Addressing Future Capacity Needs in the U.S. Aviation System

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Eno Center for Transportation

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Joshua Schank
Eno President and CEO

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While this research was funded in part by the U.S. Travel Association, our analysis is independent and solely the work of Eno staff.

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EXECUTIVE SUMMARY

The United States' aviation system plays an integral role in our economy, providing a means to transport people and goods over long distances. Passenger travel within the system is growing but the system's ability to accommodate increasing travelers may be limited. If the system is unable to offer the necessary capacity to meet passenger demand, would-be passengers may choose not to travel or choose destinations other than the United States, which could have adverse effects our economy. This paper explores the issue of system capacity in the airspace and at select hub airports, and finds that the U.S. aviation network in its current state is unlikely to provide adequate capacity to accommodate projected growth in passengers over the next 20 years.

The aviation system is responsible for approximately 4.9 to 5.2 percent of the United States' Gross Domestic Product (GDP).[1] Domestically, the aviation industry generates between $1.2 and $1.3 trillion in annual economic activity and provides between 9.7 and 10.5 million jobs.[2] International travelers contribute over $116 billion annually in direct spending to the U.S. economy. Further, in 2011 international visitors contributed $1 billion to the economy in indirect expenditures.[3] Passenger numbers are growing, and are projected to continue to increase. The Federal Aviation Administration (FAA) estimates in 2016 the U.S. aviation system will provide service to 800 annual passengers, potentially swelling to 1 billion annual passengers by 2027.[4] In order to capture the economic value associated with this passenger travel, the aviation system will have to adjust to accommodate the demanded capacity.

Capacity constraints within the aviation system stem from airport infrastructure, airport access, and the existing regulations and rules. Since deregulation, airlines are increasingly employing the hub-and-spoke system, concentrating activity at their hub airports. Recent mergers in the airline industry have resulted in a few large airlines controlling the largest shares of the market. With fewer airlines operating fewer hubs, many airports have experienced a reduction in flights and congestion. Delays at hub airports can create ripple effects and cause delays at smaller, generally uncongested airports. Not all airports within the system are experiencing capacity constraints, but due to the interconnectivity of the system those with constraints create congestion nationwide.

In order to better develop an understanding of the capacity issues at our nation's airports, we analyzed the busiest international airports in the U.S. and selected case studies that are among the busiest airports for domestic and international travel. The four airports selected for detailed review — John F. Kennedy International (JFK), Newark Liberty International (EWR), Los Angeles International (LAX), and San Francisco International (SFO) — were chosen due to their status as major hubs and international gateways, their projected growth, and their capacity constraints. The case studies demonstrate that addressing capacity problems at some of our largest hub airports will be challenging. JFK, EWR, and SFO all face substantial barriers to airside and airspace capacity expansion. The capacity constraints at JFK and EWR are the most immediate, as those airports are already nearing their maximum capacity. We estimate that the U.S. economy will lose out on over $6 billion of lost travel spending in 2016 due to unmet demand at the JFK and EWR, primarily from would-be overseas travelers. This is estimated to balloon to nearly $48 billion annually by 2034. SFO has sufficient capacity to handle increases in traffic during fair weather, but when poor visibility occurs, as it does often in the Bay Area, the capacity is severely restricted. Weather delays at SFO will grow worse as passengers increase. And while LAX has sufficient runway capacity, it has landside capacity and airport access issues that will constrain future demand.

Funding, physical space, and other political challenges have left these airports with few plans to develop needed capacity and improvements, and it is unclear which investments will have the greatest benefits to the national system. However, if we take an appropriate perspective in focus-

ing on national benefits from targeted investments solutions exist that can relieve congestion at these airports and in the larger aviation system. These solutions include:

• **Operational Changes:** Capacity improvements do not always require expensive and politically challenging infrastructure expansions, especially if they are targeted towards the areas of greatest need. One potentially cost-effective way to improve our transportation network is to use what we already have more effectively, either through a regulatory framework or through market-based pricing of valuable peak capacity.

• **Air Traffic Control Improvements:** NextGen, a nationwide state-of-the-art modernization program for air traffic control, promises to replace the existing radar-based system used by the aviation industry with a system that uses satellite based GPS. Since GPS can provide more precise location information, NextGen can allow for substantial benefits in terms of fuel costs and capacity improvements.

• **Airport Infrastructure Improvements:** At some major airports, even with operational improvements and NextGen implementation, there will not be sufficient capacity to accommodate demand. The four case studies in this report represent only a sampling of the U.S. airports that will need direct investment in landside or airside capacity in order to accommodate future growth and reduce delays.

Taking into account these potential solutions, we provide four policy recommendations:

• **Restructure the federal Airport Improvement Program to target investment to the greatest national interest:** Current AIP funds are distributed via formula, with non-primary airports receiving 35 percent of all funding and the remaining spread amongst the remaining primary airports. Reforming the AIP to target funding to where it provides the greatest national benefit would go a long way towards making adequate funding available to support necessary upgrades in our aviation infrastructure.

• **Create a new federal discretionary grant program to address improvements and innovation in airport operations:** The new discretionary program would be targeted more towards the political obstacles than the funding obstacles, and more towards operations than infrastructure. Airports and other entities wishing to relieve congestion in the national aviation system could apply for grants from the FAA. By creating competition with ideas around the country for relieving congestion and creating national economic benefits, this program could foster innovative ideas such as peak runway pricing or other operational changes.

• **Explore the idea of separating the air traffic control and safety functions of the FAA to accelerate the delivery of NextGen:** The simplest way to separate these functions is to create two separate government agencies, but another alternative would be to corporatize the new entity into a nonprofit. Either way might allow the new organization to behave more like a business with respect to investment decisions, particularly related to NextGen, and provide operators with more certainty about technological advances.

• **Relax the current federal restrictions on the airport PFC to allow airports to raise revenues from users:** While from a policy perspective it is understandable that the federal government might want to regulate how much airports can charge passengers, this is an argument for maintaining a cap on PFC charges, not for maintaining it at the current rate of $4.50. At a minimum, the FAA should be given discretion to increase the PFC cap if and when an airport can demonstrate the need for more investments in order to accommodate demand in the national aviation system.

We recognize that there are substantial barriers to implementing these policy recommendations, including from existing stakeholders. Given the stakeholder limitations and the very real national need to address capacity constraints in the U.S. aviation system, a large effort by non-stakeholders will likely be necessary to address this problem from a national perspective. Change will likely occur only when the larger business community comes together to call for substantive policy changes addressing how we operate and fund our aviation infrastructure.

The aviation system plays a fundamental role within our economy and within our transportation system, both domestically and worldwide. As demand grows, the aviation system must adjust and grow with it or risk the potential loss of revenue and negative affects on our economy. Solutions exist, and while they are politically challenging, they have the potential to be moved forward. If we are successful, the United States will have the ability to remain as a global competitor in aviation travel.

INTRODUCTION

The aviation system in the United States is an essential component of the U.S. economy, providing a means for efficient, long haul travel. The FAA, an operating administration of the U.S. Department of Transportation (USDOT), currently predicts an annual passenger growth rate of 2.2 percent, adding an additional 400 million annual passengers to the system by 2033.[5] Yet our nation's aviation infrastructure may not be capable of accommodating the predicted growth in demand. A few of the United States' largest hub and international airports are already congested and demand is projected to increase.[6] This congestion creates systematic delays, increases costs, adversely affects passenger experience, and ultimately hinders would-be travelers from planning trips to the U.S.

This paper examines the following aspects of the national aviation system:

- Aviation's impact on the economy and growth in air travel
- Capacity constraints in the national aviation system
- Capacity constraints at the largest international gateway airports
- Potential capacity solutions

The exploration of these issues demonstrates that the present aviation system, and its planned expansions, is unlikely to provide adequate capacity to accommodate projected growth in passengers over the next twenty years. The problem is most acute at a few large airports that significant barriers to increasing their capacity. Not addressing these problems would result in net economic losses and a diminished travel experience within the United States. The U.S. has the potential to be a global competitor in terms of travel, but failing to implement system-wide innovations to provide for the projected increase in passenger demand will result in our nation falling behind. Solutions exist, but current federal policy in aviation is not oriented towards maximizing national economic benefits that could result from improvements to our aviation system. Substantial legal and political barriers must be overcome in order to implement these solutions and ensure that future demand for travel within and to the United States, and the economic benefits associated with it, can be captured. But our analysis indicates that this is a challenge that is worth the effort.

Research Approach

Our analysis examines projected growth in aviation for both domestic and international passengers. It examines where capacity constraints exist both within the broader aviation network and at four large international airports used as case studies:

- New York John F. Kennedy International Airport (JFK)
- Newark Liberty International Airport (EWR)
- Los Angeles International Airport (LAX)
- San Francisco International Airport (SFO)

For each case study we identify specific capacity constraints, barriers to overcoming those constraints, and their current and projected impacts on travel. Finally, the analysis examines stakeholders and policies, evaluating how they are working to address this problem. The paper concludes by presenting a number of policy recommendations to overcome those barriers by better orienting federal policy towards the national benefits of reducing congestion in our aviation network.

AVIATION'S IMPACT ON THE ECONOMY

The value of the nation's aviation system is partially rooted in its ability to continually contribute to the United States' economy. Aviation bolsters the U.S. economy and well-being by facilitating the flow of information, goods, investment, and human capital, providing a means for international and domestic travelers to invest in U.S. products and services, and fostering global connectivity for business and personal benefit.

Commercial aviation's role in the United States' economy establishes an incentive to maintain and grow the nation's system, strengthening our fiscal resiliency. This section provides insight into this economic role, reinforcing this pivotal relationship.

The aviation system provides a potential vehicle for increased economic benefits if the U.S. is able to accommodate and stimulate growth in passenger and freight traffic. An August 2011 FAA report[7] found that commercial aviation was responsible for 4.9 to 5.2 percent of U.S. gross domestic product (GDP), a value echoed in a May 2012 report by the International Air Transport Association (IATA)[8] that estimated $669.5 billion in GDP (4.9 percent). Of that share, IATA found that $206.4 billion (30.7 percent) was contributed directly by airlines, airports, and related ground services.[9] According to the FAA, the U.S. domestic aviation industry generates $1.2-$1.3 trillion in overall annual economic activity and between 9.7 and 10.5 million jobs.[10]

International visitors alone contribute over $116 billion in direct spending to the U.S. economy.[11] The average overseas traveler spends more than $3,200 on a visit to the United States, while the average traveler from China, a rapidly growing market segment, spends over $7,000 per visit.[12] Further economic benefits also result from exchanges that occur during international visitors' stay on U.S. soil. Spending from international travelers in the U.S. hovered between $400-500 billion annually from 1995-2003, and in the past decade has been increasing, reaching over $1 billion in 2011, demonstrated in Figure 1. In 2009, U.S. air carriers transported 793 million passengers over $1039 billion revenue passenger miles. These passengers spent a collective amount of $249 billion on aviation goods and services, not to mention other spending on travel related goods or business activity.[14] U.S. airports provide 361 direct connections to international cities whose populations exceeds 10 million, with more than 900,000 international flights per year to 279 airports in 108 countries. As a result, the U.S. is one of the world's best-connected economies relative to its economic size.[15] More than 53 billion revenue ton-miles of scheduled freight passed through U.S. airports in 2009, and around $562 billion of freight was transported domestically to other countries.[16] Table 1 summarizes the economic impact of the commercial aviation industry as reported by the FAA, highlighting the importance of the industry to the economy.

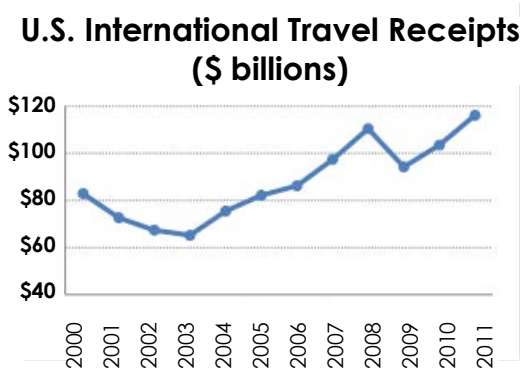

Figure 1: U.S. International Travel Receipts[13]

Economic Impact of Commerical Aviation on the U.S. Economy (2006-2009)	
Economic Activity/Output (annual)	$1.2 - $1.3 trillion
Personal Earnings (annual)	$370 - 405 billion
Share of GDP	4.9 - 5.2%
Job Impact	9.7 - 10.5 million jobs

Table 1: Economic Impact[17]

PASSENGER GROWTH IN AIR TRAVEL

Aviation is an economic driver that is currently undergoing substantial growth both domestically and internationally. The most recent passenger projections were released in the FAA's annual Aerospace Forecast Fiscal Years 2013-2033 (Figure 2), estimating that in 2016, the U.S. will handle 800 million total annual passengers, growing to 1 billion by 2027, and potentially reaching 1.2 billion by 2033.[18] While the total number of domestic passengers is growing faster than international passengers, the rate of growth for international traffic is higher, with most new traffic expected to originate from Latin America and Asia. International passengers are expected to grow to account for 16 percent of total passengers in 2033, up from 11 percent in 2012.

Under the assumption of "stable worldwide economic growth," the FAA projects international passenger enplanements, or boardings, to total 185.7 million in 2033, illustrated in Figure 2. For domestic travel, the FAA estimates a stable growth rate of passenger traffic at 2.1 percent through 2033, leading to a projection of 1.15 billion enplaned passengers by 2033.[19] Passenger trip length is forecasted to continue to increase through 2033, reflecting an increase in longer domestic and international trips.[21]

International Vistiors

Though international travelers only account for 11 percent of the total traffic in the U.S., the international market is a key driver of growth. International passengers contribute disproportionately to the economy and constitute a large portion of travelers at the largest hub airports. Since 2003, the number of international arrivals to the U.S. has grown relatively continuously, hitting a record high 67 million in 2012.[22] The U.S. is projected to remain the single largest market for international passengers globally, with Department of Commerce projections estimating 76.6 million visitors in 2016, and 106.6 million by 2034.[23]

While Canada and Mexico continue to be the largest source of international passengers, growth from overseas Latin American and Asian markets is leading projected demand. Table 2 shows the top ten inbound markets to the U.S., with Brazil and China doubling traffic from 2008 to 2011.

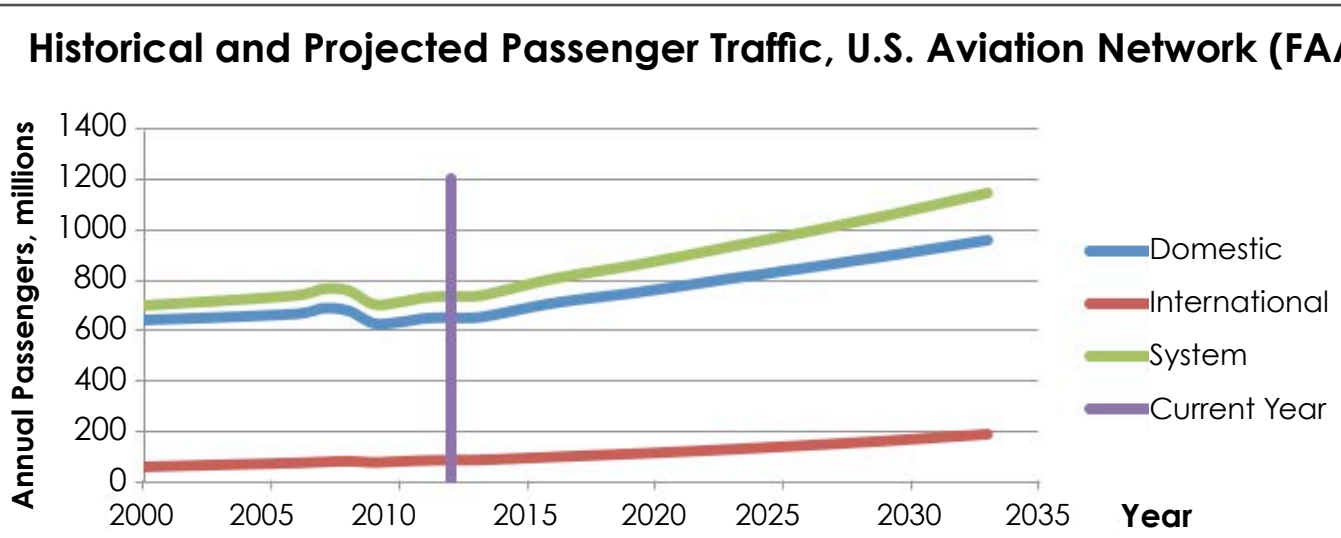

Figure 2: Projected Growth in the U.S. Aviation Market, Annual Passengers (millions)[19]

According to the U.S. Department of Commerce, international air traffic to and from the U.S. totaled 89.7 million passengers from June 2012 to June 2013. Of that, 40 million were U.S. citizens, and the remaining 49.7 million were non-U.S. citizens. Of the total number of international air traffic, U.S. operated airlines carried 48.3 million passengers and foreign airlines carried 41.4 million passengers out of American airports.[25] Foreign carriers play a major role in transporting international passengers, yet they often rely on U.S. carriers to shuttle passengers to their final destinations beyond the gateway airports.

Origin Countries of Foreign Arrivals into the U.S.

	2008	*2009*	*2010*	*2011*
Canada	18,915,000	17,977,000	19,964,000	21,337,000
Mexico	13,686,000	13,229,000	13,469,000	14,391,000
United Kingdom	4,564,895	3,899,167	3,850,864	3,835,300
Japan	3,249,578	2,918,268	3,386,076	3,249,569
Germany	1,782,299	1,686,825	1,726,193	1,823,797
Brazil	769,232	892,611	1,197,866	1,508.279
France	1,243,942	1,204,490	1,342,207	1,504,182
South Korea	759,394	743,846	1,107,518	1,145,216
China	492,958	524,817	801,738	1,089,405
Australia	689,927	723,576	904,247	1,037,852

Table 2: Arrivals from the Top 10 Inbound Countries to the U.S.[24]

Recent trends are expected to continue, with air travel projected to continue to increase on a global scale over the next 20 years. IATA projects global air traffic to reach approximately 3.6 billion passengers in 2016, suggesting a 5.3 percent annual passenger growth rate from 2016 to 2011.[26] Figure 3 illustrates the continuous growth of world international tourist arrivals since 1995, hovering around 1 billion in 2011.

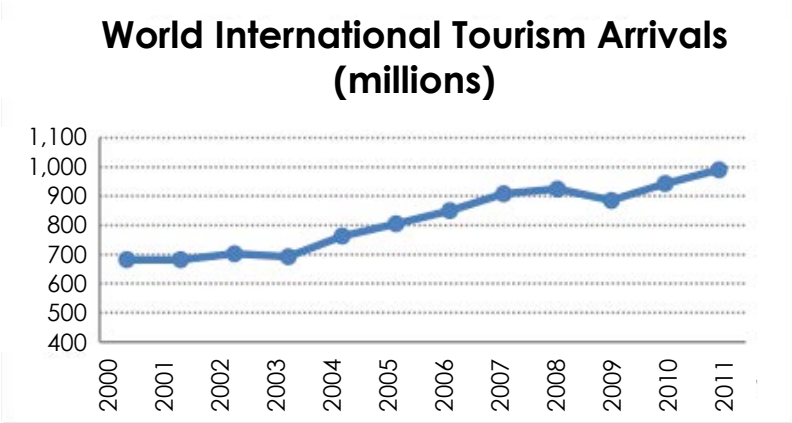

Figure 3: World International Tourism Arrivals[22]

Although inbound international travel to the U.S. is increasing, the U.S. has lost significant market share globally over the past decade. In part due increased economic activity in other regions of the world and in part due to security and visa restrictions imposed after September 11, 2001, the U.S. market has declined from 17 percent of the global market in 2000 to 12.4 percent today.

In efforts to raise this market share, the groups are encouraging Congress to reform security and visa procedures. However, if U.S. hub and international airports lack capacity to move these would-be passengers, such efforts will not be as effective as they could be.

Providing capacity for the projected growth in both domestic and international passengers and recapturing lost global market share could have considerable benefits for the U.S. economy. In order to reclaim any previous loss in the global market, however, substantial and innovative policy changes and infrastructure investments will likely be required.

CAPACITY CONSTRAINTS IN THE NATIONAL AVIATION SYSTEM

The U.S. aviation network's ability to accommodate growing passenger demand is pivotal for the industry and the economy. This section examines the national aviation network in terms of capacity, demonstrating the interconnectedness of the system and establishing the necessity for a system-wide approach to capacity constraints.

