U.S Department
of Transportation

**Federal Aviation
Administration**

REPORT TO CONGRESS

LONG-TERM AVAILABILITY OF ADEQUATE AIRPORT SYSTEM CAPACITY

Washington, DC 20591 **June 1992**

DOT/FAA/PP-92-4

**Report of the
Secretary of Transportation
to the United States Congress
pursuant to Section 309
of the Airport and Airway
Safety and Capacity
Expansion Act of 1987
(P.L. 100-223)**

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

July 23, 1992

The Honorable Dan Quayle
President of the Senate
Washington, DC 20510

Dear Mr. President:

I am pleased to transmit the final report on the results of our study on long-term airport capacity needs as required by Section 309 of Public Law 100-223, the Airport and Airway Safety and Capacity Expansion Act of 1987.

This report summarizes the range of possible future demand for air transportation, and the implications for airport system capacity. We are continuing with an airport system capacity analysis and expect to gain additional insights as that work progresses.

Our studies to date, as summarized in the accompanying report, indicate that airport system capacity should be expanded and the pace of implementation should be accelerated in order to provide adequate facilities for the future. The initiative for airport construction is and should remain with State and local government and private entrepreneurs. However, the Federal Government is undertaking a variety of steps to encourage the provision of adequate airport capacity. Through these measures, we can proceed with the development of an adequate national airport system.

An identical report has been sent to the Speaker of the House.

Sincerely,

Andrew H. Card, Jr.

Enclosure

THE SECRETARY OF TRANSPORTATION

WASHINGTON, D.C. 20590

July 23, 1992

The Honorable Thomas S. Foley
Speaker of the House
of Representatives
Washington, DC 20515

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Executive Summary: This report is submitted in accordance with Section 309 of the Airport and Airway Safety and Capacity Expansion Act of 1987, which requires the Secretary of Transportation to conduct a study for the purpose of developing an overall airport system plan through the year 2010.

The report describes the probable extent of airport congestion in the future, given current trends. Specific proposals for airport development seldom extend more than ten years into the future, so the report relied heavily on the judgement of experts from various segments of the air transportation industry. Three assessment techniques were used, each based on a different analytical process. All three point to a persistent shortfall in capacity at some of the busiest airports as development lags behind the growing demand for air travel. Some of the shortfall may be corrected by improved technology and demand management to encourage more efficient use of available capacity. However, a significant gap will probably remain even if the current plans for these measures are implemented, and a major increase in the rate of airport development may be needed, together with measures to maximize the efficient use of existing capacity and, in the longer term, to supplement air transportation with high speed ground transportation.

Airport planning and development is a local responsibility, but the Federal Government is an important participant and can affect the course of the process. The Airport Improvement Program will provide $1.9 billion in Federal grants to aid airport planning and development during fiscal year 1992. Airports have the potential to collect up to $1 billion in additional revenues annually to finance development through a passenger facility charge. A number of former military airfields are being converted to civil use, and the Federal Aviation Administration and Department of Defense are working together to determine where additional civil use of military airfields is in the national interest. The FAA is working with other elements of the Department of Transportation to conduct airport planning in a multimodal, strategic framework. Other modes of transportation are being considered both for airport access and, in some cases, as an alternative to air travel in high density corridors. Consideration is being given to methods to encourage more efficient use of airport capacity through improved technology and economic and administrative measures. The FAA's 1991 strategic plan includes capacity strategies to guide agency actions over the next 20 years. The FAA will monitor the effectiveness of these activities in closing the capacity gap and will adjust or supplement them to meet the requirement for airport system capacity.

Chapter 1

Background

History: The Federal Aviation Administration (FAA) initiated a long-term airport system planning process in 1986, when it asked the Transportation Research Board of the National Research Council to consider the future need for airports and to outline a program for further study of airport requirements. The Transportation Research Board (TRB) issued a report in 1988 describing a serious problem with congestion and delay increasing sharply, principally at metropolitan airports, and delays rippling out into the entire air transportation system.

The report noted that delay might be lessened in the short term by making more efficient use of existing airports. However, the anticipated demand could not be met by increasing efficiency alone. Additional measures were needed, and TRB recommended a program to analyze the alternatives.

Concern about the long-term adequacy of the airport system led to a provision in the Airport and Airway Safety and Capacity Expansion Act of 1987 directing the Secretary of Transportation to prepare a plan to ensure the availability of adequate airport capacity through the year 2010. The FAA made an interim report in January 1989, relying on the initial work of TRB. This is the second and final report required by that legislation.

Relationship to the National Plan of Integrated Airport Systems: The FAA publishes the National Plan of Integrated Airport Systems (NPIAS) on a biennial basis. The NPIAS is prepared on a "bottom up" basis, by selectively compiling the recommendations in thousands of airport plans prepared by local, State, and regional agencies responsible for airport planning and development. The NPIAS reflects plans that have been adopted at the local level, and it is an indication of the type and amount of development that may be undertaken in the coming decade. This report incorporates information from the NPIAS and supplements it by estimating the long-term adequacy of airport system capacity from a national perspective and suggesting alternative strategies for meeting the future demand for air transportation.

Unique Features of Long-Term Planning: Planning is always a difficult activity, and doubt and risk of error increase as planners look far into the future.

Long-term plans often rely on qualitative, rather than quantitative, analysis. They indicate whether something will be very large or very small in the future, but do not attempt to give exact dimensions. Because unforeseen developments might affect predictions, planners make broad recommendations and provide flexibility to adjust for unanticipated developments.

One of the most attractive features of long-term planning is that it provides an opportunity for constructive leadership. Short-term plans respond to developments that have already occurred or are about to occur, and there is little that can be done to alter the course of events. However, long-term plans can predict how the future is most likely to develop, given current trends, and also suggest how those trends might be altered to provide a more desirable outcome.

Procedure: In order to provide the broadest range of advice and to compensate for the inherent inaccuracy of all forecasts, this report is based on three separate analyses, each conducted by a different group employing a different analytical approach.

The FAA conducted a statistical analysis of air traffic delay trends and the prospects for increased airport capacity. This concentrated on development likely to occur by 1998.

A second study, conducted by the consulting team of Apogee Associates and Hickling, estimated the risk that capacity will be inadequate at the busiest air carrier airports in the period from the years 2000 to 2030. Probability curves were developed for future peak hour demand and these were compared to forecasts of capacity under three scenarios, one with no change to current capacity, a second carrying through improvements that now seem likely, and a third very aggressive effort to expand capacity and divert some air travelers to ground transportation in short-haul, high density markets in order to relieve airport congestion.

