (1997), AA (1998), CO (1998), NW (1998), US (1999), TW (2000)
Daytona Beach	FL	DL (1999)
Des Moines	IA	DL (1997), HP (1997), AA (1998), NW (1998)
El Paso	TX	CO (1999), HP (1999)
Eugene	OR	HP (1999)
Evansville	IN	DL (1997), AA (2000)

(Continued From Previous Page)

Cities	State	Airline and year RJ service started
Fayetteville	NC	DL (1998)
Fayetteville	AR	AA (1998), DL (1999), NW (1999), TW (2000)
Flint	MI	NW (2000)
Fort Myers	FL	DL (1999)
Fort Wayne	IN	DL (1997), AA (2000), NW (2000), UA (2000)
Fresno	CA	HP (1997), DL (1998), UA (2000)
Greenville/Spartanburg	SC	DL (1997), CO (1998), UA (1998), AA (1999), NW (2000), TW (2000), US (2000)
Gulfport/Biloxi	MS	DL (1997), NW (2000)
Harrisburg	PA	DL (1997), NW (1999)
Huntsville/Decatur	AL	DL (1997), US (1998), AA (1999), CO (1999), NW (2000)
Jackson	MS	DL (1997), UA (1999), NW (2000), TW (2000)
Kalamazoo	MI	DL (1997), NW (1998), AA (1999), UA (2000)
Knoxville	TN	DL (1997), NW (1998), AA (1999), CO (1999), US (1999)
Lafayette	LA	CO (1998)
Lansing	MI	DL (1998)
Lexington	KY	DL (1997), NW (1998)
Little Rock	AR	DL (1997), US (1998), CO (2000), UA (2000)
Louisville	KY	DL (1997), CO (1998), US (1999), UA (2000)
Macon	GA	DL (1997)
Madison	WI	DL (1998), AA (1999), UA (1999), CO (2000)
Melbourne	FL	DL (1999)
Mobile	AL	CO (1998), DL (1999), UA (1999), NW (2000)
Monterey	CA	HP (1999)
Montgomery	AL	AA (1998)
Newburgh	NY	DL (1998)
Omaha	NE	DL (1997), AA (1999), CO (1999)
Pensacola	FL	CO (2000), NW (2000)
Peoria	IL	AA (1999), UA (1999), TW (2000)
Reno	NV	DL (2000)
Richmond	VA	DL (1997), AA (2000), CO (2000), US (2000)
Saginaw	MI	NW (2000)
Santa Barbara	CA	HP (1997)
Sarasota	FL	DL (1999)
Savannah	GA	CO (1998), UA (1998), DL (1999), US (1999), AA (2000)
Shreveport	LA	AA (1998), TW (2000)
South Bend	IN	DL (1997), NW (1998), AA (2000)
Springfield	MO	UA (1998), AA (2000), NW (2000)

(Continued From Previous Page)

Cities	State	Airline and year RJ service started
Syracuse	NY	DL (1997)
Tallahassee	FL	DL (1997)
Toledo	OH	DL (1997), AA (2000)
Tucson	AZ	HP (1999)
Tulsa	OK	DL (1997), NW (2000), UA (2000)
Wichita	KS	DL (1997), CO (1998), HP (1999), NW (2000)
Wilkes-Barre	PA	DL (1997), UA (1998)
Worcester	MA	DL (2000)
South Bend	IN	DL (1997), NW (1998), AA (2000)
Medium cities		
Abilene	TX	AA (1998)
Amarillo	TX	CO (1998), DL (2000)
Asheville	NC	DL (1997)
Billings	MT	DL (1997), UA (1999)
Bloomington	IL	AA (2000), NW (2000)
Burlington	VT	CO (1998), UA (1999), US (1999), DL (2000)
Cedar Rapids	IA	DL (1997), AA (1998), NW (1998)
Champaign/Urbana	IL	AA (2000)
Charlottesville	VA	DL (1998)
Columbus/Starkville	MS	DL (2000)
Duluth	MN	AA (1998), NW (1998)
Fargo	ND	NW (1999), UA (1999)
Fort Smith	AR	AA (2000)
Ft. Walton Beach	FL	DL (1997)
Gainesville	FL	DL (1998)
Green Bay	WI	DL (1998), NW (1998), AA (2000), UA (2000)
La Crosse	WI	NW (1998), AA (2000)
Lincoln	NE	TW (2000)
Lubbock	TX	CO (1998), AA (2000), DL (2000)
Manchester	NH	DL (1997), CO (1999)
Myrtle Beach	SC	DL (1997), CO (1999)
Panama City	FL	DL (1997)
Pasco	WA	DL (1997)
Portland	ME	UA (1998), CO (2000), DL (2000)[a], US (2000)[a]
Roanoke	VA	DL (1997), UA (1998)
Rochester	MN	NW (2000)
Sioux Falls	SD	UA (1999)

(Continued From Previous Page)

Cities	State	Airline and year RJ service started
Tri City Airport	TN	DL (1997)
Wilmington	NC	DL (1999)
Small cities		
Bangor	ME	DL (1999)
Bozeman	MT	DL (1997), UA (2000)
Butte	MT	DL (1997)
Casper	WY	DL (1997)
Durango	CO	HP (1999)
Grand Forks	ND	NW (1997)
Harlingen	TX	CO (2000)
Helena	MT	DL (1997)
Idaho Falls	ID	DL (1998)
Missoula	MT	DL (1997)
Rapid City	SD	DL (1997)
Traverse City	MI	AA (1999), NW (1999)
White Plains (Westchester County)	NY	DL (1997), CO (1998), NW (2000)

Airline Codes
AA — American Airlines
CO — Continental Airlines
DL — Delta Air Lines
HP — America West Airlines
NW — Northwest Airlines
TW — Trans World Airlines
UA — United Airlines
US — US Airways

Note: For 1997, the airline either started RJ service in that year or was already providing it before May 1997. For some cities, carriers may have provided less than 20 departures in October 2000.

[a]The carrier no longer provides RJ service to this city as of February 1, 2001.

Source: GAO's analysis of data from BACK Aviation Solutions, Kiehl Hendrickson Group, and the U.S. Bureau of the Census.

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