According to the 2011-2015 National Plan of Integrated Airport Systems (NPIAS) released by the FAA, there are currently over 19,700 airports operating in the United States today. About 5,000 of those airports are open to the general public, and a little over 500 of those airports offer commercial service.[29] Of those, 382 airports are considered "primary," defined as airports with more than 10,000 annual passenger boardings. Primary airports are responsible for 99.75 percent of all commercial air passenger traffic in the United States.[30] The largest primary airports handle an outsized proportion of that traffic: the 20 busiest airports in the U.S. handle more than 57 percent of all air passengers.[31] Commanding the bulk of aviation passengers, congestion and capacity issues at the largest airports have a greater effect on the aviation system as a whole. This analysis focuses on primary airports, specifically the largest hubs, and their capacity to accommodate aircraft and passengers.

There are three principal types of aviation capacity discussed in this analysis:

- **Airside Capacity**: Runways and taxiways at airports
- **Landside Capacity:** Terminals and gates to process passengers, and ground access and, parking
- **Airspace Capacity**: Regulations and rules on minimum separations between aircraft in flight

Capacity Projections

In the United States, the FAA is the principal authority for traffic projections for the nation's aviation system. The most recent FAA capacity analysis report, "Capacity Needs in the National Airspace System 2007-2027 (FACT 2)" was released in 2007.[32] It contains capacity analyses of existing U.S. airport infrastructure and projects airport capacity for the 291 largest commercial service airports in the country for the years 2007, 2015, and 2025. FACT 2 identifies airports with capacity or delay constraints and makes recommendations for the expansion of these airports based on FAA air passenger traffic projections.

FACT 2 indicates that the number of smaller and medium hub airports needing additional capacity has decreased, while the number of large hubs needing capacity has increased.[33] This has been the result of a greater concentration of airport traffic at the largest airports and an increased intensity of use of the hub-and-spoke air traffic model by the largest domestic airlines.

In the 2007 report, the FAA identified four airports that needed immediate capacity expansion: Newark (EWR), Fort Lauderdale (FLL), O'Hare (ORD), and LaGuardia (LGA). By 2015, the report predicts that 18 airports will need capacity beyond current infrastructure and in 2025 that number will grow to 27. The report was produced and published with data and projections made prior to the recession in 2008 but air traffic has since rebounded to pre-recession levels and demand is expected to continue to grow.

Many of the issues that were facing the U.S. aviation network in 2007 are still relevant today. Aside from passenger volumes, other changes in the aviation network since 2007 have had

Airline	Merged Into	Year
America West	U.S. Airways	2005
Northwest	Delta	2009
Midwest	Frontier	2010
Continental	United	2010
AirTran	Southwest	2011
U.S. Airways	American	2013 *(proposed)*

Table 3: Major U.S. Airline Mergers, 2004-2013

substantial effects on the capacity of the network.

Delays resulting from restricted capacity and increased demand do not affect all airports evenly. Airline consolidation has resulted in fewer hub airports, and remaining airlines have concentrated their presence and air routes at those airports. The aviation industry once had dozens of airlines serving many domestic and international markets, but in the past decade several airline mergers have occurred, shown in Table 3. Assuming the U.S. Airways and American merger is completed, the five largest airlines (American Airlines, Delta, United, JetBlue, and Southwest) will control over 73 percent of all domestic air traffic.[34]

In June 2013, Gerald Dillingham, Director of Physical Infrastructure Issues at the Government Accountability Office (GAO), testified before the U.S. Senate on how mergers could lead to reductions in redundant hubs, specifically in the case of the proposed American Airlines and U.S. Airways merger. He reminded the audience that, "Following the American acquisition of Trans World Airlines (TWA) in 2001, St. Louis ceased to be an American hub and following the Delta–Northwest merger, service at Delta's hub in Cincinnati and Northwest's hub in Memphis has been greatly reduced."[25]

Table 4 shows how some medium hub airports such as Cincinnati, Cleveland, and Memphis have experienced dramatic declines in passenger traffic since 2006, due in part to the number of mergers that have already occurred. Some of the decline can be attributed to the economic recession, but since 2006 overall air traffic in the U.S. is up almost 5 percent.

The airports that have experienced traffic reductions have not necessarily experienced a corresponding reduction in delayed flights. At each of the five airports listed in Table 4, all experienced only a moderate increase in on time performance.[37] The average delay per delayed aircraft increased at the airports except for St. Louis and Pittsburgh, which only saw a modest decline in delay time, shown in Figure 4. A reduction in traffic at a specific airport does not always reduce the amount of delayed aircraft or passengers in a hub-and-spoke system because initial delays radiate throughout the system.

Since deregulation in 1978, the airline industry has relied increasingly on the hub-and-spoke network to organize air traffic. This system results in the necessity for most travelers, both domestic and international, to make a connecting flight to reach their final destination. The interconnectivity of the aviation network results in delay increases having strong ripple effects across other large airports across the entire country.

Moreover, with fewer airlines operating larger networks, the number of medium-sized hubs is falling and the passenger volumes at the large hubs are increasing.[39] The consolidation of more traffic to fewer airports constrains capacity at the larger hub airports, even if overall traffic is not growing. This can be made worse when an airline, in an effort to create convenient schedules for passengers, schedules more flights than the airport can realistically handle. In many cases delays at hubs are not

Hub Airport	Hub Airline	Departing Passengers (2006)	Departing Passengers (2012)	Change
Cincinnati	Delta	7,506,000	2,813,000	-62.5%
Cleveland	Continental	5,298,000	4,194,000	-20.8%
Memphis	Northwest	5,288,000	3,320,000	-37.2%
Pittsburgh	US Airways	4,841,000	3,808,000	-21.3%
St. Louis	American	6,877,000	6,103,000	-11.3%

Table 4: Passengers in Mid-sized Hub Airports[36]

directly caused by limited capacity at those hubs, but by tight scheduling of flights by airlines to accommodate their hub-and-spoke network.

FAA's FACT 2 report states that "not only is the volume of aircraft at most large hubs expected to increase over the next 20 years, the mix of aircraft operating at most large hubs is also expected to become increasingly complex over the forecast period."[40] Although overall activity at control towers fell in 2011, activity at the largest airports increased and delays remained at historically high levels. In the last five years, large airports have experienced a higher rate of increase in total enplanements than smaller airports, and it is likely that this increased demand will continue to cause congestion and delays.

The magnitude of these global passenger growth trends demonstrates the importance of domestic and international travel for the economic vitality of the United States. In response to these projections for increased domestic demand and a heavy influx of international visitors to the U.S., the state of the nation's aviation system needs to be examined.

Capacity Constraints at the Largest International Gateway Airports

In order to develop a better understanding of the capacity issues at our nation's airports, we analyzed the busiest airports in the U.S. to select case studies that 1) are among the busiest airports for domestic and international travel; and 2) demonstrate significant capacity and delay problems. The four airports selected for detailed review — John F. Kennedy International, Newark Liberty International, Los Angeles International, and San Francisco International — were chosen due to their status as major hubs and international gateways, their projected growth, and their capacity constraints. These airports are not the only airports with capacity constraints, but they highlight areas that are experiencing the greatest problems. The Appendix presents the selection process for these four detailed case studies. Tables 5 and 6 summarize the findings and conclusions of the Appendix.

Our analysis found that congestion problems were mostly limited to a few airports. Other large hub airports, such as Miami, Atlanta, Chicago-O'Hare and Denver, have experienced increased volumes but have made investments in infrastructure to enable them to handle projected demand for many years. The following section describes the case studies, examining their existing and future landside, airside, and airspace capacity.

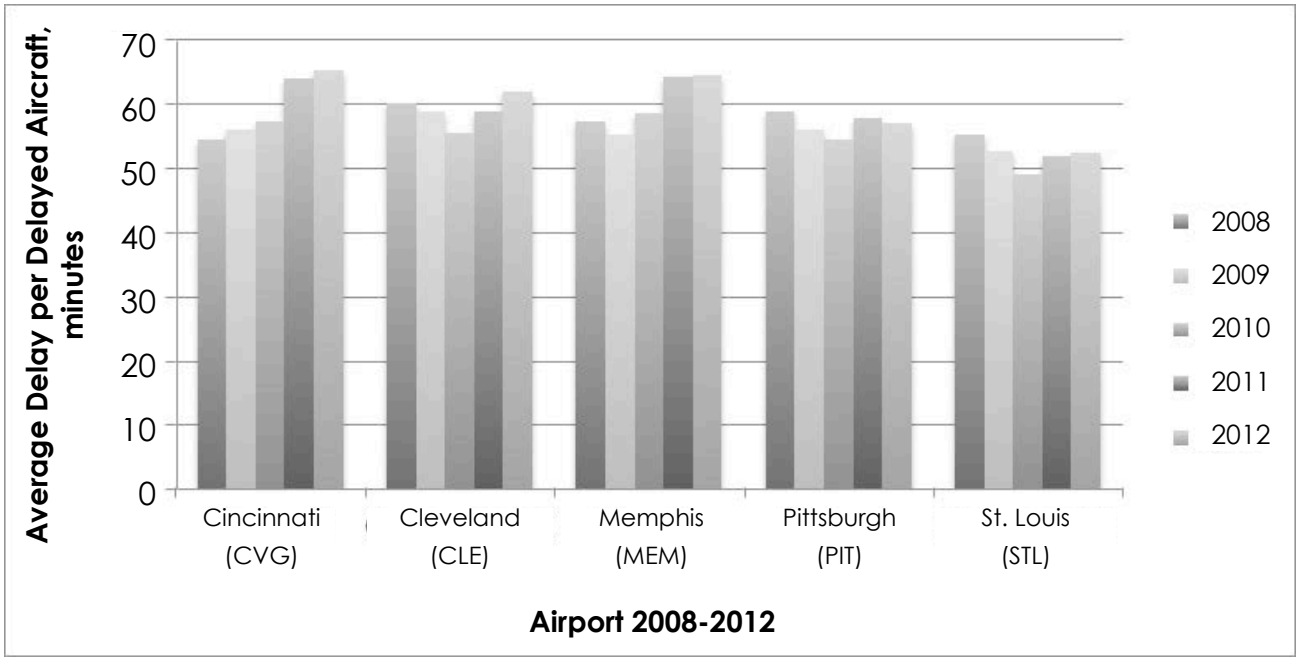

Figure 4: Average Delay at Mid-Sized Hub Airports[38]

Airport Code	Total Passengers (2012)[41]	Int'l Passengers (2012)[42]	Percent Int'l (2012)	Share of Domestic Connecting Passengers (2009)[43]	Passenger Growth Rate (2003-2013)[44]	Largest Airline Carriers (2012)[45]
JFK	49,034,266	24,774,644	51%	29%	68.7%	JetBlue (38.6%) Delta (22.6%) American (16.7%)
EWR	33,952,143	11,145,313	33%	29%	17.4%	United (50.1%)
MIA	37,033,951	18,516,559	50%	49%	33.9%	American (71.4%) Delta (11.2%)
ATL	91,466,491	9,576,889	10%	69%	21.4%	Delta (66.4%) AirTran (13.7%)
LAX	62,604,533	16,541,798	26%	28%	20.3%	United (18.7%) American (18.7%) Southwest (15.9%)
ORD	64,222,204	10,187,557	16%	54%	5.0%	United (27.5%) American (22.5%)
SFO	42,616,804	9,144,975	21%	27%	32.4%	United (37.9%) SkyWest (11.4%)
IAH	38,020,084	8,477,922	22%	60%	20.6%	United (57.7%) ExpressJet (20.9%)
IAD	21,610,571	6,461,788	30%	45%	55.9%	United (42.0%) ExpressJet (13.6%)
DFW	56,033,767	5,805,920	10%	61%	15.1%	American (85.1%)
PHL	29,179,750	3,735,700	13%	41%	32.6%	US Airways (40.6%) Southwest (8.7%)
BOS	28,620,708	4,064,918	14%	-	33.2%	JetBlue (28.0%) United (13.4%) US Airways (13.0%)

Table 5: Airport Information Related to Passengers, Summary of Analysis in the Appendix

Airport Code	Airport Footprint in Acres[46]	Number of Runways[47]	Investment in Runway Capacity Over Past Decade?	FAA Slot Control	Terminals[48]	Gates[49]	Expected Landside, Airside and/or Airspace Capacity Problem?
JFK	5,200 acres	4	Yes	Yes	8	117	Short Term
EWR	2,027 acres	3	No	Yes	3	61	Short Term
MIA	3,300 acres	4	Yes	-	3	119	Long Term
ATL	4,700 acres	5	Yes	-	2	239	Medium Term
LAX	3,500 acres	4	Yes	-	9	153	Short Term
ORD	7,627 acres	8	Yes	-	4	172	Long Term
SFO	5,207 acres	4	No	-	4	87	Short Term
IAH	10,000 acres	5	No	-	5	181	Long Term
IAD	13,000 acres	4	Yes	-	1	144	Long Term
DFW	17,207 acres	7	No	-	5	195	Long Term
PHL	2,302 acres	4	No	-	6	129	Long Term
BOS	2,384 acres	6	No	-	5	103	Medium Term

Table 6: Airport Information Related to Capacity, Summary of Analysis in Appendix A

In the last five years, large airports have experienced a higher rate of increase in total enplanements than smaller airports, and it is likely that increased demand will continue to cause congestion and delays.

JOHN F. KENNEDY INTERNATIONAL AIRPORT (JFK)
NEW YORK, NEW YORK

Located 20 miles to the southeast of Manhattan, in Queens, New York, John F. Kennedy International Airport (JFK) is the nation's largest international aviation gateway. In 2012 JFK moved 49 million total passengers and 25 million international passengers.[50]

It is one of the nation's most congested airports, and despite the recession, international passenger growth has steadily increased since 2003, overtaking the amount of domestic traffic in 2012, shown in Figure 5. Six out of the ten most heavily traveled routes in the country go through JFK airport, and according to the FAA, a third of the nation's air traffic passes through the New York City region's airspace, which includes nearby Newark Liberty International (EWR) and LaGuardia International (LGA) airports.[51]

JFK has also experienced an increase in the number of overall aircraft movements since 1998.[53] Aircraft movement growth has resulted from scheduled passenger traffic, while cargo, commuter, and other small aircraft usage has declined dramatically. Traffic peaked at the airport in 2007 at more than 440,000 movements per year and has since declined slightly to about 409,000 movements per year in 2011.[54] The maintained traffic levels after 2007 reflect increased load factors on aircraft.

JFK is a major hub for three domestic airlines: JetBlue (38.5 percent of JFK's flights in 2012), Delta (28.8 percent), and American (16.5 percent).[55] Sixty-five international carriers additionally serve JFK.[56] New York City is the largest urban area in the United States, and many passengers traveling through the airport originate from, or make their final destination, the NYC area. However, JFK also serves as a hub for connecting flights for domestic and international travelers. In a 2012 passenger survey, 18.4 percent of all departing passengers at JFK connected through the airport, with 8.4 percent connecting from a domestic flight, and 10.1 percent connecting from an international flight.[57] These values are much lower than other large hub airports, such as Atlanta that is dominated by a single airline and where nearly 70 percent of passengers are connecting to another flight, but the value suggests that around nine million annual pas-

John F. Kennedy International Airport

sengers flying through JFK continue on to other destinations, making delays at JFK ripple across the aviation network.

Current Capacity

JFK has eight terminals and 117 gates to serve its passengers. Since 2012, the airport has added a new international terminal, JetBlue's Terminal 5, and improved Delta's Terminal 4. As a result, landside capacity has improved.[58] JFK still has a dated, and relatively inefficient, terminal and access design, but the airport is making some investments to improve the condition. JetBlue's domestic airline operations are based out of JFK and the air carrier recently opened a new terminal that includes additional gates and new international arrival facilities.[59] Delta has also made investments into their presence at JFK, completing a $1.4 billion Terminal 4, adding nine new gates, and streamlining passenger areas.[60] Along with improving the condition of the terminals, the airlines that are investing will likely want to increase their traffic to make the investment worthwhile.

Airside capacity constraints are mainly due to the airport's intersecting four-runway design. JFK can operate a maximum of 81 flights/hour per FAA slot-control regulations, making it one of the FAA's few slot-controlled airports in the United States. Departure "slots" are allocated for JFK by the FAA for specific days of the week and must be used at least 80 percent of the time for that day during a scheduling season.[61] Though FAA slot-control regulations allow JFK 81 flights/hour, demand frequently reaches 90-100 flights/hour during several peak hours throughout the day, shown in Figure 6.[62] By 2030, demand is expected exceed capacity for most of the day.

By 2030, demand for the three largest New York region airports is expected to increase by 50 million passengers. A report by the RPA predicts "serious capacity deficiencies [at JFK] will become even more apparent in the next 10 years," with demand predicted to rise to 110-130 flights/hour throughout the day.[64] Based on current delays at JFK, the FAA predicts that additional runway capacity at JFK will be required to meet demand through 2015 and beyond.[65]

In addition to airside capacity constraints, airspace capacity issues also create delays. Because JFK operates closely with two other large airports (EWR and LGA) within a very small geographic area, overlapping airspace creates a "tremendous air traffic management challenge."[66] As a result of the overlapping airspace, in certain wind conditions JFK must stagger and restrict operations to separate arrivals and departures from EWR and LGA, giving less flexibility to an already-constrained network.

Many of the challenges of overlapping airspace can be addressed through the use of technologies that will modernize the air traffic control system and "disentangle the airspace conflicts among the [NYC] region's airports."[67] In the U.S., these technologies are embodied in NextGen, the program overseen by FAA that promises to "transform air traffic control from current ground-based

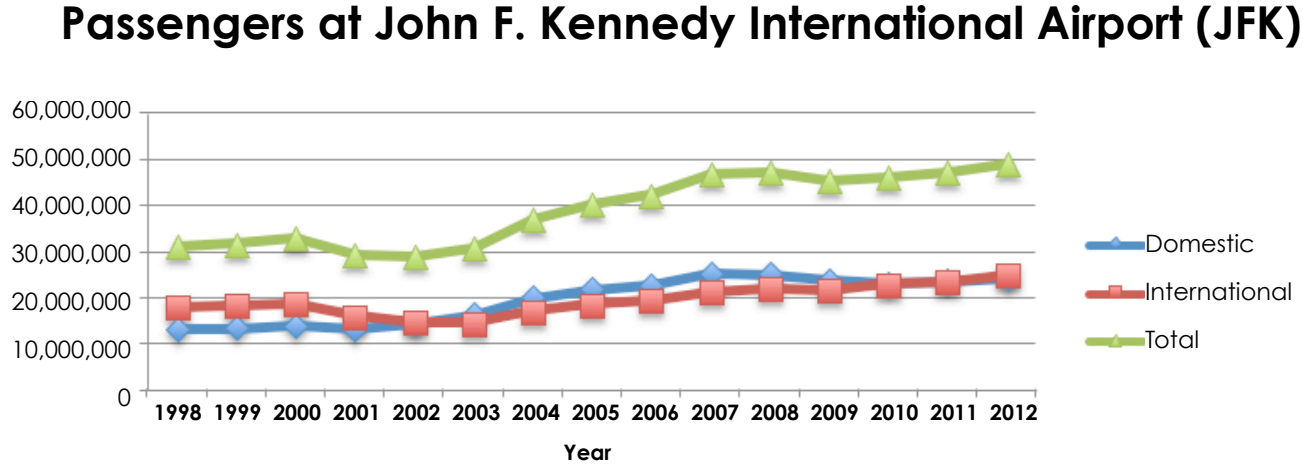

Figure 5: Passengers at John F. Kennedy International Airport (JFK)[52]

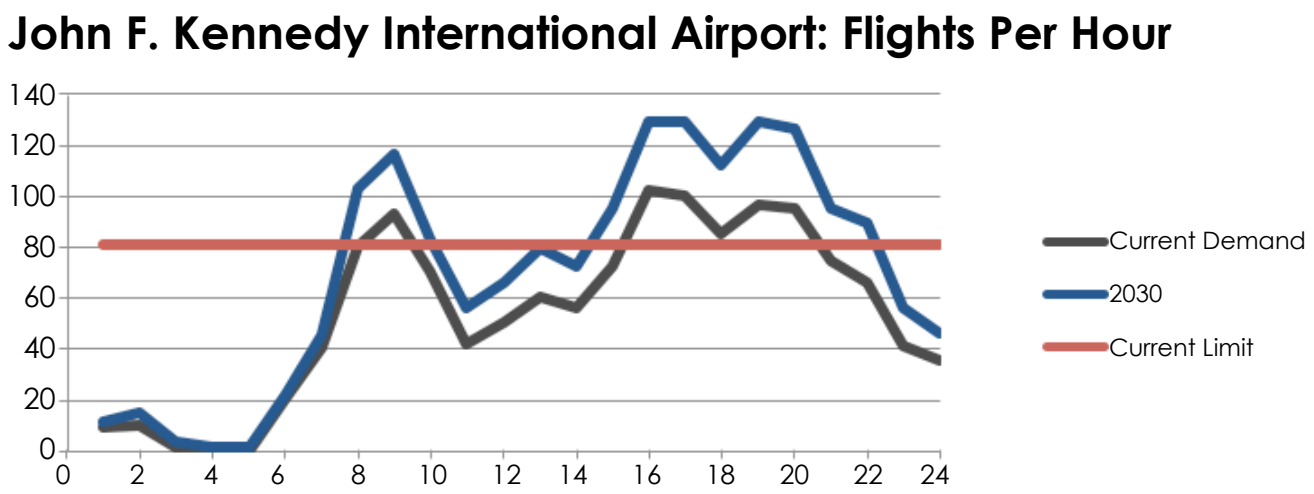

Figure 6: John F. Kennedy International Airport - Flights Per Hour[63]

technologies such as radar to satellite-based technologies such as GPS and digital communications." [68] NextGen technologies would modernize U.S. Air Traffic Control (ATC) and enable aircraft to fly closer within the airspace, likely expanding capacity and realigning departure and arrival airspace routes. NextGen is many years away from implementation, and is not expected to solve all of the region's capacity problems alone.