The TRB, at the request of the FAA, assembled an expert panel to provide advice on alternative strategies for meeting the future demand for air travel, looking out to the year 2040. The panel was charged with examining long-term airport capacity needs and measures to meet them, formulating alternative strategies reflecting varying assumptions about the growth of air travel, technology, Government roles, and institutional arrangements, identifying advantages and disadvantages of these strategies, and recommending the most promising strategies for further study and evaluation by FAA.

Each of the three efforts made use of expert panels to provide a broad range of opinion and insight into airport capacity issues. The results are summarized in the following chapters.

Chapter 2

Near-Term Outlook

Approach: The material in this chapter was taken from the 1990-1999 National Plan of Integrated Airport Systems (NPIAS). It describes the current and near-term situation with regard to airport congestion and air traffic delay.

Source of Delay Data: The data in this chapter are derived from the Standardized Delay Reporting System. Three major airlines, that together account for about 25 percent of all air carrier operations, report the delay encountered by four phases of flight. Delay is defined as the difference between actual flight time and what might have been achieved in the absence of other aircraft in the system or problems with equipment outages or severe weather. This system has been used by the FAA for airport planning and policy analysis because it provides fairly complete information about delay and can be forecast based on changes in air traffic and runway capacity at individual airports. However, the data may not be representative of all carriers under all conditions. The FAA is developing an improved aircraft delay data system to provide a single, integrated source of data to answer most analytical questions about delay at a detailed level.

Airport Congestion: Congestion is described in this report in terms of the average delay per aircraft operation. This approach is widely used by airport planners and designers, who generally attempt to keep average delay below four minutes per operation. The highest average delay experienced at the most congested airports is in the range of ten to twelve minutes per operation. In this chapter, an average delay of seven minutes per aircraft operation is used as the threshold to categorize congested airports. When delays exceed this figure, service becomes increasingly unreliable, and the situation is stressful for airline management, passengers, and air traffic controllers.

Severe air traffic delay can be explained largely by a gap between the capacity of an airport's runway and taxiway system (the airside) and the demand that is imposed on it, particularly during adverse weather conditions when instrument flight rules are in effect. Aircraft delays in excess of 15 minutes during 1991 were attributable to the following causes: weather-65.5%; traffic volume-26.7%; runway and taxiway closing-3.4%; electronic equipment outages-1.9%; and other events 2.5%. Relatively few airports are congested, but they account for a large share of total air travel. In 1990, 26 of the Nation's 100 busiest airports experienced an estimated average delay in excess of seven minutes per operation (an operation is either a landing or a takeoff), and those airports accounted for almost one-half of all enplaned passengers. Only one of the Nation's ten busiest airports had an estimated average delay below seven minutes, and that was Miami International Airport with a 6.9 minute average.

Delay is troublesome from a number of perspectives. A few minutes of delay at the beginning and end of every flight accumulates to billions of dollars of added expense annually to airlines for fuel, equipment, and personnel. Passengers are more concerned about the loss of reliability when an airport becomes congested.

Delay poses a special problem to air traffic controllers who must ensure safe separation among aircraft that are waiting to land. A certain amount of delay can be absorbed in the vicinity of an airport by slowing arriving aircraft or routing them on circuitous paths, but lengthy delay requires special measures to ensure that congestion in terminal airspace does not back up into the en route system and delay flights to other airports. The FAA's Air Traffic Control System Command Center in Washington, D.C., works with air traffic controllers, meteorologists, and airline flight dispatchers to anticipate when an airport's capacity is likely to fall short of demand because of adverse weather, construction, or other causes. The flow controllers coordinate with users to adjust demand by delaying flights en route or holding them on the ground until they can be accommodated at the congested airport. The flow control process has been very effective at reducing airborne holding in terminal areas and minimizing fuel consumption, but it is only a method for coping with congestion, not a solution to the problem.

Trend/Forecast: The demand for air transportation, measured in air carrier revenue passenger miles, is forecast to grow by an average of 4.9 percent annually from 1992 through 2003. Some of this will be accommodated by larger aircraft and higher load factors, but aircraft operations are still expected to increase by 1.9 percent annually during that period, and this increase will aggravate congestion. The number of major airports with average delay in excess of seven minutes could increase from 26 in 1990 to as many as 58 by the year 2000, if the runway capacity at those airports is not increased or used much more efficiently. Some of the increased demand may be shifted to new or improved intercity surface transportation service. However, a substantial increase in airport capacity is almost certain to be necessary.

Non-Capital Alternatives: The forecast of increased congestion takes into account the continued application of certain measures, termed noncapital alternatives, that reduce delay without substantial investment.

One measure is the redistribution of traffic to smooth out peaks that occur because of traveler preferences for morning and evening flights. Schedules tend to peak sharply at an uncongested airport, but this is reduced as traffic increases and more frequent service fills in the nonpeak hours. A few very busy airports have about the same number of flights scheduled during each of the daylight and evening hours. Peak and off-peak pricing is one means to redistribute some portion of the peak traffic loads that occur because of the popularity of morning and evening flights. Variable pricing systems are used by the airline industry to encourage passengers to travel during off-peak periods. While it is not practical to expect to eliminate peaking entirely, busy airports might reduce delays and improve efficiency by applying congestion pricing, which provides an economic incentive for the users of the airport to spread demand more evenly over the airport's normal operating hours. Congestion pricing is not a substitute for necessary airport capacity improvements but it may help to decrease traffic demand during peak times, improve off-peak airport utilization, and generally encourage more efficient use of existing airport capacity.

Another measure is to redistribute traffic among airports to make more efficient use of facilities. Reliever airports have been developed in metropolitan areas to give general aviation pilots an attractive alternative to using congested airline airports. Large cities usually have a system of reliever airports, one or more of which can accommodate corporate jet aircraft and others designed primarily for use by smaller, propeller-driven aircraft. Relievers have been very successful at relocating general aviation activity, which accounts for 65 percent of the operations at all airports with air traffic control towers, but only 4 percent of the operations at O'Hare, 3.5 percent of the operations at Atlanta Hartsfield, and 7.6 percent of the operations at LaGuardia Airport. Twenty-nine percent of the general aviation aircraft in the United States are based at the 285 reliever airports.

The FAA has considered the possibility of developing a national system of large airports (wayports) to be used primarily for transferring passengers and cargo in order to relieve congestion at Chicago, Atlanta, Dallas, and other transfer hubs. The FAA has concluded that this type of transfer airport is not feasible today because the airlines intend to continue conducting transfer operations in highly populated areas that generate substantial numbers of originating passengers. Wayports and remote transfer airports are not feasible operationally or financially at this time. However, the FAA is keeping an open mind about their future practicality. The FAA will monitor the situation in the event that new developments improve the outlook for wayports, but there are no plans to implement the concept in the foreseeable future.