Future Capacity

Congestion problems at JFK are not new and are expected to worsen over the coming decades. To address the aircraft and passenger demand predictions, the New York-New Jersey Port Authority and the RPA have examined several alternatives to expanding both JFK's passenger and runway capacity. Though the Port Authority recently improved one of JFK's busiest runways with a $376.3 million widening and taxiway upgrade, the airport will need additional capacity to handle demand.[69]

The 2011 RPA proposed four options to increase runway capacity at JFK airport. Three of these options require filling in a large section of Jamaica Bay or obtaining additional land outside the current airport land to build and extend existing runways. The fourth option proposes to reconfigure runways, but would affect air traffic and noise over parts of Queens. In line with the RPA's recommendations, the Port Authority has also cited the expansion of operational capacity as "the best long-term approach to congestion management" at JFK.[70] Land acquisition from the Bay or the neighborhoods will be very challenging, and the report does not cite a recommendation for funding the expansion. Even if the runways are expanded, the airspace conflicts with the other airports might still pose problems to capacity, especially in inclement weather.

Failure to address capacity issues has direct consequences because the airports cannot handle traffic beyond current levels. These consequences include a loss of 3.1 million annual passengers by 2016 and over 10 million annual passengers by 2024 calculated using projections provided by the Port Authority and the RPA.[71] Of these over 50 percent are would-be international travelers, meaning that the U.S. economy will lose out on over $3.7 billion in annual spending by overseas travelers by 2016, increasing to over $13 billion by 2024 and over $25 billion by 2034. Unmet domestic travel demand has a less significant spending impact, but this still accounts for over $2.5 billion in annual spending by 2024. Forecasted out to 2034, when unmet demand for domestic and international travel reaches over 20 million annual passengers at JFK, the lost economic opportunity is approximately $30 billion annually to the U.S. economy, accounting for over 160,000 jobs.[72]

The potential expansion of JFK has received strong criticism from environmental groups, New York lawmakers, local citizens, and will likely require comprehensive study and public support to proceed.[73] To date, none of the runway construction projects have moved forward, with the largest barriers being environmental and political.[74] Meanwhile the need for additional capacity to meet demand at JFK is immediate, pressing, and has national implications.

CASE STUDY 2: NEWARK LIBERTY INTERNATIONAL AIRPORT (EWR)
NEWARK, NEW JERSEY

As the oldest airport in the New York metropolitan area, Newark Liberty International Airport (EWR) is located 16 miles southwest of Manhattan, and moved close to 34 million passengers in 2012, shown in Figure 7.[75]

As an international hub, EWR sends a significant amount of passengers to the rest of the country: in 2012 nearly half of all departing passengers were connecting from a domestic or international flight.[76] Much like JFK, EWR has experienced consistent congestion-related problems as it increases its load as a major hub and a large international gateway airport.

The number of aircraft movements at EWR has been slowly declining for the last decade from a peak of 455,000 in 1998 to 410,000 in 2011, tracking closely with the passenger levels seen in Figure 7.[78] Unlike at JFK, where growth in aircraft movements is due to scheduled passenger service, EWR has lost scheduled passenger service flights, while commuter flights have been steadily increasing.[79] This is likely the result of the increased presence of United Airlines' hub flying an increased number of regional jets for its longer distance service.

Airplanes taking off at Newark Liberty International Airport

United Airlines commands the largest portion of EWR's flight operations (64.8 percent of EWR flights in 2012). United will likely remain one of the largest air carriers at EWR in years to come, suggested by plans to invest $150 million into their terminal to create a more streamlined experience for passengers.[80] Other airlines that operate out of EWR include Delta (6.1 percent of flights), JetBlue (5.6 percent), and US Airways (5.4 percent).[81]

Current Capacity

EWR operates three terminals and 61 gates to handle passengers and aircraft. Current plans to expand United's terminal are underway. However like at JFK, the majority of the problems facing EWR are airside. EWR currently operates three runways – two parallel and a third intersecting. Using these three runways, EWR is able to provide for 81 operations/hour per FAA slot-control regulations. Similar to JFK, EWR slots are allocated for specific days and time periods, and airlines allocated slots must use these slots at least 80 percent of the time.[83] A 2011 study by the RPA shows that demand at EWR is at or exceeding

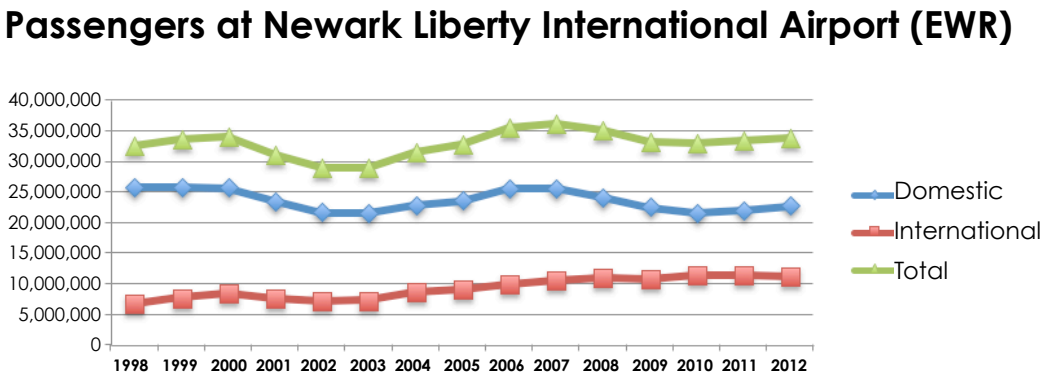

Figure 7: Passengers at Newark Liberty International Airport[83]

the capacity for a significant portion of the day, shown in Figure 8. Like JFK, by 2030 the demand will be significantly greater than the current capacity for most of the day.

EWR has faced significant challenges operating flights in the constricted NYC airspace. EWR has the strongest airspace conflicts with Teterboro Airport (TEB, a busy airport for corporate and private aircraft) and LGA. NextGen is expected to help with the conflicts, improve safety, and increase capacity, but will not be enough to completely resolve the demand constraints facing EWR.

Delays at EWR have been cited as the worst in the country, resulting in the "least-loved" (according to CNN) airport award and the worst on-time departure rate of any of the top 29 U.S. airports tracked by USDOT.[84] In 2012, almost 30 percent of flights at EWR had delays of 15 minutes or more, and only 69 percent of flights arrived on schedule, resulting in delays not only to travelers using EWR, but also to travelers that connect to and from EWR as a hub.[85] The RPA predicts that delays will continue to deteriorate unless capacity improvements are made, as the demand for travel at EWR is predicted to grow substantially over the next 20 years.

Future Capacity

Natural and manmade barriers to EWR, including the New Jersey Turnpike, have challenged the future growth of both airside and landside capacity at EWR. The RPA addressed specific strategies for capacity expansion at EWR in a 2011 report, recommending the construction of a third parallel, longer runway at EWR.[86] However, this would require the demolition of Terminal B and parts of Terminals A and C. Though the possibility of constructing a new, major airport outside of the NYC region to handle the region's air travel demand has been considered, RPA concludes that no new construction within 40 miles would be as economically efficient as expanding the region's three existing airports incrementally.

Also like JFK, EWR is at its capacity limit, and failure to address capacity constraints will result in lost passengers for the New York region and the rest of the country due to unmet demand. For EWR this means losing out on 1 million additional annual passengers by 2016 and over 5 million annual passengers by 2024, using projections provided by the Port Authority and the RPA.[87]

The economic case for expanding EWR is as compelling as it is for JFK, with $1 billion, $4 billion, and over $8 billion in lost economic spending for 2016, 2024, and 2034 respectively, primarily from would-be international passengers coming to the U.S. This translates to over 9,000 jobs in 2016 and over 58,000 jobs in 2034 just by unmet demand at EWR.[88]

Though multiple proposals have been put forward for additional capacity at EWR to address demand and congestion issues, no expansion plans are being considered and funding sources have not been identified.

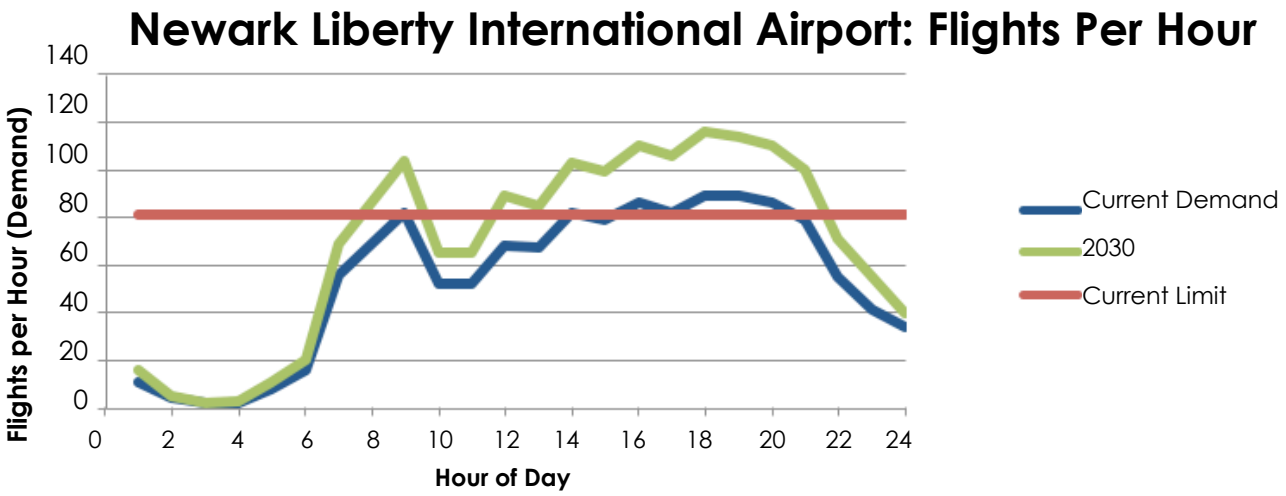

Figure 8: Newark Liberty International Airport - Flights per Hour[82]

CASE STUDY 3: LOS ANGELES INTERNATIONAL AIRPORT (LAX)
LOS ANGELES, CALIFORNIA

Los Angeles International Airport (LAX) is the largest hub for passengers on the west coast of the United States. The airport is located 16 miles to the west of downtown Los Angeles, and it handled 62.6 million passengers in 2012, including more than 16 million international passengers.[89]

LAX has experienced relatively stable passenger levels through the recession in 2008, shown in Figure 9, and has experienced growth in domestic and international passenger levels each year since then Although the number of overall passengers at LAX has been increasing for the past four years, the number of aircraft movements at LAX has declined for the past decade.[91] Traffic peaked at the airport in 2000, with over 780,000 aircraft movements that year.[92] After declining to under 550,000 in 2009, aircraft traffic has rebounded significantly, with over 605,000 movements in 2012. Passenger volumes remain high due to increased plane sizes and load factors on aircraft.

As a large hub, LAX serves a significant proportion of connecting passengers. In 2011, 38 percent of LAX passengers were connecting.[93]

Los Angeles International Airport

Twenty-two percent of connecting passengers who began their trip in California in 2006 were destined to other California cities, down from 36 percent in 2001.[94] This suggests that LAX is becoming increasingly focused on longer distance flights, a trend that coincides with a national trend among large airports towards longer distance flights. LAX is not dominated by a single primary air carrier like many other large commercial service hub airports in the United States. The largest carriers of aircraft operations at LAX are United Airlines (18.7 percent of passengers in 2012), American Airlines (18.5 percent), Southwest Airlines (15.9 percent), and SkyWest (9.8 percent).[95] Though the share of air carriers at LAX has remained relatively equal, changes appear to be on the horizon.

In March 2013, Delta announced plans to expand their presence and

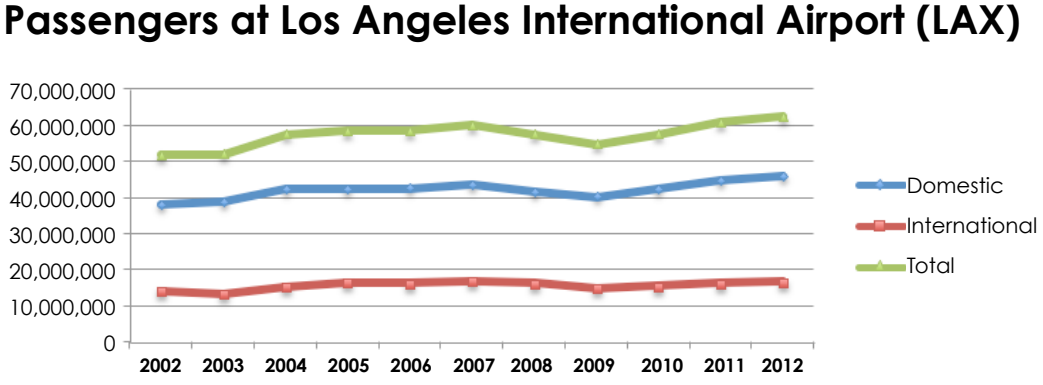

Figure 9: Passengers at Los Angeles International Airport (LAX)[90]

offer new routes at LAX, followed by American's similar announcement to expand at LAX in April.[96] In addition to existing competition over airline presence at the airport, the fate of the American/US Airways merger could also affect American's share at LAX.

Current Capacity

LAX is not under slot-controlled regulations by the FAA and instead employs a traditional "first-come, first serve" procedure for individual aircraft and airlines to access gates and terminals. From an airside capacity standpoint the airport works well as a hub, allowing flexibility for airline carriers who wish to schedule flights in clusters during the day as opposed to evenly scheduling them throughout the day and week. Four parallel runways serve aircraft at LAX, with two located on either side of the main terminals in a modern, efficient layout. LAX's current runway has the potential to move up to 160 aircraft operations/hour.[97] The FAA FACT two identified LAX needing of additional airport capacity by 2025, suggesting a runway capacity problem in the future but not immediately.

The primary capacity constraints at LAX have to do with landside capacity and airport access. The present terminal and ground access infrastructure at LAX was constructed in 1961, with three additional terminals added to the complex in the 1980s, bringing the total to nine.[98] LAX has updated some of its terminals, including the Tom Bradley International Terminal, and is adding capacity to handle the largest aircraft in service at other terminals. Though investment in updating some of the terminals has helped the passenger experience, the airport is problematic when it comes to terminal condition and airport access. While some terminals are connected via walkway or airside shuttle, to transfer between some terminals a passenger must exit the terminal, ride a shuttle bus, and re-clear security. Getting to rental car facilities, which are off-airport, is slow and unpredictable. Access to the airport is primarily achieved by using I-405, one of the most congested stretches of highway in the nation.[99]

Transit access to LAX terminals is limited to regional and local bus services and shuttle buses (on congested airport access roads) to the "Aviation" light rail station 2.5 miles away. This results in transit access to the airport accounting for only 1 percent of air passengers.[100] In general passengers traveling through LAX are often confronted with undesirable conditions, leading LAX to consistently be rated as one of the worst airports in the country.[101]

Ground access to the airport at LAX is the most significant chokehold in the airport's system, and according to Los Angeles World Airports (LAWA) airport access infrastructure was projected to hit complete gridlock at 78.9 million annual passengers without improvements to the system.[102] While 78.9 million annual passengers is a precise number, it is accurate enough to mean that adding about 15 million annual passengers above the 62.6 million in 2012 will be too much for the access and gate infrastructure to handle.

In an attempt to mitigate the traffic issues, LAX is legally restricted to 153 gates to ensure that the airport does not surpass its 78.9 million annual passenger threshold. Since the implementation of the law, LAX has been targeting funds towards improving the traffic congestion problems.[103] Under current growth rates, LAWA expects the airport to reach its maximum capacity around 2022.[104] The gate cap will likely expire by that time, but the airport will need to implement its current plans to improve the ground access problems. According to LAWA projections, passenger demand beyond the capacity threshold will continue to grow at more than two million passengers per year. After 2022, the airport and the region could be losing millions on potential passengers annually, which would have a direct impact on the economy in the region and the national economy.

Future Capacity

In response to projected demand, LAWA is in the midst of a $4.8 billion capital improvement program to improve capacity and efficiency at LAX. The majority of the program's funding is dedicated to terminal improvements, including the recently-completed reconstruction of the Tom Bradley International Terminal, but other initiatives are focusing on improving ground access infrastructure to the airport to improve the airport's overall capacity.[105]

The program also includes airside improvements, including the relocation of the northern-most runway and the construction of an additional lane for larger jet aircraft. However, not all terminals are addressed in this improvement program, and the fundamental problems that plague LAX, including inefficient design, ground transportation access, and terminal crowding will likely continue to pose challenges to the airport in the future without greater overall investment.

CASE STUDY 4: SAN FRANCISCO INTERNATIONAL AIRPORT (SFO)
SAN FRANCISCO, CALIFORNIA

San Francisco International Airport (SFO), located 13 miles south of downtown San Francisco, is the largest airport in the Bay Area and a major hub for air travel on the west coast of the United States. In 2012, SFO moved over 42.6 million passengers, of which 21 percent were international passengers.[106] SFO's passenger growth was not interrupted during the recession, shown in Figure 10, and is expected to continue to grow faster than any other airport in the region.[107]

In tandem with SFO's passenger growth, the number of aircraft movements has also increased over the last six years.[109] Aircraft operations have increased from 379,500 in 2007 to 403,564 in 2012.[110] However, in the Bay Area region, total aircraft operations out of all the region's airports decreased by 21 percent.[111] This demonstrates a greater concentration of traffic at SFO, as well as an increase in larger planes with higher load factors serving the airport.

SFO's largest carrier is United Airlines, accounting for around 49.5 percent of the airport's traffic.[112] Other airlines servicing a substantial market share at SFO include Delta (9 percent), American (8 percent), Southwest (9.14 percent), and Virgin America (7 percent).[113] Nearby airports in Oakland and San Jose have attempted to gather some of the regional traffic, particularly from low cost carriers, but have not experienced the same growth as SFO, consistent with the trend toward consolidation at larger hub airports.[114] The San Francisco Airport Commission has cited the passenger growth to "service increases by United Airlines and Virgin America" as well as "new and increased foreign flag carriers to Europe and Asia."[115]

Current Capacity

SFO operates two intersecting sets of two parallel runways, spaced relatively close together. The small separation between the parallel runways is a result of an airfield that has experienced only minor updating since the initial construction in the 1950s.[116] SFO is "ranked as one of the most delay-prone airports in the country" and "the chief cause of these delays is bad weather when foggy morning and seasonal storms limit SFO to one runway for arriving aircraft." [117]

As a result of the runway geometry and weather patterns of the Bay Area, SFO operations are severely limited during inclement weather, more so than other large international airports in the United States. Under optimal weather, FAA Visual Flight Rules allow SFO to operate at up to 100 flights per hour. [118] Inclement weather, however, restricts SFO to only 61 operations per hour under FAA Instrument Flight Rules that do not al-

San Francisco International Airport

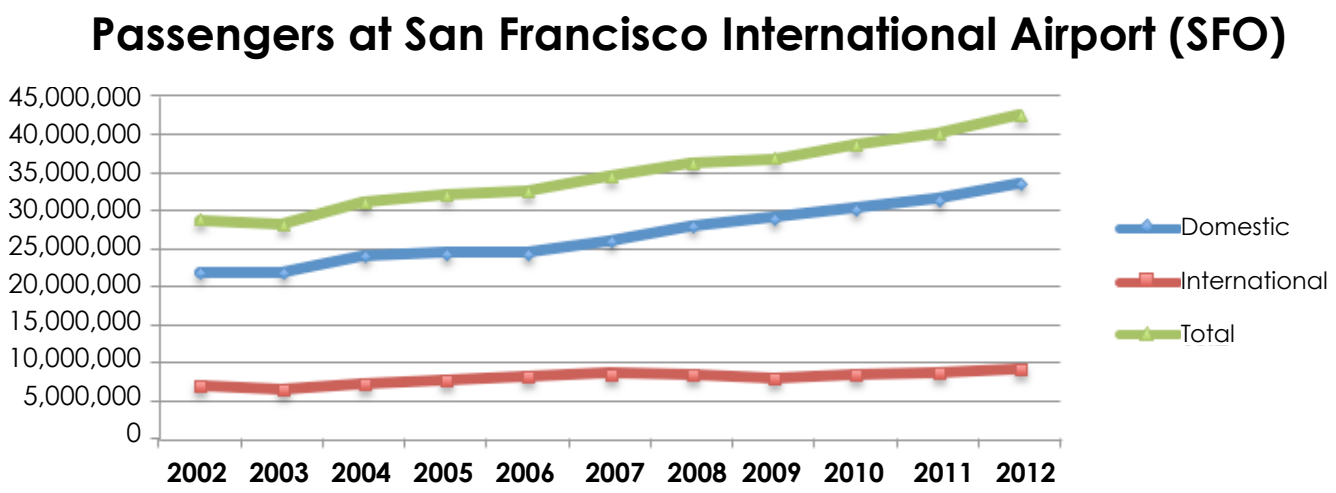

Figure 10: Passengers at San Francisco International Airport (SFO)[108]

low side-by-side approaches with the current runway layout. [119] Demand at SFO has historically exceeded 70 operations per hour at a few times during the day and by 2035 it is projected to reach over 100 operations per hour at peak times. While the airport can currently handle peak demand levels during good weather conditions, delays occur during inclement weather when the airport cannot meet current demand at peak times.[120] As demand grows, small disruptions from weather or other events will create greater problems for travelers.

Other incidents and concerns regarding safety have also called into question SFO's design. On July 6, 2013, Asiana Flight 214 crashed during landing on SFO Runway 28L.[121] While the incident does not appear to be directly caused by the runway design, the FAA responded to the crash by issuing a temporary rule stating that international carriers would not be allowed to land side-by-side at SFO regardless of weather conditions.[122] This temporary regulation decreased airside capacity for international carriers at SFO, and while it was subsequently lifted, it demonstrates the potential instability of the airport's capacity.

Future Capacity

SFO has long experienced capacity challenges related to weather, which are projected to remain and intensify as passenger demand increases in the future. In 2010, the Bay Area Metropolitan Transportation Commission (MTC) led a study that included input from the FAA, regional airports, and other regional planning organizations to examine future airport capacity in the Bay Area. The study was completed in 2011, and estimated that by 2035 the Bay Area will move 101.3 million annual passengers, a 67 percent increase from 2011.[123] The report investigated ways to mitigate delay at SFO, including shifting passengers to less congested airports, using high-speed rail, and managing demand.

These options have their limitations, as shifting traffic would be contrary to the hub and spoke network trends and alternatives have minor effects: high-speed rail was projected to reduce passenger traffic at SFO by only 3.7 percent.[124] Demand management showed more promise, but would require setting restrictions on plane sizes and using buses for shorter routes, both of which are politically challenging. The MTC report does not discuss the option of expanding the airfield by providing more space between runways or adding additional runways due to the "large expense" such a project would incur.[125] SFO's location, surrounded by the San Francisco Bay, has been a barrier that continues to challenge physical expansions of the airport's footprint, particularly of runways. As a result, the majority of alternatives to reduce congestion at SFO have focused on the use of improved air traffic and demand technologies, and increased reliance on other airports.[126]

NextGen air traffic control might be able to help planes land safely with tighter spacing, but runway improvements are likely to have the largest impact in accommodating current and future demand as well as improving the sensitivity of SFO to inclement weather. No capacity improvement projects that will add more runways or reconfigure the existing runways are currently planned.

RESEARCH SUMMARY

Due in part to the recent airline consolidations and the hub-and-spoke nature of the system, the landscape of airport capacity is shifting. Small and medium hub airports are experiencing a decrease in traffic, while capacity at large hub airports is becoming increasingly strained.

Unaddressed capacity problems at these airports have real and direct impacts on the national economy. Unmet demand at JFK and EWR alone is projected to result in $6 billion, $24 billion, and $48 billion in lost spending from travelers in 2016, 2024, and 2034 respectively, primarily from international tourists visiting the U.S. This corresponds to 42,000 jobs in 2016 and over 270,000 jobs by 2034.[127] While some of the unmet demand at New York could be rerouted to other international gateway airports in the eastern United States, increased concentration of hubs and surging demand for international travel to New York City makes this unlikely. And while SFO and LAX have capacity for growth, LAX is projected to meet its capacity limit by 2022, and poor weather at SFO will create greater delays as passengers volumes grow.

The case study analyses demonstrate that addressing capacity problems at some of our largest hub airports will be challenging. JFK, EWR, and SFO all face substantial barriers to airside and airspace capacity expansion. And while LAX has sufficient runway capacity, it has serious landside capacity issues. Funding, physical space, and other political challenges have left these airports with few plans to develop needed capacity and improvements, and it is unclear which investments will have the greatest benefits to the national system.

However, if we take an appropriate perspective in focusing on national benefits from targeted investments, solutions exist that can relieve congestion at these airports and in the larger aviation system.

John F. Kennedy International Airport

POTENTIAL CAPACITY SOLUTIONS

Demand for air travel is growing, and existing capacity at a few of the largest hub airports will not be able to accommodate it. But real, feasible solutions exist to address these aviation capacity problems from a national perspective. Addressing these issues from a national perspective means focusing policies on areas that create the greatest national economic benefits. Current aviation policy does not necessarily approach aviation system capacity in this manner, thus all of these solutions represent a significant break from existing policy.

While none of the solutions are easy to implement, they are all plausible. This section analyzes potential solutions, including operational changes, NextGen air traffic control program, and the expansion of airport infrastructure.

Operational Changes

Capacity improvements do not always require expensive and politically challenging infrastructure expansions, especially if they are targeted towards the areas of greatest need. One potentially cost-effective ways to improve our transportation network is to use what we already have more effectively. There are two methods that are typically used to reduce airside airport congestion: the "regulatory" approach and the "market-based" approach. In a "regulatory" approach, runway or gate access is restricted by slot controls or other regulations. With a "market-based" approach runways or gates are priced according to specific demand factors such as time of day. The following two sections explore these concepts.

Regulatory Approach

The regulatory approach has been used in the U.S. to varying degrees, with limited success. Slot controls were implemented in 1969 when the FAA designated JFK, LaGuardia, Newark, Chicago O'Hare International Airport (ORD), and Regan National Airport (DCA) as high-density airports.

In implementing what became known as the High Density Rule, FAA indicated that slot controls were needed to provide relief from excessive delays at these airports.[128] However, these airports, particularly in New York and Chicago, continued to experience substantial delays despite slot controls.[129] Slot controls at Chicago O'Hare expired in 2002, but congestion and high traffic continued after slot control was dismantled [before any new runways were opened under the O'Hare Modernization Program (OMP)].

In 2004, the FAA implemented a flight cap at O'Hare, limiting the amount of flights that airlines could schedule during peak hours. The first runway was projected to open in late 2007 and, with the recession and the addition of more runways, the cap was lifted in late 2008 and congestion has since abated. Slot controls continue in various forms at the other airports, but due to their ineffectiveness at some of the most congested airports in the country, it is unlikely they will be effective elsewhere.

Slot controls are ineffective primarily due to their blunt nature in controlling, not eliminating, congestion.[130] They do not account for potential airspace delays in a region, revealed to be a serious concern through the case of New York's three major airports. They leave substantial residual congestion because they are implemented based on optimal weather conditions and they provide no incentive for efficient use of scarce airspace. Not surprisingly, discussions about slots at Washington National, in particular, tend to get caught up in the political machinations of Congress. This results in a less than optimal and demonstrably ineffective method of managing congestion.

Pricing Approach

Most landing fees for runways at major airports in the U.S. are priced based on aircraft weight. While this makes some sense in terms of the cost to maintain the runway, in congested conditions the fact that small aircraft pay substantially less than large aircraft creates the wrong incentives for efficient use of limited

Most landing fees for runways at major airports in the U.S. are priced based on aircraft weight. While this makes some sense in terms of the cost to maintain the runway, in congested conditions the fact that small aircraft pay substantially less than large aircraft creates the wrong incentives for efficient use of limited capacity.

capacity. When it comes to issues of landing capacity, a small aircraft and a large aircraft take roughly the same amount of time to land.[131] Therefore, the weight of an aircraft has very little to do with the congestion the aircraft causes. In fact, larger aircraft are far more efficient from this perspective since they bring more people onto the airport runway for the same amount of delay time.

However, changing pricing schemes at airports is incredibly challenging, and attempts to do so have met substantial political and legal impediments. Two congested airports in the U.S. – Boston Logan International Airport (BOS) and LaGuardia – have tried, and failed, to implement effective versions of peak pricing in the past.[132] Such schemes typically face substantial opposition from both general aviation aircraft and smaller regional carriers that do not want to be priced out of the runways at peak travel times. Other opposition has come from communities served by smaller regional carriers who depend on hub-and-spoke service at peak times in order to access the larger hubs in the aviation network. Thus, while peak pricing schemes could be implemented at some airports to help increase capacity by encouraging larger aircraft during peak times, the solution would face serious legal impediments and institutional challenges.

Operational Solutions

Implementing operational changes,

While Los Angeles International Airport (LAX) has the runway capacity to handle traffic growth over the medium term, the airport is long overdue for a redesign of its terminals and access infrastructure.

either regulatory or market-based, can be daunting, in large part because of a lack of federal support. There is a clear national economic interest in reducing congestion at major airports illustrated by reasons enumerated in this paper. But the federal government provides little support for airports that wish to tackle congestion in an innovative way and potentially reduce congestion in the national system. Instead, funding for airport improvements is provided in a highly politicized manner with little regard for return on investment from the perspective of national benefits. In order to break the logjam on operational changes and develop creative solutions, the federal government needs to assist states and airport authorities in overcoming the political obstacles to implementing such changes.

One solution would be to create a discretionary grant program for airport congestion. For a relatively modest sum of money, airports with capacity problems that discourage or impede travel demand could be encouraged to try new innovations that would otherwise face substantial political challenges. For example, if JFK were to try and use peak pricing on its runways, it would undoubtedly face serious opposition. But if they applied for a federal grant to do so, and could only receive funding after the implementation their proposed scheme, they would have more incentive to succeed.

This concept has been used in the past and is exemplified through the USDOT Urban Partnership Agreements (UPA), a program that allowed selected metropolitan regions to receive priority consideration for federal discretionary funds if they were able to successfully implement proposed congestion pricing schemes on their roadways.[133]

A similar program carefully targeted towards airport congestion – and the national benefits derived from reducing that congestion - could potentially bring about substantial innovation while serving a clear national purpose. While the federal government could remain agnostic about the specific solutions embraced by the airport – regulatory, pricing, or other – they could simply measure the results in terms of national benefits. If the results, specifically congestion reduction, were positive, a reward of additional funding could be provided to the grantee.

Air Traffic Control Improvements

NextGen, a nationwide state-of-the-art modernization program for air traffic control, promises to replace the existing radar-based system used by the aviation industry with a system that uses satellite based GPS. Since GPS can provide more precise location information, NextGen can allow for substantial benefits in terms of fuel costs and capacity improvements. NextGen has been a long-time project of the FAA but has moved very slowly.[134]

While there have been some funding problems for the program, the primary obstacles to implementation stem from FAA's leadership problems and resistance from existing stakeholders. Further, FAA has an inherent internal conflict due to its role as both the federal safety regulatory agency and federal air traffic control operator. This dual function has made it very challenging for FAA to move forward with NextGen in a manner that is responsive to private sector concerns.

The private sector, particularly airlines and aircraft manufacturers,

need some level of certainty regarding the benefits of NextGen before they would be willing to invest in new technologies for aircraft. They must have some confidence that FAA will select and move forward with a given technology before they upgrade their aircraft. But because FAA is a large and slow-moving bureaucracy that also happens to be a safety regulatory agency, they are not nimble enough to provide this confidence.

Existing stakeholders also present obstacles to NextGen implementation. Some stakeholders, such as the airlines, stand to gain from NextGen in the form of reduced delays and fuel consumption. However, the airlines have very small profit margins and are understandably reluctant to invest both their own funds and any funds derived from taxes on their passengers. But airlines are more open to this prospect than General Aviation and Business Aviation, who would reap relatively limited benefits from NextGen. These aircraft typically fly into the least congested airports, resulting in little potential gain for them with the implementation of NextGen.

NextGen Improvements

NextGen is unlikely to move forward at a rapid pace without both strong leadership and major institutional changes. The U.S. may consider joining Canada and the U.K. in separating their safety-regulatory arm from their air traffic control arm. This could potentially involve privatization, as has happened in Canada and the United Kingdom, but this is not an essential component. The key is to separate the two functions, which could provide an environment for accelerated NextGen implementation as well as other improvements.[135]

Improvements at airports will have national and international implications due to the interconnectivity of our aviation system and the increased reliance on large aviation hubs.

This idea gained some traction during the 1990s, and almost became a reality, but was ultimately blocked by the air traffic controllers. But a new era has dawned wherein government budget cuts, sequesters, and shutdowns have made life for air traffic controllers under FAA much less desirable.

Resultantly, there is some evidence that the FAA is more willing to contemplate such a structural change. Also, the lack of progress on NextGen has convinced much of the aviation community that the existing structure is not working. There may now be an opportunity to move forward with this large-scale change and accelerate NextGen.

Regardless of whether such institutional changes take place, NextGen needs stronger leadership, particularly at the federal level from the Executive Branch. Without Presidential intervention, NextGen will likely not become a high enough priority to move forward more rapidly.

Airport Infrastructure Improvements

At some major airports, even with operational improvements and NextGen implementation, there will not be sufficient capacity to accommodate demand. The four case studies presented in this report represent only a sampling of the U.S. airports that will need direct investment in landside or airside capacity in order to accommodate future growth and reduce delays.

Most of these airports are major hubs that handle traffic nationwide, and the biggest hubs are only increasing in importance due to industry consolidation. Thus there is a clear national interest in investing in these airports to increase capacity in the national system.

JFK, EWR, and SFO all will require modifications to their existing runways that allow for more aircraft operations. The New York airports in particular face the greatest challenge with the most significant implication for the U.S. economy. Due to the natural and manmade barriers surrounding these airports, this is a particularly challenging task and is not an issue of funding alone. Even if these airports had sufficient funds to construct such expansions, the environmental barriers and community opposition would be strong. However, committing sufficient funds to upgrade these airports would be an important first step.

While LAX has the runway capacity to handle traffic growth over the medium term, the airport is long overdue for a redesign of its terminals and access infrastructure. Traffic on the airport access road creates havoc for drivers attempting to access the airport, and there is currently no alternative access method. This congested, and sometimes dangerous, situation may serve as a substantial impediment to increased international travel, as many passengers arriving at LAX from overseas have a first experience in the U.S. that is frustrating and challenging. This congestion, combined with an outdated terminal layout and poorly organized rental car operation, make travel through LAX less than ideal. However, without substantial funding for upgrade and redesign, this is unlikely to be resolved.

Such challenges are not unique to these four airports, but their cases illustrate the magnitude of problems at the largest international airports in the country. Improvements at these airports will have national and international implications due to the interconnectivity of our aviation system and the increased reliance on large aviation hubs.

Airport Infrastructure Solutions

Improvement to aviation infrastructure will require significant resources and strong leadership. Convincing local taxpayers to fund such expansions typically proves challenging, especially because the benefits of delay reduction are spread around the country. Improvements to the policy structure that enable additional funds and empower local leaders to implement extensive improvement programs will likely be necessary. Two potential areas for improvement are the federal Airport Improvement Program (AIP) and the Passenger Facility Charge (PFC) limits.

Airport Improvement Program

The federal AIP is a grant program administered by the FAA that provides funding to public entities to help facilitate planning and development at public-use airports.[136] The program distributes about $3.5 billion annually, with 65 to 80 percent of the funds allocated through the AIP each year, obligated via a set of formulas. After the formula obligation, the remaining funding is allocated on a discretionary, non-competitive basis. This allocation methodology has effectively created a barrier to improve-

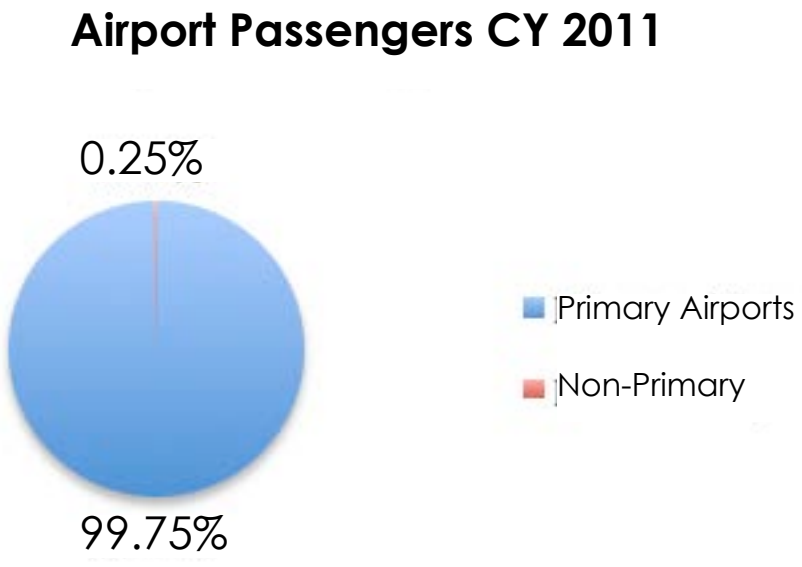

Figure 11: : Airport Passengers in CY 2011[138]

ment by resulting in a highly political distribution of available funds that is misaligned with national goals.

The FAA defines primary airports as having more than 10,000 passenger boardings each year.[137] Figure 11 below shows the share of airport passenger enplanements at primary airports versus non-primary airports. While Figure 11 demonstrates that only 0.25 percent of enplanements occur at non-primary airports, Figure 12 shows that 35 percent of AIP Grants are obligated to non-primary airports.

This is a clear misallocation of resources, given that the federal interest in the nation's aviation system should be in making investments with the greatest national benefits. It is highly unlikely that these non-primary airports, which are receiving approximately $1.35 billion annually while carrying only 1.8 million annual passengers, are the best investment of scarce resources.

Even within the primary airport category, there is room for improvement with respect to how investment decisions are made. AIP grants are made with little regard to national investment priorities within this category. There will always be political challenges that require federal funding to be distributed nation-wide, rather than allocated with maximum efficiency to a few locations. But the AIP program distributes funding based on required set asides and formulas, not based on competitive application, meaning under the current system the FAA cannot target significant amounts AIP funds to the most congested airports in the network.[140]

Passenger Facility Charges

The federal government also restricts how much revenue airports can raise on their own.[141] Congress caps the PFC, which airports assess on passengers and that does not flow to the federal government at all, at $4.50. Many existing stakeholders, including the airlines, are resistant to attempt to remove or increase this cap. Many large airports have even expressed a willingness to give up their limited AIP funds in exchange for the right to raise additional revenues from PFCs, but this idea has not yet gained any legislative traction.