A measure that provided great increases in runway efficiency in the past was the use of larger aircraft, particularly at congested airports, in order to move more passengers per operation. Between 1972 and 1988, there was a 78 percent increase in the average number of passengers per aircraft operation nationwide, and a 60 percent increase at large hub airports (see Table 1). The increase in aircraft size has slowed since deregulation, as airlines concentrated on more frequent service and connections at hub airports, for which smaller aircraft are preferred. The increase in aircraft size is also constrained by the design of many airports. The distance between adjacent taxiways and runways and the layout of terminal buildings can limit wingspans and fuselage lengths, and the strength of pavement and underlying structures such as bridges and culverts can limit aircraft weight. Because of these factors, future increases in aircraft size may be more gradual and expensive to accommodate, particularly at older and more congested airports.

TABLE 1
ACTIVITY AT LARGE HUBS

	Large Hubs			National Average
Calendar Year	Enplaned Passengers	Air Carrier Departures	Passengers/ Departure	Passengers/ Departure
1972	124,497,086	2,581,972	48.2	38.0
1975	131,277,693	2,472,756	53.1	42.5
1980	197,679,376	2,887,239	68.5	55.7
1985	264,507,144	3,439,446	76.9	66.9
1988	321,754,139	4,201,615	76.6	67.8

Approach Procedures: Over two-thirds of delays in excess of 15 minutes occur during adverse weather conditions, when more restrictive approach procedures require greater separation between aircraft. The FAA is working on a variety of new capacity-enhancing approach procedures to reduce the variation in runway capacity under different weather conditions.

Certain improvements can be made with little or no airport investment. Recent studies have shown that the minimum diagonal separation between aircraft making dependent approaches to closely spaced runways may be reduced from 2.0 to 1.5 nautical miles, permitting up to 14 additional arrivals per hour. At some locations, the minimum longitudinal separation between certain classes of aircraft in a single approach stream has also been reduced from 3.0 to 2.5 nautical miles. Work is underway to expand the range of weather conditions in which instrument approaches can be made to converging runways. Converging approaches are now limited under instrument conditions, but research indicates that there may be room for improvement.

Additional improvements in runway capacity during instrument weather are expected as the result of improved sensors and approach aids. Demonstrations are underway to test the viability of simultaneous independent instrument approaches to runways less than 4,300 feet apart, monitored by an improved surveillance system. The installation of Microwave Landing Systems (MLS) will provide greater flexibility in making instrument approaches, particularly to airports in congested metropolitan areas.

Growth: A community's attitude toward growth and its eagerness to attract airline service can determine the scope and adequacy of its airport plan. This is particularly apparent in resort areas, where attractive and uncongested facilities are expected by tourists. Resorts are responsive to the preferences of travelers. Delays at Las Vegas are well below the national average, largely because of the prevalence of good flying weather, but also because of aggressive airport improvement programs. A new parallel runway was opened recently in Orlando, and a site is being prepared for a fourth parallel runway. Other resort areas such as Miami, New Orleans, and San Diego, have new airports under consideration, and a new airport is being built in Denver. Resorts often consider the airport to be the gateway to the community, and they tend to provide attractive and spacious terminal buildings as well as ample runway capacity.

Other cities have become more interested in airport expansion during the past ten years because of airline hubbing. At a hub airport, an airline brings together as many as 50 flights in order to provide passengers with extensive transfer opportunities. Hubbing requires a considerable amount of airport and airspace capacity, but many cities welcome hubbing because it also creates thousands of jobs, provides the host city with frequent flights to all of the major U.S. cities, and often supports a city's role as a regional commercial center. Hub operations in Atlanta, Charlotte, Dallas/Ft. Worth, Denver, Minneapolis, and St. Louis have stimulated economic growth and vitality in those cities. Hub cities tend to be alert to the importance of providing adequate facilities. Most of the busiest hubs are considering development to expand the existing airport or to provide a new airport (see Table 2). The success of these plans is not certain, but they are a positive sign.

TABLE 2
IMPROVEMENTS PROPOSED FOR MAJOR HUBS

Hubs	Hubbing Airlines	Improvements
Atlanta	Delta	New Airport/ New Runway
Charlotte	USAir	New Runway
Chicago	American/United	New Airport/ New Runway
Dallas/Ft. Worth	American/Delta	New Runway
Denver	United/Continental	New Airport
Detroit	Northwest	New Runway
Memphis	Northwest	New Runway
Minneapolis	Northwest	New Airport/ New Runway
Pittsburgh	USAir	New Runway
St. Louis	TWA	New Runway

On the other hand, older and larger cities tend to be as concerned about the problems associated with airport expansion, such as noise and ground access congestion, as they are about air traffic delay. These cities, particularly in densely populated coastal areas, are not in danger of losing air service. Their huge passenger markets are magnets for air transportation, and airlines will continue to compete for access to them despite congestion and delay. The opportunities to expand airports or to build major new ones are limited by a lack of suitable sites because most land has already been developed for residential or commercial use or has been reserved for conservation and recreation. As a result, plans for the large coastal regions are often inadequate to meet the rising demand for air transportation.

Effect of Planned Development: The FAA is aware of local plans to build new runways at 42 of the 100 busiest airports. The effects of the projects vary with the level of congestion and rates of growth at individual airports.

Some of the most dramatic improvements are expected at hub airports where new runways are planned to keep pace with rapid increases in airline activity. New runways at Nashville, Cincinnati/Covington, Baltimore/Washington, Dulles, Raleigh-Durham, and Salt Lake City are expected to reduce the average delay expected in 1998 by 33 percent. An even greater improvement is expected at certain resort areas, including Fort Myers, Orlando, and Las Vegas, where new runways will reduce expected delays in 1998 by 60 percent.

Major improvements are more difficult at the largest and most congested airports. Site limitations and congested airspace make it difficult to utilize new runways fully. Many of the major airports serving large population centers would benefit from the construction of new runways, but only a few are expected to be built within the next ten years. In addition to the runways that are planned for Baltimore/Washington and Dulles, new runways have been proposed for Philadelphia and San Francisco. A variety of environmental, engineering, and financial issues must be resolved before these runways are built. Because of congestion in the airspace around these airports, it is difficult to estimate the effect of the proposed runways on the overall reduction of delay.

TABLE 3 - AIRPORTS WITH AVERAGE DELAYS EXCEEDING SEVEN MINUTES PER OPERATION

1988

	ABQ	Albuquerque
1/	ATL	Atlanta
	BDL	Bradley
	BNA	Nashville
1/	BOS	Boston Logan
	BUR	Burbank
	DAY	Dayton
1/	DCA	Washington National
1/	DEN	Denver
1/	DFW	Dallas/Ft. Worth
1/	EWR	Newark
	HOU	Houston Hobby
1/	IAD	Washington Dulles
1/	JFK	JFK International
1/	LAX	Los Angeles
1/	LGA	LaGuardia
	LGB	Long Beach
1/	MCO	Orlando
	MDW	Chicago Midway
1/	ORD	Chicago O'Hare
1/	PHL	Philadelphia
2/	PVD	Providence
	RDU	Raleigh-Durham
1/	SFO	San Francisco
	SNA	Santa Ana
1/	STL	St. Louis
2/	STT	Charlotte Amalie

Additional Airports in 1998

2/	BWI	Baltimore
2/	CHS	Charleston, SC
	CLE	Cleveland
	CMH	Columbus
	CVG	Cincinnati
2/	ELP	El Paso
	FLL	Fort Lauderdale
	GRR	Kent County Int.
	HNL	Honolulu
	IND	Indianapolis
	ISP	Islip
2/	LAS	Las Vegas
	MCI	Kansas City
	MIA	Miami
	MKE	Milwaukee
	MSP	Minneapolis
	OAK	Oakland
	OMA	Omaha
	ONT	Ontario
	ORF	Norfolk
	PBI	West Palm Beach
	PHX	Phoenix
	PIT	Pittsburgh
	RIC	Richmond
	RNO	Reno
	ROC	Rochester
2/	RSW	Fort Myers
	SAN	San Diego
	SJC	San Jose
	SLC	Salt Lake City
2/	SYR	Syracuse
2/	TUS	Tucson

1/ Locations where total annual delays to air carrier aircraft exceeded 20,000 hours in 1988.

2/ Locations where proposed development will reduce average delay below seven minutes in 1998.

When site restrictions, airspace considerations, and concern about aircraft noise rule out the expansion of an existing airport, new airport construction is an alternative. The new airport now under construction in Denver, to replace Stapleton International, is expected to reduce average delays forecast for Denver in 1998 by 40 percent, and an even greater improvement is possible if additional planned runways are added. Planning studies are underway for airports to supplement Chicago O'Hare and Boston Logan, but plans have not advanced to the point where capacity and delay projections can be made. In-house studies by FAA suggest congestion problems will remain in such areas as New York and Philadelphia, and additional planning will be warranted there.

Federal Action. The FAA has a variety of programs underway to cope with and help resolve airport congestion. These programs are discussed in the FAA's Aviation System Capacity Plan, most recently issued in September 1990.

The FAA participates in capacity design teams at major airports to consider measures to relieve congestion. The original design teams concentrated on short-term, low-cost measures, but the process has been expanded to include new runways and reallocation of airspace. The FAA is conducting research into ways to increase the capacity of existing runways, using new technology, improved instrumentation, and other techniques. The FAA also provides grants for master plan studies at major airports and gives a high priority to applications for Federal aid to relieve airport congestion. A number of planning studies are underway with Federal aid in major cities where new airports are needed, such as Boston, Chicago, Miami, and San Diego. Where acceptable sites for new airports are not available, the FAA is meeting with the Department of Defense to consider civil use of military airfields and conversion of closed military airfields for civilian use. High level staff positions have been established in the FAA's regional offices to deal with airport capacity issues and to help airport sponsors evaluate alternative measures for relieving congestion.

Chapter 3

Medium and Long Term Risk Analysis

Approach: A trend forecast was used in the preceding chapter to describe the near-term outlook, assuming that the relationship between demand, capacity, and delay would remain unchanged during the coming decade. More complex procedures are needed to take into account the changes that might occur farther out in the future. A probability-based mathematical technique was used to estimate the risk that capacity will fall short of demand at major airports 10 to 40 years in the future. The technique was developed specifically to provide numerical estimates of conditions far in the future. Many variables were taken into account, and allowance was made for the uncertainty of forecasts and the possible shift of some air travel to other modes.

Two mathematical models were developed: one to forecast air travel demand at major airports for the years 2000, 2010, 2020, and 2030, and the other to forecast hourly runway capacity at those airports for the same years. The forecasts were prepared for a "representative" airport that would represent the typical situation at the 29 busiest commercial service airports.

Forecasts: Each demand and capacity forecast was itself based on a number of other variables. For example, demand forecasts considered gross national product, average airline fare or yield, price elasticity, the distribution of demand among the different size airports, the effect of competing transportation modes, and average aircraft size. Demand forecasts were stated in terms of operations per peak hour.

Capacity was estimated as a function of current operating conditions, number of runways, variations due to weather, and likely increases due to air traffic control improvements and procedural changes. Capacity forecasts were expressed in operations per hour.

Each variable--yield, aircraft size, degree of peaking, etc.--was entered as a range of possibilities rather than a single expected value. A panel of experts in aviation forecasting and related disciplines provided advice on the values to be used.

The models were used to quantify three separate scenarios or combinations of future policies and developments in the air travel sector; baseline, mid, and low. The scenarios differed in the type and level of capacity-enhancing measures assumed to be implemented.

The baseline scenario assumed that the principal determinant of demand, gross national product (GNP), would increase at 2.5 percent annually throughout the forecast period, and the rate of increase in enplanements would be 1.7 times that of GNP at the beginning of the forecast period and gradually decline to the same rate as GNP in 2030. Capacity at representative airports was held constant in the baseline scenario with few, if any, new runways or airports.

The mid-congestion scenario incorporated improved air traffic control technology currently in the experimental or case study stages and runway construction already under consideration, combined with demand management and the implementation of alternative travel modes to reduce air travel. This scenario is intended to represent the future as it is most likely to develop if current trends in air travel and airport development remain relatively unchanged.

The low congestion scenario used upper bound estimates of the impacts of capacity enhancement and demand management to produce an extremely optimistic forecast. It includes extensive new runway and airport construction, larger aircraft, peak-hour pricing, and diversion of some short haul air passengers in heavily traveled markets to highway or rails to minimize congestion and air traffic delay.

Net capacity was computed for each scenario and each benchmark year as the difference between projected hourly operations demand and anticipated hourly capacity. The model produced a range of estimates (probabilities) for net capacity under each scenario.

Risk: Statistically, the mean value for each outcome is the average or "expected" value of all possible outcomes, but it is not a guaranteed outcome. Plans made under the mean forecasts would meet needs approximately half of the time, they would also fall short of meeting needs half of the time.

Planners may choose to minimize the risks of being caught short and plan so that there is a better chance to meet expected demand. The trade off of this approach is that scarce resources may be allocated to building unneeded capacity at certain locations while higher priority needs go unmet. Thus, in addition to computing mean values for demand, capacity, and net capacity, the models were used to estimate "risk-averse" planning positions for each. In other words, these values answer the question: At what point are 80 percent of eventualities covered?