As Table 7 indicates, PFCs account for only 11 percent of revenues at large hub airports. However, they are one of the few mechanisms available to these airports to raise additional funds. The challenges with increasing landing fees or terminal rental fees, which are assessed directly on airlines, are well known. Airlines operate on razor-thin profit margins and have the power to resist such price increases, especially when one airline controls a majority of airport traffic,

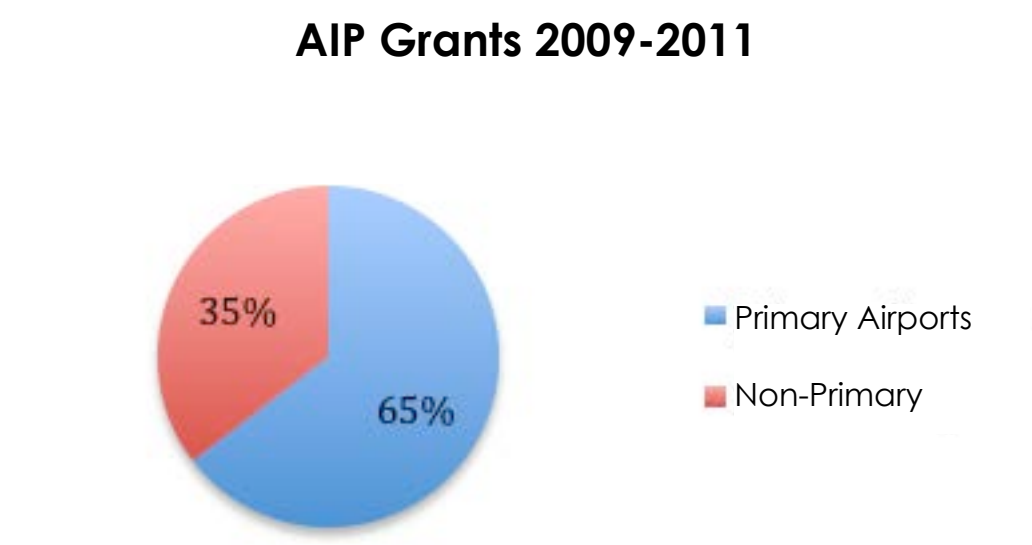

Figure 12: AIP Grants from 2009-2011[139]

as they do at most major hubs. This leaves parking and PFCs as the biggest sources of revenue for airports. Without the flexibility to increase PFCs, airports are left with parking as the only revenue source they can control. This makes capital improvement plans challenging and delays infrastructure investment.

Resistance to increasing PFCs remains strong. While it is not a federal tax, it can be perceived as such by members of Congress because of the federal government's authority to cap it. Legislators are often reluctant to vote for anything that might appear to be a tax increase, even when it clearly is not one. Also, they lack further incentive to expend political capital on this issue, as they would not enjoy the political benefit of being able to spend this money.

More importantly, existing stakeholders in the industry are resistant to an increase. The airlines see PFCs as something that would hurt demand because it would increase the cost of travel. Airlines operate on thin profit margins and already believe they are overtaxed. While they might like to see infrastructure improvements at airports, they would much rather the cost be borne by existing taxes or by people parking at the airport. Business and General Aviation is similarly opposed because the PFC increases their cost of doing business. The PFC cap increase, while plausible, will not be easily achieved without a strong advocacy effort and leadership on Capitol Hill.

Large Hub Airports, 4-Year Average 2008-2012		
Landing Fees	$3,093,698,745	14%
Terminal Rental	$3,878,526,161	17%
Cargo and Hanger Fees	$592,492,261	3%
Fuel Sales	$322,942,892	1%
Other	$1,090,793,569	5%
Total Aviation Fees	**$8,978,453,627**	**40%**
Facility Leases	$540,888,948	2%
Terminal Concessions	$1,444,631,673	7%
Rental Cars	$1,444,018,890	7%
Parking	$3,012,522,502	14%
Other	$839,432,569	4%
Total Non-Aviation Fees	**$7,281,494,581**	**33%**
Interest	$409,389,793	2%
Grants	$2,784,592,379	13%
PFC Revenue	$2,537,062,716	11%
Other	$184,967,937	1%
Total Capital Grants and PFCs	$5,916,012,824	27%
Grand Total	**$14,846,364,800**	**100%**

Table 7: Capital and Operating Revenues by Source, U.S. Large Hub Airports, Average from 2008-2012[142]

The airlines see PFCs as something that would hurt demand because it would increase the cost of travel. Airlines operate on thin profit margins and already believe they are overtaxed.

Conclusions: Stakeholder Limitations

Without substantial infrastructure and policy improvements over the next decade, the U.S. aviation system will not meet global travel demand due to capacity constraints. Unfortunately, most existing aviation stakeholders have little incentive or ability to make these improvements on their own, and federal policy is currently more oriented towards accommodating existing stakeholders than advancing national interests. Some of these stakeholders and their motivations are examined below:

Airlines

The airline industry is highly competitive and operates on very thin profit margins. This ultra-competitive atmosphere serves consumers in that it keeps fares down. However, this also means that the industry's bottom line is more dependent on cutting costs than on accommodating demand for growing passengers. As a result, airlines are focused on policies that will result in lower costs for the industry, such as reducing the taxes and fees assessed on fuel and tickets. Airlines for America, a trade group, frequently cites federal taxes and fees, currently at about 20 percent of a ticket price, as an undue burden.[143] Attempts to increase fees or taxes on the airlines or passengers will almost certainly be met with resistance. While they would not object to more capacity investment, they have no incentive make those investments.

The airline industry is highly competitive and operates on very thin profit margins. This ultra-competitive atmosphere serves consumers in that it keeps fares down.

General and Business Aviation

The General Aviation (GA) community does not typically see capacity constraint as a major issue. GA pilots tend to fly into smaller, less congested airports. Business aviation specifically serves markets that are underserved by major carriers and do not face congestion. Meanwhile, these constituencies are very sensitive to potential increases in cost. Unlike larger aircraft where costs can be spread amongst a larger number of passengers, GA and business aircraft tend to carry fewer passengers. This usually makes any cost increase more onerous for them than for the airlines.

Airports

Large airports have a strong interest in increasing capacity when it is needed. However, large airports represent a small fraction of the airport community, and many airports have seen declines in traffic volumes as airlines have consolidated at fewer large hubs. Representation of airports within trade associations does not always correspond directly with the number of passengers served. Moreover, public sector entities typically own the largest airports. While these entities are concerned with congestion, and want to reduce congestion, doing so is not essential to their bottom line. They do not need to grow their capacity or revenues to satisfy investors, for example. They also are not well financed enough to out-lobby by the airlines and GA communities. Therefore they typically do not have the political strength or capability to

The Federal Aviation Administration has a strong interest in reducing constraints on the airspace system.

push for controversial and challenging expansion initiatives.

Federal Government

The FAA has a strong interest in reducing constraints on the airspace system. Unfortunately, the FAA has consistently demonstrated an inability to accomplish this goal. NextGen has been delayed over many years and many stakeholders are losing confidence in FAA's ability to move forward with the program. Meanwhile, airport capacity investments are not made on the basis of national interest. Overall, FAA is not in a position to seriously address capacity issues without substantial assistance from Congress and the private sector.

Policy Recommendations

Given the outlined stakeholder limitations and the very real national need to address capacity constraints in the U.S. aviation system, a large effort by non-stakeholders will likely be necessary to address this problem from a national perspective. Change will only occur when the larger business community comes together to call for substantive policy changes addressing how we operate and fund our aviation infrastructure. Assuming such a group could come together, we recommend they strongly encourage Congress to make the following policy recommendations:

Restructure the AIP to Target Investment to the Greatest National Interest

The AIP is a program established and managed by the FAA that delivers funding to airports around the country for infrastructure improvements. However, the way that AIP funding is allocated bears little relationship to return on investments or national goals. Reforming this program to target funding to where it provides the greatest national benefit would go a long way towards making adequate funding available to support necessary upgrades in our aviation infrastructure. Our analysis indicates that a substantial amount of this funding – if allocated on the basis of national need – should go to the New York airports. This may change in future years as improvements are made and capacity constraints shift to other parts of the system.

This might seem like an obvious reform but it will face substantial political obstacles. The AIP program is structured to spread funding effectively over a large enough swath of the country in order to ensure consistent political support, and is weighted toward smaller airport that typically have less ability to raise significant amounts of capital.

Redirecting funding toward the largest airports, where it is most needed, will not be a popular idea in Congress. Nonetheless, the idea of injecting some accountability into the AIP program for national benefits should appeal to any member of Congress concerned about government waste or the federal budget deficit. It is worth exploring whether there are ways to improve the AIP program allocations without dismantling the political coalition that keeps it in place.

Create a New Federal Discretionary Grant Program to Address Airport Operations

The concept of a new discretionary grant program to support innovative transportation investments is well known in the surface transportation world. The oldest of these programs is the federal transit "New Starts" program, which supports new investments in rail transit. Applicants from across the country compete for a limited amount of funds to support their proposed investment. They must make the case for their investment based on the benefits it provides per federal dollar. Similar pro-

grams for federal highway and transit investment have since been implemented to support congestion pricing (Urban Partnership Agreements under the Bush Administration) and general infrastructure innovations (TIGER Program under the Obama Administration).

These discretionary programs have demonstrated success using federal dollars to leverage local investment in innovative transportation projects that would have otherwise faced political and funding obstacles too great to overcome. In aviation, this new discretionary program would be targeted more towards the political obstacles than the funding obstacles, and more towards operations than infrastructure. Airports and other entities wishing to relieve congestion in the national aviation system could apply for grants from the FAA. By creating competition with ideas around the country for relieving congestion and creating national economic benefits, this program could foster innovative ideas such as peak runway pricing or other operational changes. But it could also be used to support, for example, new bus or train operations that would demonstrably reduce capacity constraints at airports. It is exactly these kinds of innovations that have the potential to take hold under such a program.

This program would not have to be based on a particularly large amount of money. Even a few hundred million dollars could be sufficient to generate interest. The money for the program could be carved out of the AIP program, though it actually might be politically simpler to allocate general funds for this purpose given the wide variety of potential applicants. While it is never easy to create a new program from scratch, especially with the legal and regulatory barriers that might make creating such a program challenging, this is one that could have a substantial financial return.

There are many possible routes to go with regard to separating air traffic control and safety functions. The simplest way is to create two separate government agencies: Federal Aviation Administration and U.S. Air Traffic Control.

Explore the Idea of Separating the Air Traffic Control and Safety Functions of FAA

This idea is not a new one, and was pushed by both the Clinton and Bush Administrations without success. A new era has dawned in aviation where most stakeholders are fed up with FAA and the slow implementation of NextGen. Even air traffic controllers, who work for FAA, are beginning to see the value in potentially separating from their parent organization.

There are many possible routes to go with regard to separating air traffic control and safety functions. The simplest way is to create two separate government agencies: FAA and USATC (U.S. Air Traffic Control). This would likely be the simplest method of separating the two functions, though it might not resolve all of the current challenges, since the federal government would still control both entities. The next step would be to corporatize the new entity into a nonprofit instead of a government agency. This would allow the new air traffic control agency to behave more like a business with respect to investment decisions, particularly related to NextGen, and give the ability to provide operators with more certainty about technological advances. Canada operates their system with a nonprofit called NavCanada, and has experienced some substantial benefits from this arrangement.

More research is needed to investigate the possible approaches and recommend the one that might work best in the U.S., but any such change will re-

The aviation system plays a fundamental role within our economy and within our transportation system, both domestically and worldwide.

quire sustained political leadership to be achieved. This means convincing Congress and the Administration of the value of moving forward in this manner even before such details are ironed out.

Relax Restrictions on the Airport PFC

The idea of increasing the cap on the PFC remains one of the top goals of the largest airports in the United States. Airports see the PFC cap as a substantial barrier to increased investment in capacity within their facilities, and they know that increasing their PFCs would bring in substantial revenue without suppressing demand.

From a policy perspective, it is understandable why the federal government might want to regulate how much airports can charge passengers. The federal government has an appropriate role in facilitating interstate commerce, and if one strategically placed airport with a monopoly on certain routes decided to start gouging consumers, this could be detrimental to interstate travel. However, that is an argument for maintaining a cap on PFC charges, not for maintaining it at the current rate of $4.50. The reason it is maintained at the current rate is that the airlines and other stakeholders do not want the cost of air travel to rise, even if it means that airport infrastructure will improve. Airlines are also sensitive to increases in PFCs, as a PFC increase for a particular airline's hub might put it at a competitive disadvantage. But there is a clear need to increase funding in order to address our aviation capacity issues and the PFC provides one of the simplest and fairest options for doing so.

At a minimum, the FAA should be given discretion to increase the PFC if and when an airport can demonstrate the need for more investments in order to accommodate demand. If there are clear national benefits to an increased PFC, Congress should allow it. It is almost a free lunch for Congress – increased investment without raising federal taxes or fees. This is a concept that should resonate strongly with those who care about increasing national aviation system capacity, which should be everyone.

Conclusions

The aviation system plays a fundamental role within our economy and within our transportation system, both domestically and worldwide. Demand for passenger travel is growing, and within our current infrastructure and operational paradigm the aviation system may not able to accommodate all of this growth. Our four case studies highlight some of the most limiting capacity issues within the network, providing a sampling of system-wide capacity challenges. While congestion and capacity constraints are concentrated at only a few airports, delays created at congested hub airports ripple through the entire system. In order to ensure that the United States' aviation system is ready for the next generation of travelers, capacity will need to be expanded.

Solutions exist, and while they are politically challenging, they have the potential to be moved forward. Stakeholder limitations may provide a distinct barrier to the aviation system's ability to adapt, but non-traditional stakeholders have the opportunity to step up to work within the system and encourage thoughtful policy changes. The United States has the ability to remain as a global competitor in aviation travel if we are successful in moving these ideas forward.

APPENDIX – AIRPORT INFORMATION

The 20 largest airports were compiled below in Table A-1 in terms of total passengers and international passengers, using data from the U.S. DOT Bureau of Transportation Statistics (BTS).[144] Of the 20 airports, 12 were selected as most relevant to this study, based on infrastructure, hub status, recent investment plans, and passenger levels for domestic and international travelers. Some airports were not selected due to their lower level of overall passengers, as was the case with Honolulu, and some do not have a large presence of a hub airline, as is the case with Orlando and Fort Lauderdale.

We evaluated each of the 12 airports using criteria that aimed to reveal characteristics of the airports' current and future capacity. The information gathered informed the selection of the four most critical airports for further review. The airports were evaluated according to the following factors:

- **Airport Location:** The location and physical footprint of the airport provides a physical context and demonstrates land constraints that an airport is currently facing or will face. Many airports are located adjacent to bodies of water, highways, or other physical constraints that may play a role in limiting capacity expansion.

- **Passenger Levels:** The annual number of passengers for each airport provides data to estimate future demand for airside and landside capacity. Passenger levels also reveal impacts of the recent economic recession on the airport and future expected capacity issues.

- **Connecting Passengers:** The annual number of connecting passengers indicates the influence and interconnectedness of the airport to other airports in the nation. Airports with larger shares of connecting passengers have a greater influence on the national air space, particularly in terms of delays and resulting impacts on other airports.

- **Largest Airline Carriers:** Airline carriers operate using one or more primary hub airport. The presence of a large airline carrier hub at a congested airport could translate into spillover delays for connecting passengers. Spillover delays are a concern for international passengers flying through an airport classified as a major international gateway in the United States.

- **Terminal/Gate Capacity:** The number of terminals and gates indicates the number of passengers the airport can process and move through the airport. Terminals and gates are needed to process passenger movements and dock planes for passenger loading and unloading. In some instances, airports may have sufficient runway capacity but not enough terminal/gate capacity for landed planes to dock.

- **Runway Capacity:** The number and characteristics of runways at an airport determines how many aircraft can safely arrive and depart the airport. Depending on the number of runways, the runway layout, runway location, and other airport characteristics, the FAA determines a maximum operation per hour level for each airport. The layout and orientation of an airport's runways also affects the airport's ability to operate departures and arrivals. Intersecting runway configurations operate significantly less flights than parallel runways, because aircraft have to yield to each other on both arrival and departure. With parallel runways aircraft can be operated simultaneously, handling significantly more aircraft operations than intersecting runways. Older runway infrastructure designs used multiple intersecting runways to accommodate the needs of wind direction, however improved aviation technology has allowed for the construction of parallel runways.

- **Recently Completed/Planned Improvements:** Each airport in the United States produces a Capital Improvement Plan every five

	Airport	Code	Total Passengers	Int'l Passengers	% of Int'l Passengers
1	John F. Kennedy Int'l Airport	JFK	49,034,266	24,774,644	51%
2	Miami Int'l Airport	MIA	37,033,951	18,516,559	50%
3	Los Angeles Int'l Airport	LAX	62,604,533	16,541,798	26%
4	Newark Liberty Int'l Airport	EWR	33,952,143	11,145,313	33%
5	Chicago O'Hare Int'l Airport	ORD	64,222,204	10,187,557	16%
6	Hartsfield-Jackson Atlanta Int'l Airport	ATL	91,466,491	9,576,889	10%
7	San Francisco Int'l Airport	SFO	42,616,804	9,144,975	21%
8	George Bush Int'l Airport	IAH	38,020,084	8,477,922	22%
9	Washington Dulles Int'l Airport	IAD	21,610,571	6,461,788	30%
10	Dallas-Fort Worth Int'l Airport	DFW	56,033,767	5,805,920	10%
11	Honolulu Int'l Airport	HNL	18,246,166	4,364,651	24%
12	Boston Logan Int'l Airport	BOS	28,620,708	4,064,918	14%
13	Philadelphia Int'l Airport	PHL	29,179,750	3,735,700	13%
14	Orlando Int'l Airport	MCO	34,335,365	3,672,832	11%
15	Ft. Lauderdale Int'l Airport	FLL	22,745,073	3,403,248	15%
16	Detroit Metropolitan Airport	DTW	31,201,645	3,192,624	10%
17	Charlotte Douglas Int'l Airport	CLT	40,075,222	2,913,543	7%
18	Las Vegas McCarran Int'l Airport	LAS	39,547,126	2,807,978	7%
19	Phoenix Sky Harbor Int'l Airport	PHX	39,547,126	2,807,978	7%
20	Minneapolis-St. Paul Int'l Airport	MSP	31,857,466	2,177,302	7%

Table A-1: Top U.S. Gateway Airports, by Volume of International Passengers[145]

or 10 years that includes planned improvements for airside capacity and landside capacity. These plans and resultant project lists can be indicators of the airport's predicted passenger growth and ability to handle that growth.

- **Estimated Capacity Need:** Using the data regarding the airport's characteristics and existing airside and landside capacity, an inference was made regarding whether the airport needs immediate airside or landside capacity, short-term capacity (next 10 years), medium term capacity (next 20 years) or long-term capacity (30 or more years).
- **Max Slot Operations Per Hour:** A slot is the right to take off or land during a specified period of time during the day at an airport. The FAA releases slot control rules to manage congestion at specific congested airports by limiting the number of takeoffs and landings that some airlines can make per hour.

JOHN F. KENNEDY INTERNATIONAL AIRPORT (JFK)
NEW YORK, NEW YORK

Located 20 miles to the northeast of Manhattan, in Queens, New York, John F. Kennedy International Airport (JFK) is the nation's largest international aviation gateway, moving 49 million total passengers and 25 million international passengers annually (as of 2012).[146] It is one of the nation's most congested airports, and despite the recession, international passenger growth has been steadily increasing since 2003.

This growth has overtaken the amount of domestic traffic through the airport in 2012, shown in Figure A-1. Six out of the 10 most heavily traveled routes in the country are through JFK, and according to the FAA, a third of the nation's air traffic passes through the New York City region's airspace, including traffic at nearby Newark Liberty International and La Guardia International Airports.[147] JFK is a hub for three domestic airlines: JetBlue (38.5 percent of JFK's flights in 2012), Delta (28.8 percent), and American (16.5 percent).[148] In addition, 65 international carriers serve JFK.[149] Even with congestion levels high, carriers are projected to increase their presence at the airport. JetBlue's domestic airline operations are based out of JFK,[150] and the company recently opened a new terminal that includes additional gates and new international arrival facilities, indicating sustaining its presence into the near future.[151] Delta has also recently made serious investment with a recently completed $1.4 billion Terminal 4, adding nine new gates and streamlined passenger areas.[152]

Many passengers using the airport are originating or have their final destination in the area, however JFK is a hub for connecting flights for domestic and international travelers. In a 2012 passenger survey, 18.4 percent of total departing passengers were connecting through the airport.[153] Of those, 8.4 percent were connecting from a domestic flight, and 10.1 percent were connecting from an international flight.[154] This value is lower than a larger hub airport, such as Atlanta, which has nearly 70 percent connecting passengers, but the value suggests that around nine million passengers flying through JFK continue on to other locations in the U.S.

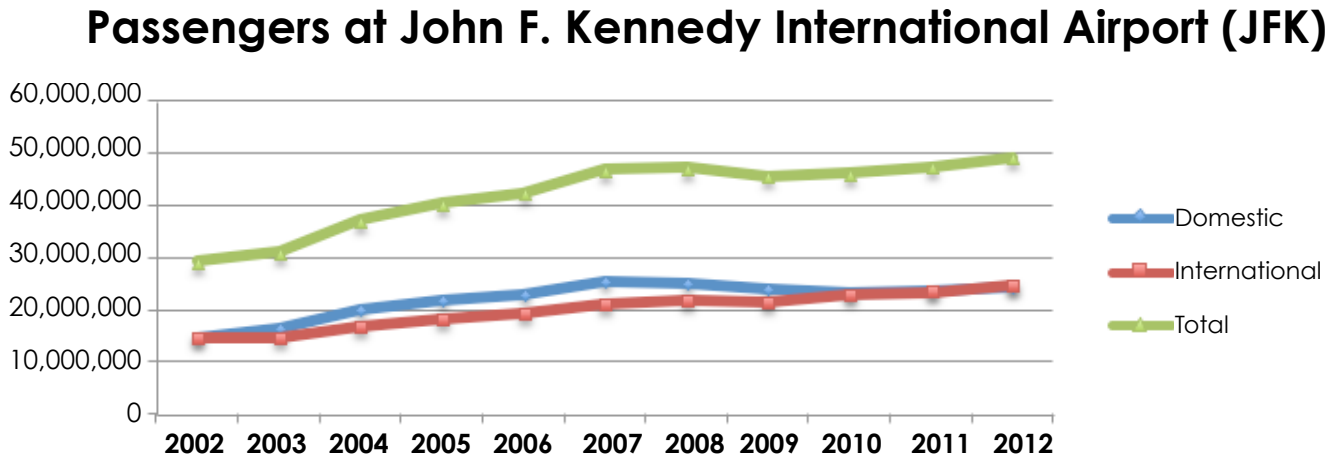

Figure A-1: Passengers at John F. Kennedy International Airport (JFK)

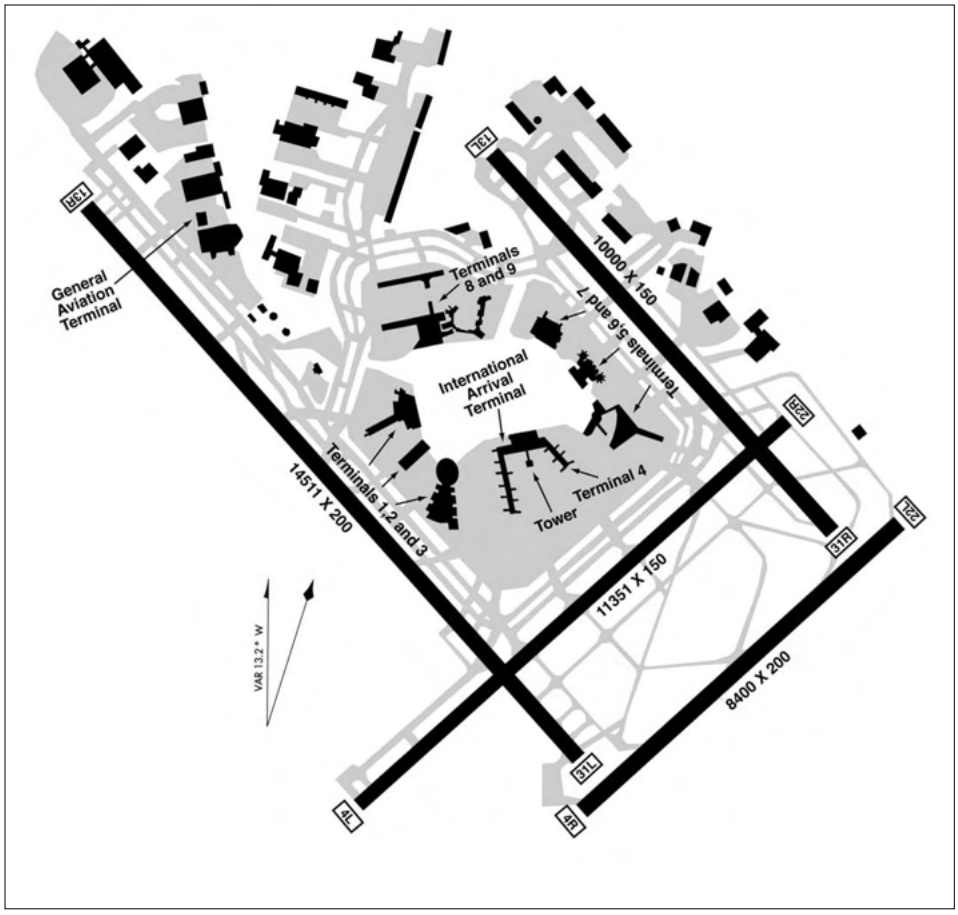

Figure A-2: John F. Kennedy International Airport Layout[158]

Current Capacity

JFK has eight terminals and 117 gates to serve its passengers. Since 2012, the airport has opened two new international terminals – Delta's Terminal 4 and JetBlue's Terminal 5 –improving of its landside infrastructure.[155] However airside capacity constraints are primarily from the intersecting four-runway design. JFK can operate a maximum of 81 flights/hour per FAA slot-control regulations. JFK is one of the four slot-controlled airports in the United States, monitored and regulated the FAA for congestion purposes (other slot controlled airports include Newark, La Guardia, and Washington National).

Departure "slots" are allocated for JFK by the FAA for specific days of the week and must be used at least 80 percent of the time for that day during a scheduling season.[156] Though FAA slot-control regulations allow JFK 82 flights/hour, demand already frequently reaches 90-100 flights/hour during several peak hours throughout the day.[157]

Taking into account the capacity of nearby EWR and LGA airports, the New York City region can currently operate 236 flights/hour. However, demand is expected to increase by 78 additional peak hour flights – close to a 33 percent increase by 2030.[159] By 2030, demand for all New York region airports is expected to increase by 50 million passengers, according to a 2011 report by the New York City RPA. The report predicts "serious capacity deficiencies [at JFK] will become even more apparent in the next ten years,"[160] with demand predicted to rise to 110-130 flights/hour throughout the day.[161] Based on current delays at JFK, a report by the FAA predicts that additional runway capacity at JFK will be required to meet demand through 2015 and beyond.[162]

Because JFK operates closely with the two other large regional airports (Newark and La Guardia) within a very small geographic area, overlapping airspace creates a "tremendous air traffic management challenge."[163] FAA rules for air traffic control cover flight rules, conditions, landing and takeoff configurations, instrument landing systems, and separation standards for the airspace. As a result of the overlapping airspace, JFK must stagger and restrict operations to separate arrivals and departures from EWR and LGA.

Many of the challenges of these overlapping airspace constraints can been addressed through the use of technologies that will modernize the air traffic control system and "disentangle the airspace conflicts among the [NYC] region's airports."[164] In the United States, these technologies are embodied in NextGen[165] which will modernize ATC and enable aircraft to fly closer together within the airspace, likely expanding capacity and realigning departure and arrival airspace routes. Other elements of NextGen still under research have the potential to further improve capacity and efficiency by using 4-D trajectories. NextGen is many years away from implementation, and even when it does bring benefits to the region it is unlikely that this will solve all the capacity problems.

JetBlue Airline opens its new Terminal 5 at John F. Kennedy International Airport.

Future Capacity

To address these aircraft and passenger demand predictions, the Port Authority and the RPA have examined several alternatives to expanding both JFK's passenger and runway capacity. The Port Authority improved one of JFK's busiest runways in early 2010 with a $376.3 improvement plan that extended JFK airport runway in 2010 that has been cited to benefit New York travelers.[166] However, the airport will need additional capacity to handle demand. A January 2011 final draft report by the RPA proposed four options to increase capacity at JFK airport, three of the options will require filling in a large section of Jamaica Bay or obtaining additional land outside the current airport land to build and extend existing runways.[167]

The fourth option proposes to reconfigure runways, potentially affecting air traffic and noise over parts of Queens. If approved, RPA suggests that the extended runway would add $150 million in wages and $707 million in economic activity to the region.[168] In line with the RPA's recommendations, the Port Authority has also suggested the expansion of operational capacity as "the best long-term approach to congestion management" at JFK.[169]

Land acquisition from the Bay or the neighborhoods will be challenging, and the report does not cite a recommendation for funding the expansion. Filling part of the Jamaica Bay has received strong criticism from environmental groups, New York lawmakers, local citizens, and will likely require comprehensive study and public support to proceed.[170] To date, none of the runway construction projects have moved forward and no groups have proposed a method for funding such a project. Yet the need for additional capacity to meet demand at JFK is immediate and pressing.

NEWARK LIBERTY INTERNATIONAL AIRPORT (EWR)
NEWWARK, NEW JERSEY

As the oldest airport in the New York-New Jersey metropolitan area, demand for travel at Newark Liberty International Airport (EWR) has grown significantly since the airport began operation in 1928.[171] EWR is located 16 miles southwest of Manhattan, in New Jersey, and is a hub for both domestic and international flights, moving close to 34 million passengers in 2012, shown in Figure A-3.[172]

EWR experienced substantial growth in passengers from 2000 to 2008, and following the recession has struggled to stabilize. EWR provides a significant amount of passengers to the rest of the country due to international travelers; close to 21.3 percent of EWR passengers were connecting from an international flight.[173] Much like JFK, Newark has experienced consistent congestion-related problems as it has increased its load as a major hub and one of the largest international gateway airports.

EWR is home to 70 air carriers, with United commanding the largest portion of EWR's overall flight operations (64.8 percent of EWR flights in 2012). United will likely remain one of the largest air carriers at EWR in years to come, due to plans to invest $150 million into their terminal to create a more streamlined experience for passengers.[175] Delta (6.1 percent of flights), JetBlue (5.6 percent), and US Airways (5.4 percent) also operate at EWR.[176]

Current Capacity

EWR operates three terminals and 61 gates to handle landside capacity. On the airside, EWR currently operates three runways – two parallel and a third intersecting. Using these three intersecting runways, EWR is able to perform 81 operations/hour according to FAA slot-control regulations.[177] Similar to JFK, EWR slots are allocated for specific days and time periods. Airlines allocated slots at EWR must use these slots at least 80 percent of the time.[178]

A 2011 study by the RPA demonstrates that the airport is at or exceeding the capacity for a significant portion of the day. Like JFK, by 2030 the demand will be significantly greater than the current capacity for most of the day.

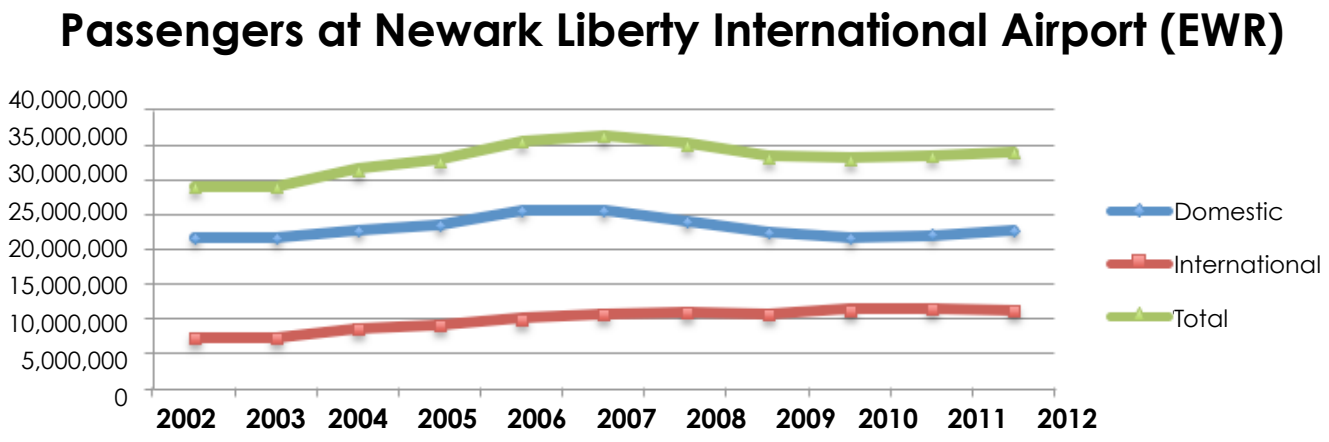

Figure A-3: Passengers at Newark Liberty International Airport (EWR)[174]

EWR has also faced significant challenges operating flights in the constricted New York City airspace. EWR has the strongest airspace conflicts with Teterboro Airport (TEB) and LGA. After implementation, NextGen will help with the conflicts, improve safety, and increase capacity. However NextGen alone will not be enough to completely resolve the demand constraints facing Newark International Airport. Delays at EWR have been cited as the worst in the country, giving the "least-loved" (according to CNN) airport award and the worst on-time departure rate of any of the top 29 U.S. airports tracked by USDOT. [179]

In 2012, almost 30 percent of flights at EWR had delays of 15 minutes or more, and only 69 percent of flights arrived on schedule.[180] The New York RPA predicts that delay will continue to deteriorate unless capacity improvements are made, as the demand for travel at EWR is predicted to grow by nearly 50 percent in the next 20 years.[181]

Future Capacity

Natural and manmade barriers to EWR, including the New Jersey Turnpike, have challenged the future growth of both airside and landside capacity at EWR. RPA addressed specific strategies for capacity expansion at EWR in a 2011 report,[182] recommending the construction of a third parallel, longer runway for additional capacity at EWR. However this would require the demolition of Terminal B and parts of Terminals A and C.[183]

Though the possibility of constructing a new, major airport outside of the New York City region to handle the region's air travel demand has been considered, the RPA report concludes that no new construction within 40 miles would be as economically efficient as expanding the region's three existing airports incrementally. Though multiple proposals have advocated for additional capacity at EWR to address demand and congestion issues, no expansion plans are being considered and no funding sources have been identified.

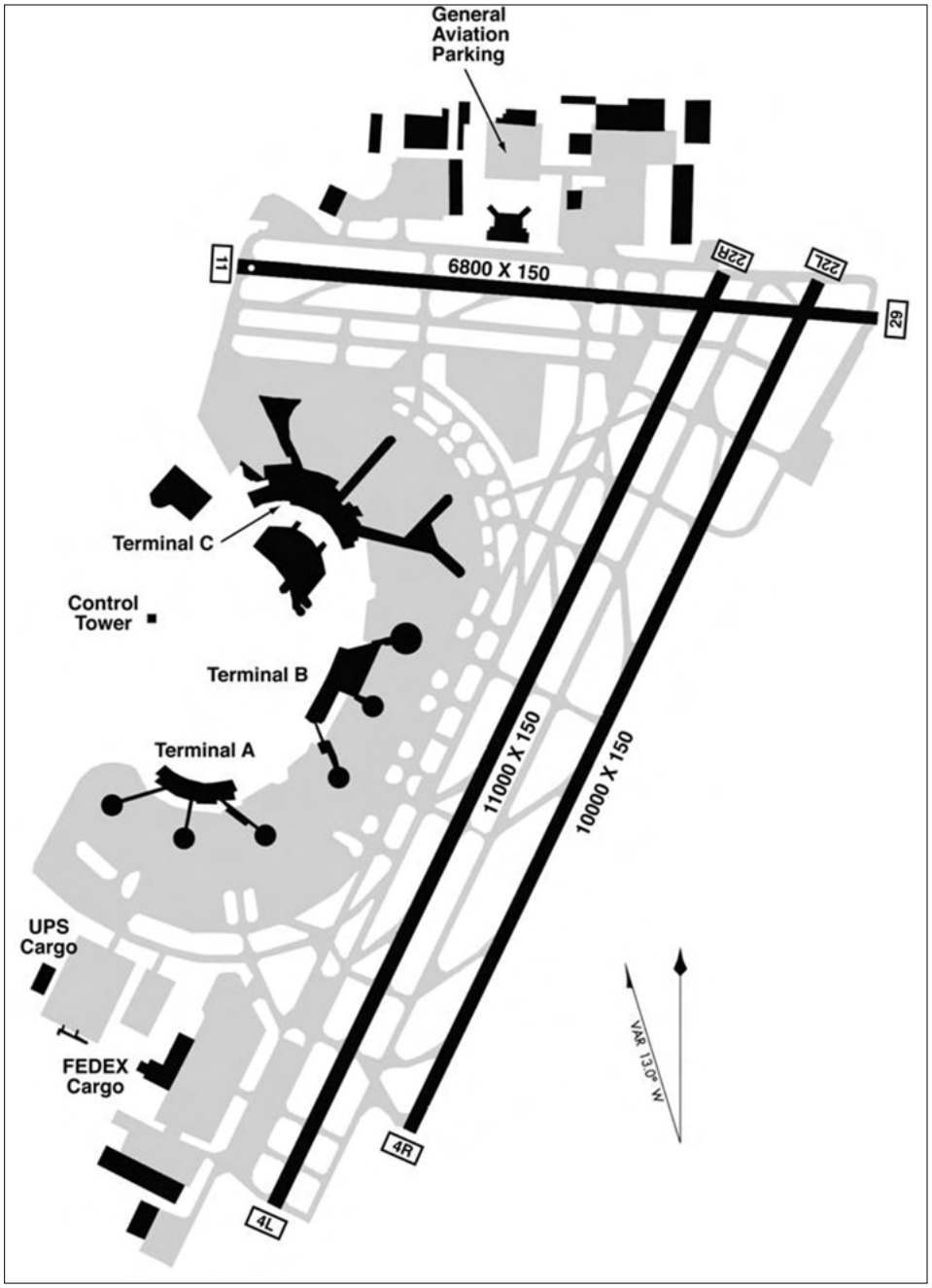

Figure A-4: Newark Liberty International Airport Layout[171]

MIAMI INTERNATIONAL AIRPORT (MIA)
MIAMI, FLORIDA

Miami International Airport (MIA) is the second largest international gateway into the United States. MIA is a crucial connecting point between the United States and Europe, Central America, and South America. In 2012, MIA carried 37 million total passengers and 18.5 million international passengers.[184]

Domestic passenger growth has been slight in the last decade, but the rapid increase in international passengers has encouraged the development of new international facilities and terminals at the airport.[185] Figure A-5 demonstrates growth in both overall and international passengers at MIA over the past decade, slowing modestly after the 2008 recession.

MIA is home to over 80 domestic and international airline carriers, dominated by American Airlines (78.5 percent of MIA flights in 2012) and Delta Airlines (11.5 percent).[187] More than 50 international carriers operate from MIA to approximately 150 destinations around the globe, and the airport recently built a large International Arrivals Facility as part of the north terminal to serve this expanding international demand for passenger traffic.[188]

Currently, MIA's four runways, shown in Figure A-6, can move up to 70 million passengers/year. However, landside capacity – three terminals and 119 gates – can only handle 50 million passengers/year, creating a gap between how many planes MIA can land and how many passenger facilities the airport has to move them. According to MIA Aviation Director José Abreu, "the airport can land [airplanes], but can't gate them," a problem that is causing issues, but could also limit growth in the future as demand continues to increase.[189] With view to MIA's future, the most recent Airport Master Plan (2010) projects a potential demand of approximately 68 million passengers in 2035, nearly double that of the 37 million passengers who moved through MIA in 2012.[190] Though the current runway structure of MIA can handle the airport's passenger projections in 2035, the current terminal and runway capacity will require expansion to accommodate the demand by that time.