Capacity: Table 4 summarizes the results of the analysis in terms of the difference between projected capacity and demand during the peak hour, or busiest hour of the average day. The expected value is the "average" situation, one in which estimates are just as likely to be too optimistic as too pessimistic. The "risk-averse planning basis" presents the levels that must be considered in planning if officials want to be 80 percent sure of their forecasts. That is, the model indicates that there is an 80 percent probability that net shortfall will not be any worse than this figure.

Under the low congestion scenario, it is expected that capacity will be slightly more than sufficient for demand, with a surplus of ten operations per peak hour at the representative airport by 2030. Projection at the lower end of the probability distribution (the risk-averse position) indicates that there is a 20 percent chance that demand could outstrip capacity by 40 operations per peak hour in 2030.

TABLE 4 - CAPACITY SHORTFALL AT A REPRESENTATIVE AIRPORT

(OPERATIONS/PEAK HOUR)

	Expected/Mean Value			Risk-Averse Planning Basis		
	Congestion Scenario			Congestion Scenario		
Year	Baseline	Mid	Low	Baseline	Mid	Low
2000	35	14	(6)	50	30	13
2010	67	27	(0)	92	54	28
2020	93	23	(10)	133	58	25
2030	118	28	(10)	174	74	40

Note: Value in *brackets* indicates net surplus, during the peak hour of the day, measured in aircraft operations. The surplus is the amount by which the capacity of the runways is expected to exceed air traffic demand.

Policy Implications and Potential Solutions: A continuing shortfall in capacity is likely at the Nation's major airports, and no single measure is likely to resolve it. Even under the most optimistic assumptions, there is a chance that the busiest airports will be unable to satisfy peak-period demand in future years. However, the likelihood of meeting needs can be enhanced by policies to mitigate demand and expand capacity. The difference between the baseline and mid-congestion scenarios is due to assumptions concerning demand management, diversion of some travelers to other modes, technological innovation, and moderate construction of new runways. These are likely to occur if the industry continues to pursue the same development policies as it has in the past.

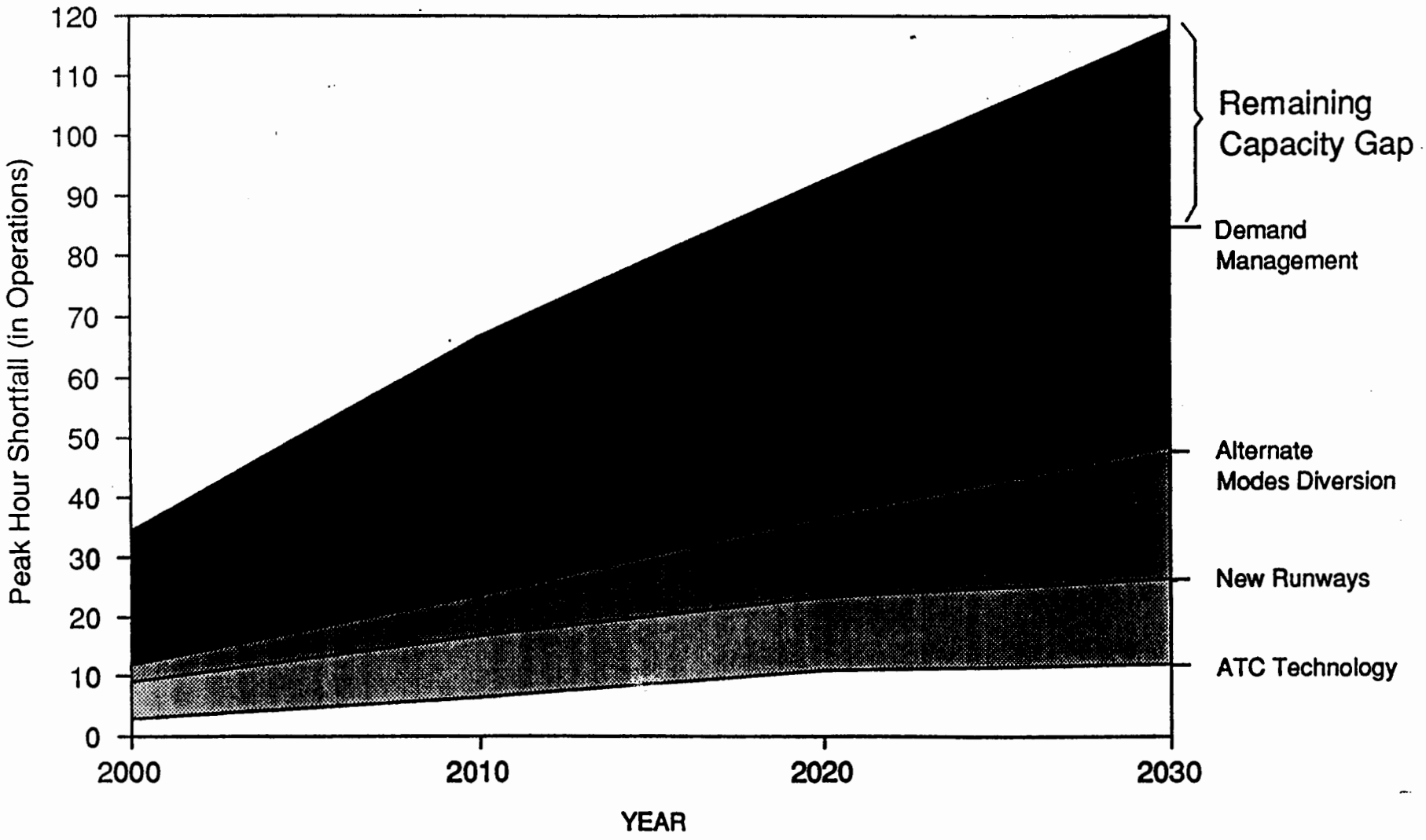
The importance of these factors in closing the potential capacity gap is illustrated in Figure 1, which describes the difference between the expected/mean values for the baseline and mid-congestion scenarios. The uppermost line is the baseline peak-hour shortfall at a representative major airport (baseline congestion, expected/mean value); i.e., demand grows at a steady rate in line with gross national product growth and capacity is held to 100 operations per hour. The various segments in the baseline below represent the opinion of an expert panel regarding the contribution of various options toward meeting the shortfall in peak hour capacity. The bottom segment is the increase in hourly operations likely to result from the use of improved air navigation facilities and related changes in air traffic control rules. By the year 2030, these improvements could be equivalent to a capacity expansion of 12 operations per hour at the representative airport; i.e., an increase of 12 percent in base capacity. Adding new runways shown on long-range plans could further increase capacity by an average of 14 operations per hour by 2030.

The gains from air traffic control and the new runways that are currently proposed fall short of meeting projected peak hour capacity requirements. More substantial, in the long range, is the diversion of air travelers to other modes. This includes highway travel and the use of conventional high-speed rail or maglev. Another possible alternative is tiltrotor aircraft or other types of aircraft that can land at special-use areas near major population centers, avoiding congested airports. These alternate modes are most promising for trips of less than 500 miles in densely traveled corridors such as the northeast corridor.

The final measure is demand management. This could involve a variety of economic and administrative steps to encourage traffic to be distributed evenly over time, to adjust demand when adverse weather reduces airport capacity, to ensure that aircraft operations are efficiently distributed among available airports, to encourage the use of larger aircraft, and to locate hubbing operations at uncongested airports.

FIGURE 1

Options to Meet Projected Shortfall in Peak Hour Capacity



This combination of measures offers a 50 percent chance of meeting most of the increased demand for air transportation, closing the gap from 118 to 28 operations during peak hour at a typical large airport in 2030. However, there is a 20 percent chance that the shortfall could be as high as 74 operations. This indicates that, if the Nation wants to avoid the risk of severe capacity shortfalls and lengthy air traffic delays, additional improvements will be needed, over and above what is already expected to occur. The development needed to provide capacity for another 28 to 74 operations was not specified in the study, but it is equivalent to a requirement for one or two major new runways at each of the Nation's busiest airports; say, the top 25 airports.

Chapter 4

Strategies for the Future

Approach: The Transportation Research Board (TRB) of the National Research Council, at the request of the FAA, assembled an expert panel to provide advice on alternative strategies for meeting the future demand for air travel. The panel was charged with:

1. Examining long-term airport capacity needs and measures to meet these needs.
2. Formulating alternative strategies reflecting varying assumptions about the growth of air travel, technology, Government roles, and institutional arrangements.
3. Identifying advantages and disadvantages of these strategies.
4. Recommending strategies for further study and evaluation by FAA.

The panel adopted an approach that emphasized qualitative rather than quantitative analysis. It began with identification of an array of actions that could be taken to meet future demand. Called options, these actions constituted the building blocks used later to construct strategies.

Seven strategies, made up of various combinations of options, were devised. These strategies ranged from an approach consisting solely of incremental improvements at existing facilities to sweeping programs of new airport construction, system management, and application of advanced transportation technology.

The ability of these strategies to meet future demand was assessed qualitatively under three growth scenarios that embraced a range of plausible assumptions about the state of the economy, the cost of air travel, propensity for travel, and technological innovation in air and surface transportation. These scenarios were designated high growth, maturing economy, and economic difficulty.

The TRB indicated that no single approach should be selected for the long-term development of the airport system. A range of alternatives must be kept open until future needs become better defined and financial and technological capabilities are determined. However, the TRB was able to narrow the field and suggest three strategies that appear most promising at this time.

Options: The options presented by TRB are building blocks that could be used in various combinations to devise a long-term strategy for ensuring adequate airport capacity. They include measures to upgrade or add airport infrastructure, manage system use, and develop new transportation technology.

Option 1. Make incremental capacity improvements at existing airports. This is a practical, relatively low cost, short-term measure that could be undertaken to alleviate capacity problems at specific sites. A major objective of this option would be to reduce the gap between IFR and VFR capacity and mitigate the disruptive effect of adverse weather.

Option 2. Create new hubs at presently underused airports. This would take advantage of the excess capacity available at these sites. By utilizing these airports as new secondary hubs for airline operations, it might be possible to accommodate some of the growth in air travel demand over the short term (up to ten years) without adding appreciably to the congestion and delay now experienced at the busiest transfer hub airports.

Option 3. Add new airports in metropolitan areas with high traffic volume. This would provide capacity increases at the points of highest present traffic concentration. The problems of implementation could be very great, however, because such projects are likely to encounter strong local opposition on the grounds of noise, community disruption, competing land use, and cost.

Option 4. Develop new airports dedicated to serving as transfer points, eventually separating transfer traffic from origin-destination traffic at major metropolitan airports. In theory the transfer airport would be an approach to accommodating very large increases in air travel demand that might materialize in the early decades of the next century. The TRB committee expressed reservations about this concept because it is untried and it has not been analyzed adequately to determine its feasibility and practical effect on airport system capacity.

Option 5. Manage demand by administrative and regulatory techniques. This would accommodate growing demand without substantially increasing airport capacity. The purpose of this option is to distribute demand in a way that makes more efficient use of the airport capacity available at any given time. This has been achieved to some degree at four airports, (LaGuardia, John Fitzgerald Kennedy, O'Hare and Washington National), under an FAA rule that limits the number of aircraft operations during peak hours. While it might be effective, the TRB committee believed that extensive regulatory control of capacity would be difficult to impose and quite controversial. The TRB committee had reservations about the practicality and public acceptance of a regulatory approach.

Option 6. Employ economic measures to redistribute demand in a market-based approach to allocating scarce resources. This approach is preferable in the committee's view to administrative methods of demand management because of its consistency with the policy of a deregulated airline industry.

Option 7. Promote development of new aviation technology which would lead to the introduction of new aircraft and air traffic control technology that could improve operating efficiency, reduce operating cost, and allow new forms of service. There are risks that efforts to develop improved air traffic surveillance equipment and computer aided control techniques might not succeed, or that the air transportation industry might not accept and implement these improvements. However, the capacity gains possible from improved technology may be less costly than building new airport infrastructure.

Option 8. Develop high-speed surface transportation technology which could lead to the introduction of new high-speed line-haul surface transportation systems to serve as substitutes or supplements for air travel, especially in the range of 200 to 400 miles. The barriers to such systems now are both technical and economic. This could change as technology advances as the patterns of urbanization and population growth cause major metropolitan areas to expand and the volume of intercity travel to increase. It appears likely that the development of advanced surface transportation technology (rail, magnetic levitation, or highway) will be driven by general urban and intercity travel demand and not by air travel alone.

Strategies: A total of seven strategies were examined in the course of the TRB study (see Table 5). These strategies, composed of the options outlined above, were formulated to provide different approaches to accommodating both short-term increases in intercity travel and demand for airport capacity (through the year 2000) and long-term growth that could materialize by 2040.

All strategies are based, at least for the short term, on incremental capacity improvements at existing airports (Option 1) and establishment of new secondary hubs at presently underused airports (Option 2). The panel concluded that these two options are essential while longer-term solutions are being considered and implemented.

Strategy A. Continue on Present Course. This strategy consists solely of Options 1 and 2 supplemented on a local and highly selective basis by administrative management of demand (Option 5) as a measure of last resort at extremely congested airports where no other form of relief is available. This strategy, although adequate for the short term, probably would not be sufficient to accommodate even the lowest rate of demand growth assumed for the period 2000 to 2040.