To address the current capacity challenges and the gap between airside and landside capacity, MIA has been working on several renovation projects as part of their $6.4 billion Capital Improvement Program in 2011. A new North Terminal opened

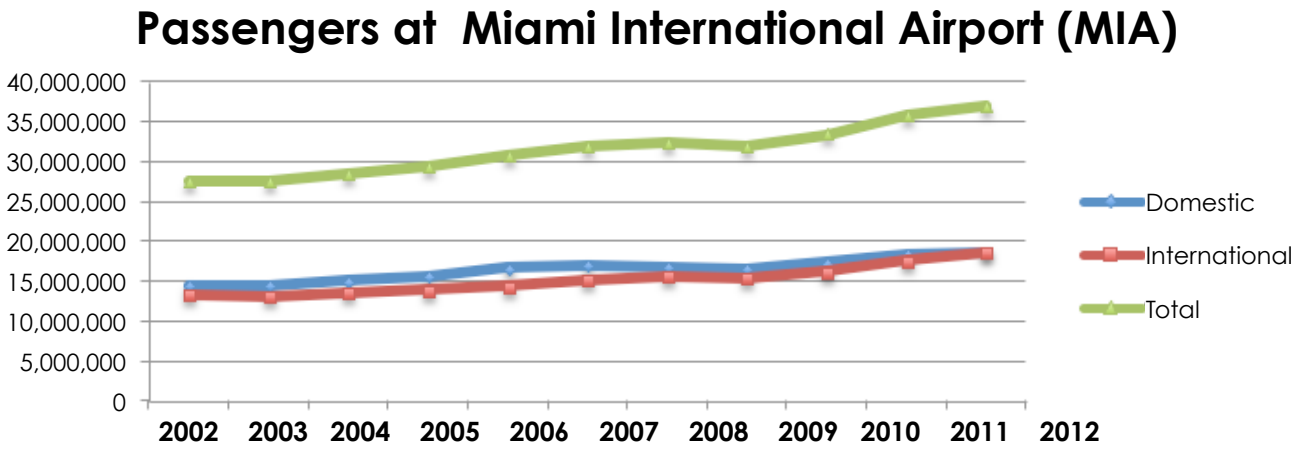

Figure A-5: Passengers at Miami International Airport (MIA)[186]

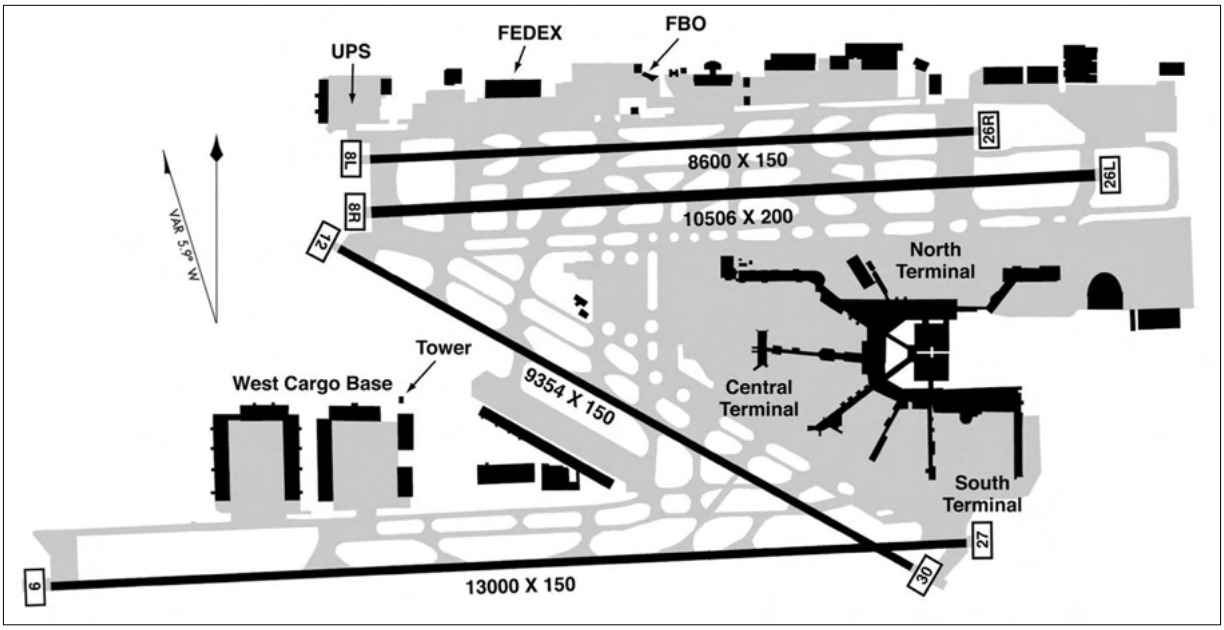

Figure A-6: Miami International Airport Layout

in Fall 2011, serving as the hub for American Airlines' South America and Caribbean flights and other international travel.[191] Improvements made by the airport have included a new runway (Runway 8L-26R), new taxiways, increased navigational aids, updates to the South Terminal, and other improvements to parking facilities.[192] MIA appears to be proactively working on expansion projects to serve current capacity constraints and address the projected growth.

Miami International Airport has been working on several renovation projects as part of their $6.4 billion Capital Improvement Program in 2011.

LOS ANGELES INTERNATIONAL AIRPORT (LAX)
LOS ANGELES, CALIFORNIA

Los Angeles International Airport (LAX) is the largest hub for passengers on the west coast of the United States. The airport is located 16 miles west of downtown Los Angeles, in the neighborhood of Westchester, and serviced 62.6 million passengers in 2012, including more than 16 million international passengers.[193] LAX experienced relatively stable passenger levels through the recession in 2008, shown in Figure A-7, but has experienced growth in passenger levels annually for domestic and international travel.

In 2006, 34 percent of LAX passengers were connecting.[195] Less than one-quarter (22 percent) of connecting passengers who began their trip in California in 2006 were destined to other California cities, down from 36 percent in 2001.[196] This means that LAX is becoming increasingly focused on longer distance flights – a trend that coincides with a larger trend toward longer flights.

LAX is home to 63 airline carriers, but is not dominated by a single primary air carrier like many other large commercial service hub airports in the United States. The largest carriers of aircraft operations at LAX are United Airlines (18.7 percent of passengers in 2012), American Airlines (18.5 percent), Southwest Airlines (15.9 percent), and SkyWest (9.8 percent).[197] SkyWest, a regional carrier, operates flights for United, American, and Delta under code sharing agreements. Though the share of air carriers at LAX has remained relatively equal, changes are on the horizon.

In March 2013, Delta announced plans to expand their presence and offer new routes at LAX, followed by American's similar announcement to expand at LAX in April.[198] In addition to existing competition over airline presence at the airport, the fate of the American/US Airways merger could also have effects on American's share at LAX.

Current Capacity

LAX has comparatively adequate airside capacity. Four parallel runways serve aircraft at LAX, with two located on either side of the main terminals. As a result of the geometric configuration of the parallel runways, LAX can operate up to 160 operations/hour, one of the highest operation rates of any airport in the United States (twice that of New York's JFK airport).[199] LAX is not under slot-controlled regulations by the FAA,

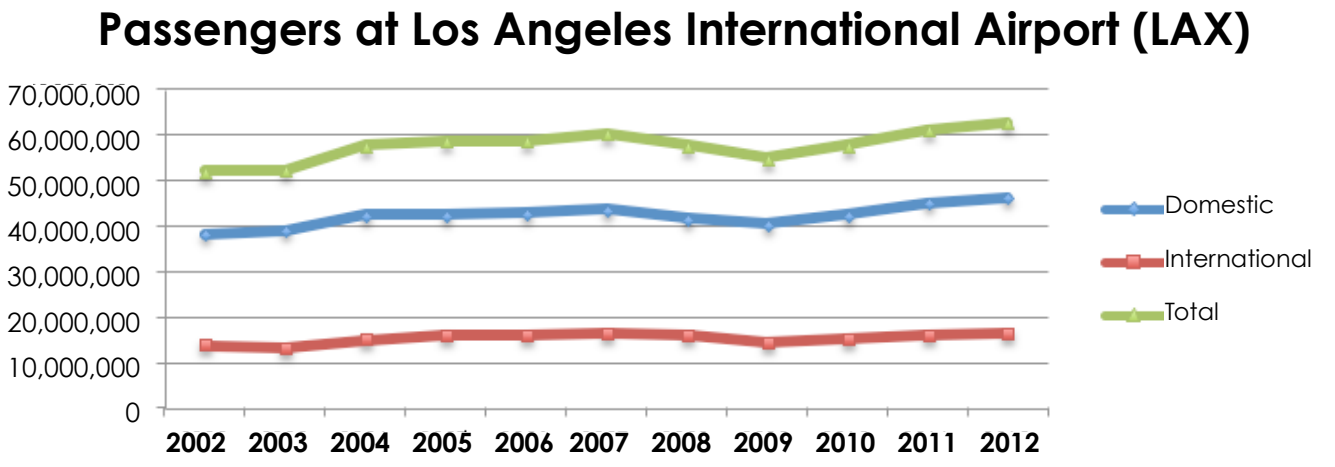

Figure A-7: Passengers at Los Angeles International Airport (LAX)[194]

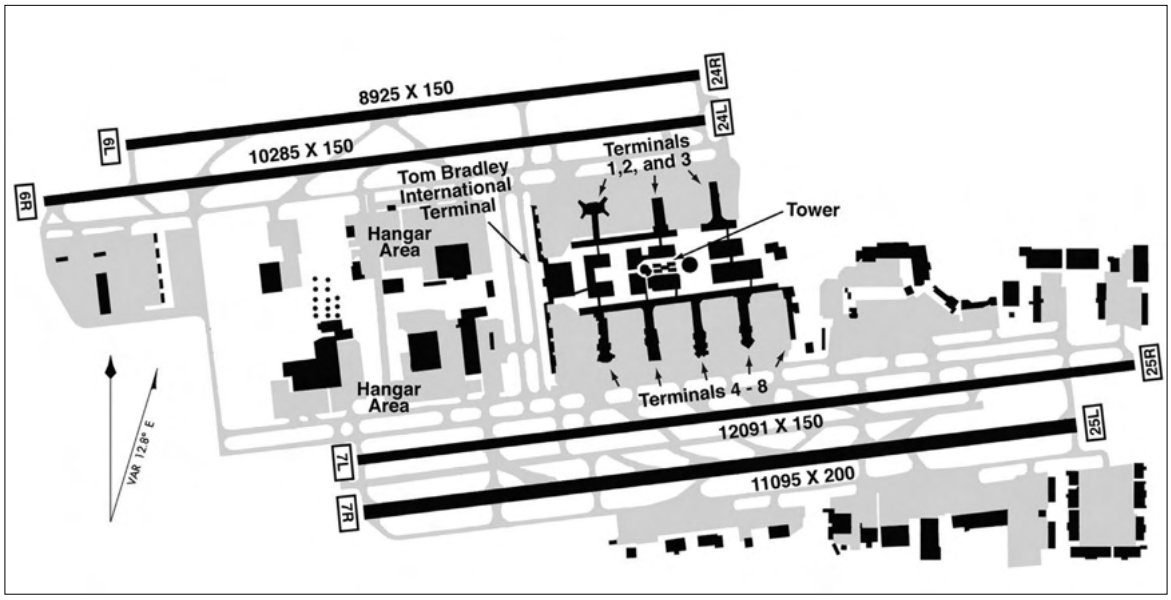

Figure A-8: Los Angeles International Airport Layout

and instead employs a traditional "first-come, first serve" procedure for individual aircraft and airlines to access gates and terminals. From an airside capacity standpoint the airport works well as a hub, allowing flexibility for airline carriers who wish to schedule flights in clusters during the day as opposed to evenly scheduling them throughout the day and week. The FAA identified that LAX needed additional airport capacity by 2025, suggesting a runway capacity problem may manifest itself. However, recently announced service increases by Delta and American could necessitate capacity improvements sooner.

In terms of landside capacity, LAX has nine passenger terminals arranged in a horseshoe layout. The present terminal and ground access infrastructure at LAX was constructed in 1961 with three additional terminals added to the complex in the 1980s.[200] LAX is updating some of its terminals, including the Tom Bradley International Terminal, adding capacity to handle the largest aircraft in service. Though investment has helped the passenger experience, the airport remains unsatisfying regarding terminal condition and airport access.

To transfer between most terminals, passengers exit the terminal, ride a shuttle bus, and then re-clear security. Passengers primarily access the airport via a congested, outdated highway.[201] Transit access to the terminals is limited to local bus services and shuttle buses to the Aviation light rail station 2.5 miles away. Transit access to the airport accounts for 1 percent of air passengers.[202]

While the airport has sufficient runway capacity to land aircraft, the dated terminals and airport access infrastructure will not allow the airport to easily handle future passenger volumes. Passengers that do travel through LAX often undergo a poor experience, which is why LAX is consistently rated as one of the worst airports in the country.[203]

Future Capacity

LAWA is responsible for managing the airport's capacity, growth, and development projects. LAWA is currently in the midst of a $4.8 billion capital improvement program to improve capacity and efficiency at LAX, under the LAX Modernization Program. The program was approved in 2011, and is composed of many different improvements.

Most of the funding is dedicated to terminal improvements, including the reconstruction of the Tom Bradley International Terminal.[204] The program does have some airside improvements, including the relocation of the northern-most runway and allowing for the construction of an additional lane that allows for larger jet aircraft. Not all terminals are addressed in this project and the fundamental problems that plague LAX, including the inefficient design, airport access, and terminal crowding, will not be fully addressed.

CHICAGO O'HARE INTERNATIONAL AIRPORT (ORD)
CHICAGO, ILLINOIS

Twenty miles from downtown Chicago, O'Hare International Airport (ORD) provides air access to the Chicago region in partnership with smaller Midway International Airport (MDW), 10 miles to the southeast of downtown Chicago. In 2011, ORD served 878,798 airline operations, second in the world behind Atlanta Hartsfield-Jackson International Airport.[205]

O'Hare is a major hub for connecting domestic and international flights - in 2009, around 14 million connecting passengers departed ORD, approximately 60 percent of total passengers.[206] However, total passenger traffic has declined in recent years. Figure A-9 demonstrates a peak in passenger traffic before the recession, and recent stabilization of passenger traffic at levels similar to that of 2003.

O'Hare offers daily flights to 198 destinations, and the largest air carriers that operate out of O'Hare include United (40.1 percent of passengers in January 2012) and American (34.4 percent).[208] United is based out of Chicago, and recently modernized its terminal at O'Hare in an effort to maintain and update their presence as a hub. However, both United and American Airlines recently eliminated over 60 daily flights at O'Hare, citing high fuel prices and delay statistics at the airport.[209]

Chicago O'Hare International Airport

ORD has four intersecting runways (Figure

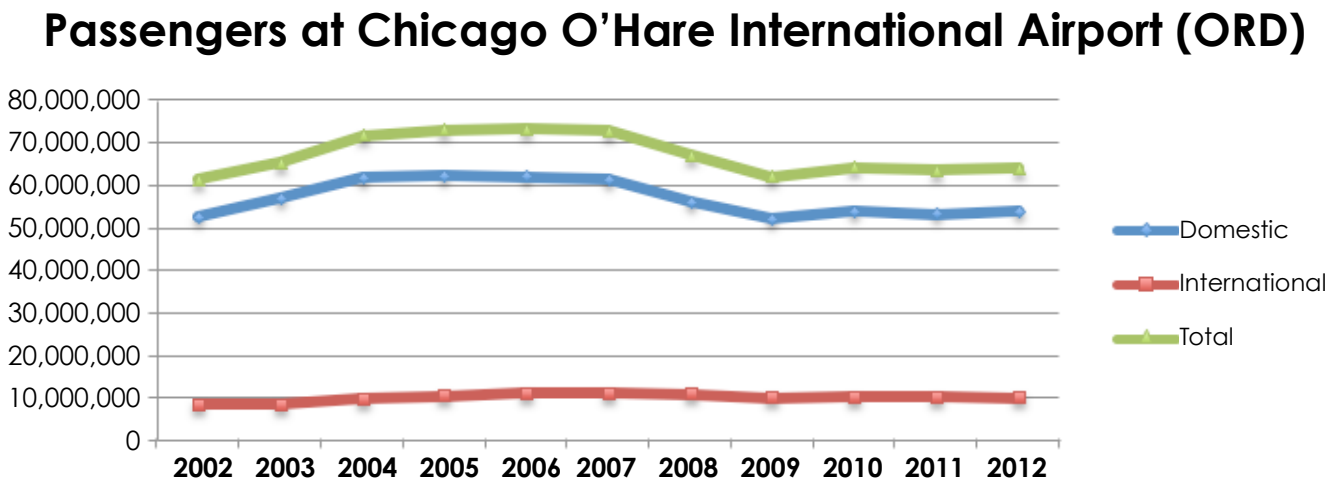

Figure A-9: Passengers at Chicago O'Hare International Airport (ORD)[207]

A-10), and in February 2013, the *Chicago Tribune* reported that O'Hare was the "most delay-plagued" airport in the nation, with less than 66 percent of flights taking off on time.[210] In response to continual problems with delay at ORD, in 2003 the Chicago Department of Aviation (CDA) developed the $8.7 billion O'Hare Modernization Program (OMP).

Since its approval in 2005, the OMP has evaluated existing airport infrastructure, runway design and length, terminal size, and other supporting technologies to modernize ORD systems to handle future capacity.[211] After the OMP's completion, the airport will have eight runways – six parallel and two that intersect.

The new runway layout is designed to "reduce flight delays and increase flight capacity well into the future," and lengthen runways so ORD can handle more large international aircraft.[212] Before the beginning of the OMP, the airport's daily capacity was 2,700 operations/day. Once the OMP is completed, the airport's daily capacity is projected to rise to 3,800 operations/day.[213]

It is projected that the additional capacity provided to ORD through OMP projects will enable the airport to handle current capacity and future growth for some time.

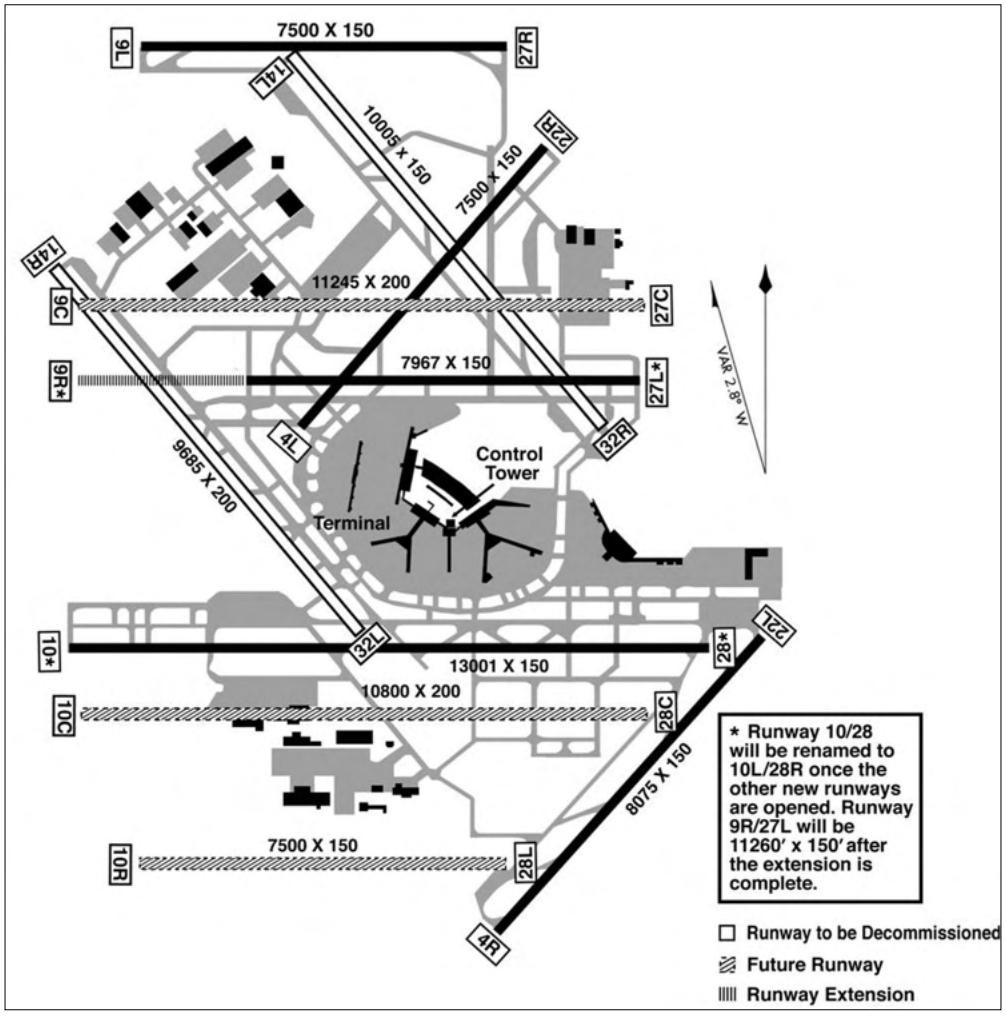

Figure A-10: Chicago O'Hare International Airport Layout

HARTSFIELD-JACKSON INTERNATIONAL AIRPORT (ATL)
ATLANTA, GEORGIA

The busiest airport in the world, the Hartsfield-Jackson Atlanta International Airport (ATL) is 15 miles south of downtown Atlanta, and spans 4,700 acres.[214] ATL provides service to approximately 10 million international passengers each year, and serves eight times as many domestic passengers, for a total of around 90 million. Of those 90 million total passengers, around 69 percent connect through ATL, and 31 percent are originating or ending their trip at ATL.[215]

ATL exceeds all other U.S. airports in terms of domestic connecting passengers (25 million in 2009).[216] The airport provides service to 150 U.S. destinations and 75 international destinations around the world in 50 countries. At ATL, Delta Airlines has the largest share of passenger traffic (at 79.0 percent), seconded by Southwest/AirTran (at 13.2 percent).[217] While the airport carries a substantial amount of domestic and international flights, domestic flights have the largest capacity concern.