Strategy B. Build More Airports. This strategy includes, in addition to Options 1 and 2, building 10 or so large new airports to serve the centers of heaviest traffic concentration in the next century (Option 3). As in the previous strategy, administrative demand management would be applied in very limited fashion as a stopgap or measure of last resort. This strategy might prove adequate to handle levels of future demand perhaps double that of today, but it depends heavily on achieving community acceptance and support for building new facilities equivalent in size to the largest airports in this country today. To rely on this strategy exclusively would be risky, but it should not be rejected since it is the strategy that is most consistent with the historical course of airport system evolution in this country.

The remaining five strategies (C through G) represent long-term approaches that include a balance of several options. They do not rely exclusively on any single type of solution. They address congestion and delay as system problems to be dealt with by a coordinated program of airport congestion, system management, and new air and surface transportation technology. The strategies differ primarily in the relative emphasis placed on these three kinds of solutions.

Strategy C relies on centralized system management through administrative and regulatory methods to attain efficient use of existing facilities and to promote research on new transportation technology. Strategy D extends the centralized management approach beyond allocation of scarce capacity to include a lead role for the Federal Government in planning the development of new airport infrastructure and in promoting development and deployment of new transportation technology. Strategy E employs a market-based approach to achieve the same objective as Strategy D. Strategy F involves restructuring the airport network to segregate transfer from origin-destination traffic and promoting the development of technology appropriate to operation of this kind of system. Strategy G emphasizes development and deployment of revolutionary new air and surface transportation technology. All of these strategies involve broad new approaches to meeting long-term airport capacity needs and intercity travel demand. Each entails a departure from present policy and the traditional role of the Federal Government with respect to airport development and overall system planning and management.

TABLE 5
OPTIONS AND STRATEGIES

STRATEGIES	OPTIONS		
	INFRASTRUCTURE	SYSTEM MANAGEMENT	NEW TECHNOLOGY
A. Continue on present course	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports	5. Administrative and regulatory techniques (limited and temporary)	7. Air 8. Surface } Present level of federal R&D
B. Build more airports	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports 3. New airports in metropolitan areas with high traffic volume	5. Administrative and regulatory techniques (limited and temporary)	7. Air 8. Surface } Present level of federal R&D
C. Centralize system management	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports	5. Administrative and regulatory techniques to manage and allocate existing capacity	7. Air 8. Surface } Expanded federal R&D
D. Build an expanded, centrally managed airport system	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports 3. New airports in metropolitan areas with high traffic volume	5. Administrative and regulatory techniques to manage existing capacity and to plan and allocate new capacity	7. Air 8. Surface } Expanded federal R&D
E. Let the Market Decide	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports 3. New airports in metropolitan areas with high traffic volume	6. Economic measures to manage and allocate existing capacity and to plan and allocate new capacity	7. Air 8. Surface } Expanded private-sector R&D
F. Reconfigure the airport system	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports 4. New airports dedicated to serving as transfer points	5. Administrative and regulatory techniques to manage existing capacity and to plan and allocate new capacity	7. Air 8. Surface } High level of federal R&D (including demonstration projects)
G. Revolutionize intercity transportation technology	1. Incremental capacity improvements at existing airports 2. New hubs at presently underused airports	5. Administrative and regulatory techniques and 6. Economic measures to manage existing capacity and to plan and allocate new capacity	7. Air 8. Surface } All-out government and industry effort to develop and deploy new technology

The strategies were tested against a variety of possible future scenarios involving different degrees of economic growth and technological advancement. A matrix of nine possible scenarios was developed (see Table 6). Four scenarios were judged unlikely and were not given detailed consideration. For instance, a scenario involving high economic growth and limited technological improvement seems unlikely, because a future society with a vigorous economy would be expected to invest heavily in advanced transportation technology. Similarly, a sluggish economy would not provide the stimulus and resources for major technological advances.

TABLE 6 - SCENARIOS AND CORRESPONDING STRATEGIES

		SOCIOECONOMIC VARIABLES		
		High Growth	Maturing Economy	Economic Difficulty
TECHNOLOGICAL VARIABLES	Limited Improvement		B	A
	Significant Advances	D(?), E(?)	C, D, E	
	High Achievement	E(?), F, G		

Legend

Unlikely Scenarios

Most Likely Scenarios

(?) Strategy with marginal or doubtful applicability

Within the time and resources available, the TRB committee could not assemble evidence to conclude that any one of these strategies is clearly superior. Strategies D, E, and G appear most promising because they contain short-term elements that could be implemented immediately as well as measures to deal with long-term problems. All require more extensive study and analysis to refine the details, to assess advantages and disadvantages, and to consider the policy implications. The committee did reach general agreement that a less comprehensive strategy probably would not be effective in satisfying the Nation's air transport system into the early decades of the next century.

A more detailed account of the study is contained in Special Report 226, Airport System Capacity-Strategic Choices, issued by the Transportation Research Board, National Research Council, Washington, D.C.

Chapter 5

Conclusions and Federal Initiatives

Conclusions: Three assessments--a projection of delay trends, a medium and long-term risk analysis, and a review of alternative future strategies--indicate a potential for a gap between runway capacity at the Nation's major airports and anticipated air traffic in the long-term. The result would be more congestion, delay, higher user costs, reduced productivity, and stress on the air traffic control system. The average delay encountered during landing or takeoff at the Nation's 100 busiest airports is now more than seven minutes, significantly higher than the design figure of four minutes.

Various measures are being taken to relieve the problem, including demand management, use of improved technology, and new runway construction, planned at 42 of the 100 busiest airports. These measures, however, may not arrest completely the trend toward increased delay. If all of the known measures are implemented successfully, delay is still expected to increase to an average of 8.7 minutes per operation by the turn of the century.

This report concludes that airport system capacity should be expanded and the pace of implementation should be accelerated in order to provide adequate facilities for the future. Further, airport system development should be conducted in the context of the U.S. Department of Transportation's National Transportation Policy and should include consideration of other modes. The initiative for airport construction is and should remain with state and local government and private entrepreneurs. However, the Federal Government should encourage the development of an adequate national air transportation system and coordinate efforts to use it more effectively. The various analyses suggest that, while there is a serious deficiency in current planned airport expansion, the shortfall can be closed by a determined effort at all levels of government.

Current Federal Initiatives: The Federal Government is undertaking a variety of steps to encourage the provision of more adequate airport system capacity. Adoption of many of these measures was stimulated by the preceding analyses, which reflected the prevailing situation in 1989 and 1990. The prospects for relieving congestion as assessed will be substantially improved when the full impact of these steps is taken into account.

For example, one of the major obstacles to airport development is community concern about aircraft noise. The national noise policy flowing from the Airport Noise and Capacity Act of 1990 requires replacing or quieting of the noisiest jet transport by the year 2000. As a result, the residential population exposed to unacceptably high noise levels will decline from about 2.7 million currently to an estimated 400 thousand at the turn of the century. A significant reduction in noise levels will occur in areas around most commercial service airports. One of the effects of the noise policy is likely to be reduction in the opposition to airport development, although the extent of that effect is not known yet.

The availability of capital can determine the rate of airport development. Major projects are now financed primarily with bonds secured by income from rents and fees, and with Federal grants. Federal regulations have been issued that permit commercial service airports to supplement these sources with a passenger facility charge of up to $3 per enplaned passenger. This could make more than $1 billion in additional revenues available annually for airport capital improvements.

Another important factor is public awareness of the need for airport development. The FAA conducts a broad airport planning process to help local government anticipate the need for additional capacity, examine alternatives, and select practical solutions. The process is becoming more effective as planning techniques are improved. Computers are being used to analyze complex issues such as forecasting aeronautical demand, airport and airspace capacity, and future delay. Computers are also being used to present the results of analyses in an easily understood manner. For example, computer simulations of the movement of aircraft through congested airspace are being shown with animated graphics, so that the effects of congestion can be seen and discussed. These techniques make it easier to understand the nature of problems and the merits of alternative solutions.

The FAA has also developed guidance on how to estimate the economic significance of airports to the surrounding area. Information about the jobs and payroll that are related to civil aviation has proven useful in generating public support for improvements. Most of the major airport improvements that are now underway are supported by an economic impact analysis. The FAA guidance is being updated and refined to make it easier to apply to a wider range of airport development proposals.

The FAA is conducting a top-down analysis to determine the degree to which local airport plans add up to an adequate national system. The material in Chapter 2 of this report is a product of that analysis. It indicates that there are serious shortfalls in airport plans, particularly for certain major metropolitan areas. The FAA cosponsored a national symposium on airport system planning, together with the Transportation Research Board, the National Association of State Aviation Officials, and the Minnesota Office of Aeronautics, to call attention to the shortfall in capacity and to discuss how the planning process can be improved to correct it. The FAA will participate in similar meetings in the future.

A variety of activities are underway to encourage more efficient use of existing airport capacity. There is continuing emphasis on use of reliever airports by general aviation aircraft. Studies are underway of methods to accommodate more activity at busy commercial service airports, through the use of technology to permit more aircraft operations per hour, or by peak-period pricing to encourage some users to shift to off-peak periods or to use larger aircraft during peak periods. The FAA is also studying the potential development of secondary hub airports to supplement the congested airline hubs. There is increased analysis and coordination between the FAA and Department of Defense regarding civil use of military airfields.

The FAA has designated airport capacity program managers in each of its nine regional offices to coordinate these measures and apply them to help solve the unique problems of airports within their jurisdiction. The FAA's airport planners in Washington, D.C., oversee the regional efforts and participate in a strategic planning process, under which airport requirements are coordinated with air traffic control, policy analysis, and other FAA components. There is increasing coordination between airport development planning and the FAA plans to install navigation and approach aids and air traffic control equipment.

The National Transportation Policy has led to increased and more effective intermodal planning. The near-term emphasis is largely on airport access, but the longer-term topics include the use of high speed ground transportation as a supplement for aviation. For example, the FAA is coordinating with the Federal Highway Administration to ensure that airport highway access needs receive appropriate consideration in legislation. The FAA is developing a technique to evaluate the adequacy of ground access to busy airports and will include a ground access index in the 1993 edition of the National Plan of Integrated Airport Systems. This index will consider the percentage of potential passengers within various travel times of the large hub airports. The FAA and the Federal Railroad Administration have a number of cooperative projects under consideration, addressing rail access to airports. A recent study by the Transportation Research Board into transportation in high density corridors provides useful insight into intercity passenger travel patterns and markets and the future role of innovative technology.

These Federal initiatives will assist and supplement activities by State and local governments toward the provision of an adequate national transportation system. The FAA will monitor their effectiveness and adjust or supplement them to help meet the requirement for airport system capacity.

Current Long-Term Strategies: The 1991 FAA Strategic Plan presents five specific capacity strategies to guide FAA actions over the next 20 years. Those strategies, and some of the key actions available to achieve them are:

1. Implement effective capital investment programs for expanding airspace and airport capacity to accommodate growth and provide flexibility for future innovation by supporting:

    a. The building of new airports,

    b. The conversion of appropriate military airports to commercial use in conjunction with the Department of Defense.

    c. The development of new runways at busiest airports, and

    d. The further investigation of other expansion options.

2. Preserve and enhance the capacity of and access to existing airspace and airports, using effective management techniques and advanced technology.

    a. Develop satellite-based en route and possibly terminal navigation system based on GPS.

b. Assist airports devising airport-specific solutions such as high speed turnouts or increased use of parallel approaches that would increase efficiency at available runways.

c. Participate in intermodal studies to improve ground access to major airports and/or divert traffic and reduce airport congestion.

3. Encourage more efficient use of capacity through such measures as off-peak travel, and reliever airports.

a. Help develop potential new hubs at underutilized airports and increased capacity at existing hubs for alleviation of congestion at major airports.

b. Utilize a new generation air traffic control system to redesign and increase efficiency in airspace.

4. Influence, coordinate, and provide leadership in development of an integrated transportation system.

a. Broaden AIP eligibility to allow funding off-airport projects that directly improve airport access and encourage funding and research for airport intermodal connections.

b. Research alternative forms of transportation such as the tiltrotor and high-speed rail.

c. Encourage participation by airport operators and planners in the local transportation process.

5. Provide leadership to ensure coordinated airport system development among Federal, state, and local governments.

a. Provide greater incentives to third parties and increased flexibility in financing options such as joint public-private initiatives, benefits assessment on property owners, and joint development.

b. Encourage private participation in airport development and, where appropriate, privatization of airports, subject to continued compliance with grant requirements and protection of the public and users by maintaining reasonable user charges.

c. Enhance the ability of state and local governments to raise revenues and use them for transportation facilities and service.

A New Long-Term Initiative: To address the airport capacity problem the FAA intends to analyze the gap between demand at the busiest airports and projected capacity. The analysis will include a "most likely" planning scenario and a recommended set of actions to address the gap between future demand and capacity. It will also discuss a range of alternative scenarios and how the FAA's efforts should change in response to each. The FAA will present it to state and local governments, as well as Congress, as an aid to the development of local airport plans.

Outlook: Through undertaking the long-term gap analysis and continuing the current Federal initiatives and plans, we can proceed with the development of a national aviation system with the capacity and flexibility to meet future needs.