Improving capacity, efficiency, and delay is crucial to ATL's operations. In 2007, the FAA's 2007 Capacity Needs in the National Airspace System report identified the Atlanta metropolitan area as needing additional airport capacity by 2025, even with planned capacity expansion.[218]

In response to predicted passenger demand, ATL constructed and opened a new fifth runway in 2007 that has since allowed the airport to accommodate 134 flight arrivals and 120 departures/hour in fair weather. ATL's airport layout is illustrated in Figure A-12. In inclement weather, the new runway has allowed ATL to handle 100 operations/hour – the same number that the pre-2007, two-runway system could handle in good weather.[219] ATL has been making positive strides toward addressing its current and future capacity problems, and looks to have sufficient capacity to handle projected passenger traffic in coming decades.

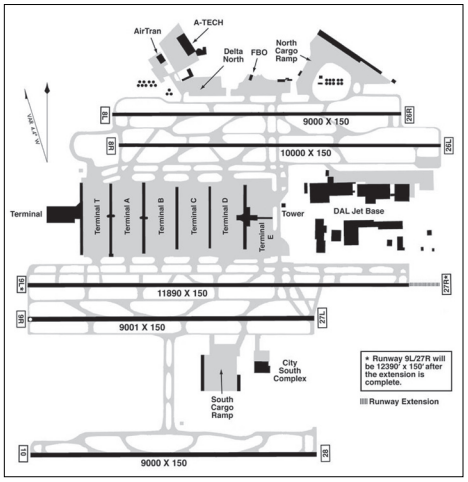

Figure A-12: Hartsfield-Jackson Atlanta International Airport Layout

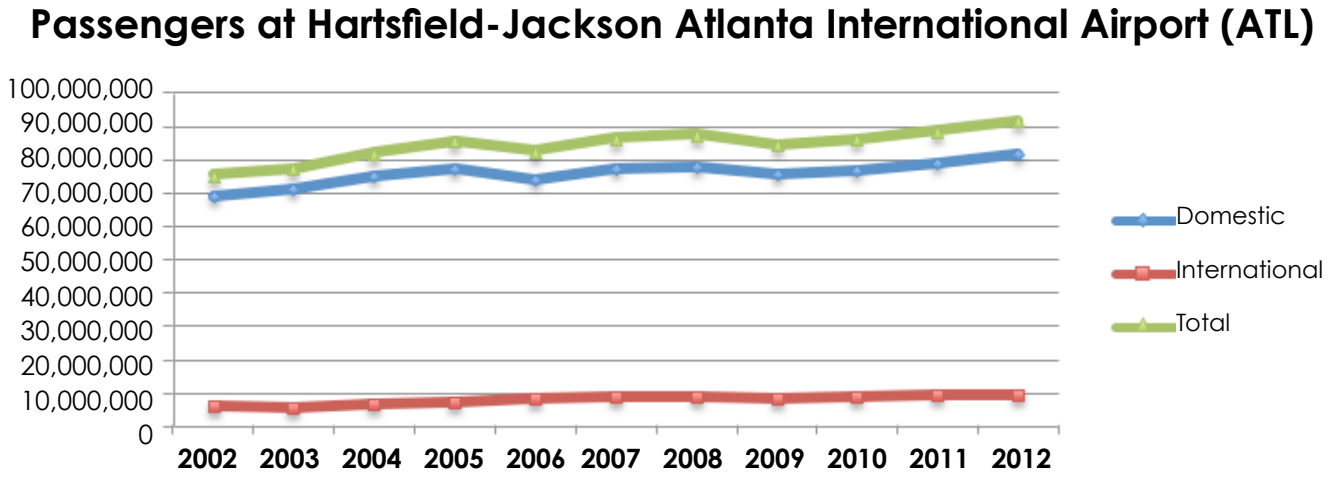

Figure A-11: Passengers at Hartsfield-Jackson Atlanta International Airport (ATL)

SAN FRANCISCO INTERNATIONAL AIRPORT (SFO)
SAN FRANCISCO, CALIFORNIA

San Francisco International Airport (SFO), located 13 miles south of downtown San Francisco, is the largest airport in the Bay Area and is a major hub for air travel on the west coast of the United States. In 2012, SFO moved just over 42.6 million passengers, 21 percent were international passengers.[220] SFO's passenger levels did not have an interruption in growth during the recession, shown in Figure A-13, and are expected to continue to grow faster than any other airport in the region.[221]

SFO hosts 54 international and domestic airline carriers, with the largest share being United, accounting for around 49.5 percent of the airport's traffic.[222] Other airlines servicing a substantial market share at SFO include Delta (9 percent), American (8 percent), Southwest (9.14 percent), and Virgin America (7 percent).[223]

Nearby airports in Oakland and San Jose have attempted to gather some of the regional traffic, particularly from low cost carriers but have not had the same growth as SFO, consistent with the trend toward consolidation at larger hub airports.

San Francsico International Airport

Current Capacity

SFO operates two intersecting sets of two parallel runways that are very close together. The small separation between the parallel runways is a result of an airfield that has only minor updating since the initial construction in the 1950s.[224] As a result of the increased size of aircraft, the runways are now too close together for parallel approaches under poor weather conditions. This has drastically reduced the number of aircraft that can land safely at SFO, especially combined with chronic weather issues in the Bay Area.

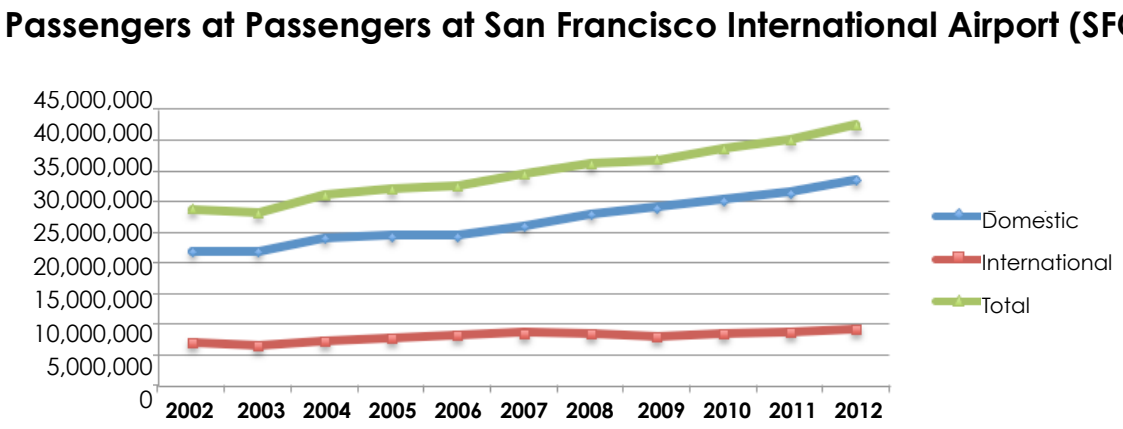

Figure A-13: Passengers at San Francisco International Airport (SFO)

Other incidents and concerns regarding safety have also called into question SFO's design. On July 6, 2013, Asiana Flight 214 crashed during landing on SFO Runway 28L.[226] In response, the FAA issued a temporary rule stating that international carriers will no longer be allowed to land side-by-side at SFO regardless of weather conditions, however domestic carriers are still allowed to land side-by-side in fair weather.[227] This temporary regulation decreased airside capacity for international carriers at SFO, and while it was subsequently lifted, it demonstrates the instability of the airport's capacity.

Future Capacity

SFO has experienced capacity challenges that are projected to remain and intensify as passenger demand increases. In 2010, the San Francisco Metropolitan Transportation Commission (MTC) led a study that included input from the FAA, regional airports, and other regional planning organizations to examine future airport capacity in the Bay Area.

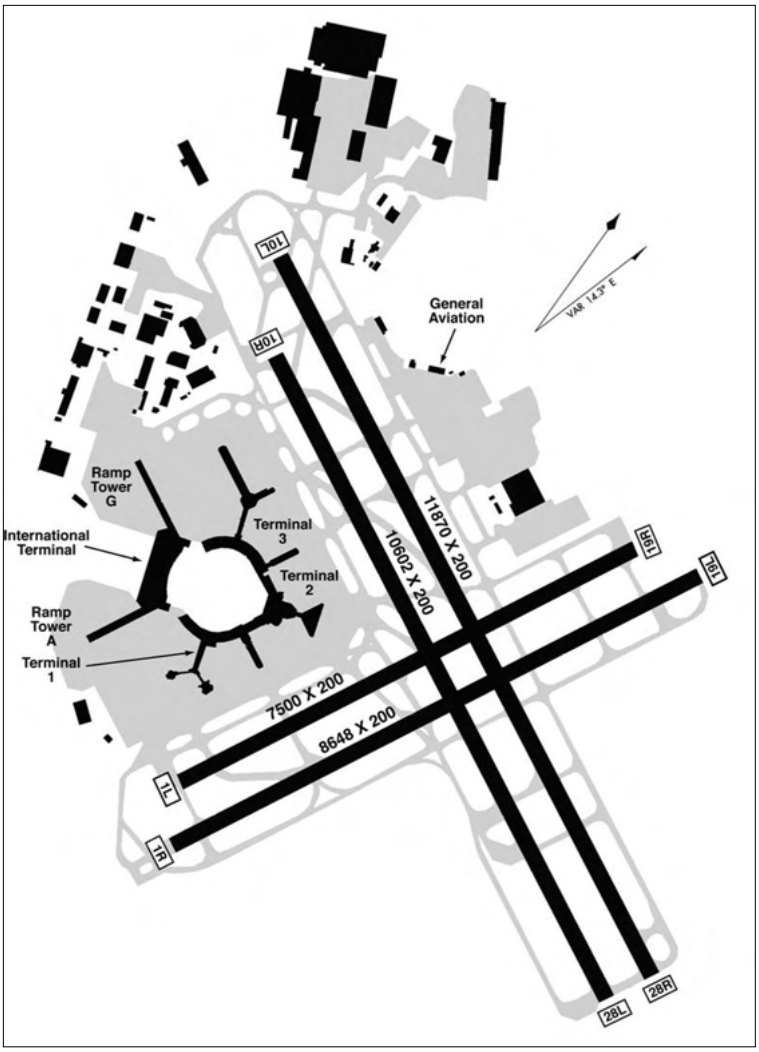

Figure A-14: San Francisco International Airport Layout

The study was completed in 2011, and projects that by 2035 the Bay Area will move 101.3 million annual passengers, a 67 percent increase from 2011.[228] Combined, the three largest Bay Area air travel hubs are projected to face capacity issues around 2020,[229] and will not have the capacity to meet demand projections for 2035.[230]

Another report, conducted in 2010 by the Flight Transportation Associates, similarly projects that if no improvements or expansions are made, SFO will reach full capacity sometime between 2020-2035.[231] The FAA's FACT 2 report identified similar capacity restraints to SFO, citing 2025 as the year that the airport would reach capacity.[232]

In response to the projected capacity challenges at SFO, the reports propose solutions to remedy congestion issues. SFO's location, surrounded by the San Francisco Bay, has been a barrier that continues to strongly challenge physical expansions of the airport's footprint, particularly of runways. As a result, the majority of alternatives to reduce congestion at SFO have focused on the use of improved air traffic and demand technologies, and increased reliance upon other airports.[233] No capacity improvement projects that will add more runways or reconfigure the existing runways are planned, nor has the Bay Area identified a way to pay for any such improvements.

GEORGE BUSH INTERCONTINENTAL AIRPORT (IAH)
HOUSTON, TEXAS

George Bush Intercontinental Airport (IAH) services the Houston metropolitan region as the area's primary international gateway. IAH is located 23 miles north of downtown Houston, near the Sam Houston Tollway, and spans 10,000 acres of land.[234] The airport was named the fastest growing of the top ten airports by the USDOT in 2006, but since the recession and the merger of Continental Airlines with United, the airport has had an overall decline in passenger growth.

However, international passenger traffic has continued to increase over the past decade at IAH, unaffected by decreasing domestic traffic, shown in Figure A-15. According to a 2011 Forecast of Aviation Demand by GRA International, overall passenger traffic at IAH is projected to increase through 2030.[235]

IAH serves over 170 destinations domestically and around the world, with nearly 40 million passengers passing through IAH in 2012. The airport offers more service to Mexico than any other U.S. airport, serving 30 Mexican destinations.

Prior to the merger with United Airlines, Houston-based Continental Airlines operated its largest hub presence at DFW airport. Only 20 airlines operate out of IAH, with United having the strongest presence (85.6 percent of flights in 2012).[236]

The current runway configuration at IAH allows five runways to operate concurrently, illustrated in Figure A-16. In terms of landside capacity, IAH has five terminals and 181 gates.[237] Terminal E, the airport's newest terminal, opened in 2003, is designed to provide a streamlined experience for international travelers, merging customs, immigration, and baggage to serve international visitors. The airport's renovations for efficiency have proven to be successful, as the airport was named the most "on-time" airport in the nation by the FAA in 2010.[238] The rapid passenger growth experienced at the beginning of last decade has tapered at IAH, and as a result it is likely that the airport's current capacity will be sufficient beyond 2025. IAH is working to meet projected capacity needs through a number of capital projects including expansion and redevelopment of Terminal B, however has no other major expansion projects slated.[239]

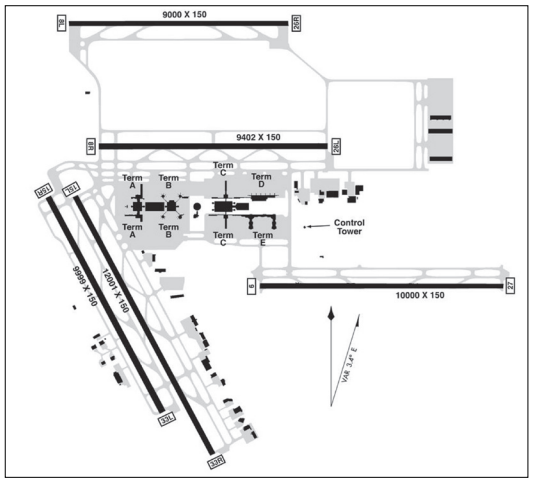

Figure A-15: George Bush Intercontinental Airport Layout

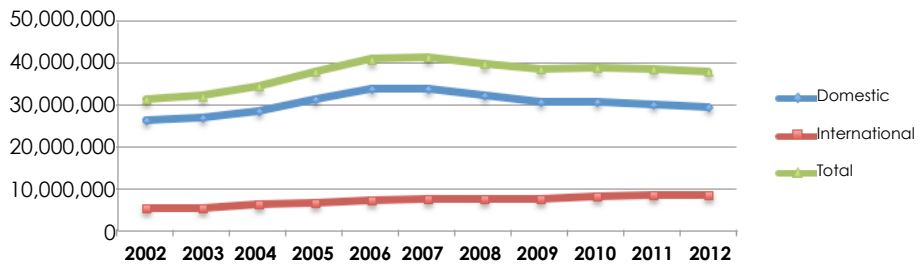

Figure A-15: Passengers at George Bush Intercontinental Airport (IAH)

WASHINGTON DULLES INTERNATIONAL AIRPORT (IAD)
WASHINGTON, DC

The Metropolitan Washington Airports Authority (MWAA) operates two airports for domestic and international air service to the Washington, DC. metropolitan area – Washington Dulles International Airport (IAD) and Reagan National Airport (DCA). Located on 12,000 acres of land, IAD is located in Chantilly, Va. – 26 miles west of downtown Washington, DC.[240] DCA operates primarily domestic flights into the nation's capital, while IAD serves both domestic and international flights.

In 2012, Dulles Airport moved approximately 21.6 million passengers, down from the peak passenger rate of 25 million in 2005. Passenger traffic at IAD grew dramatically between 2002-2005, but between 2007 and 2012 passenger traffic declined at an average rate of 1.77 percent.[241]

International passenger traffic steadily increased between 2002 and 2012 at Dulles Airport, and is expected to continue to increase.[242] Figure A-17 details IAD's passenger growth and decline between 2002 and 2012.

IAD provides non-stop service to 81 U.S. destinations and 48 international destinations.[244] Thirty airlines operate out of IAD, 24 are international airline carriers.

The largest airline at IAD is United, accounting for 64.1 percent of IAD passengers in 2010.[245] However, in 2012, United began decreasing flights and seat capacity at IAD along with other carriers who have also began to focus on serving the DC metropolitan region with flights out of DCA and Baltimore's BWI airport.[246]

Airside capacity at IAD is comprised of four non-intersecting runways, one passenger terminal, and 181 airline gates, shown in Figure A-18.[247] IAD recently completed an airport-wide expansion in 2012 that increased capacity from 25 to 45 million passengers per year.

The Dulles Development Program (D2), designed by MWAA in 2000 to address future capacity projects to handle growth predictions included "two new parking garages, a fourth runway, a new concourse, a new Air

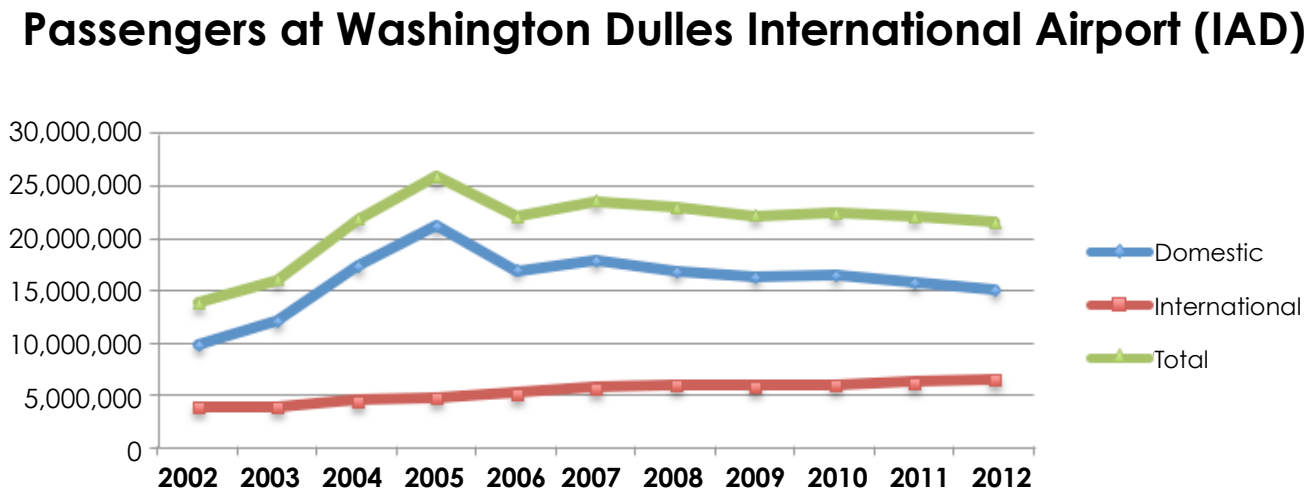

Figure A-17: Passengers at Washington Dulles International Airport (IAD)[243]

Traffic Control Tower, pedestrian walkways, the AeroTrain System, and an expansion to the International Arrivals Building."[248]

As of 2011, all of these improvements to IAD have been completed, resulting in substantial capacity improvements.

MWAA has plans to add an additional runway and two more terminals in the next decade, in an effort to double the number of international passengers it processes.[249] The airport appears to currently have sufficient capacity, and plans for expansion that will address projected passenger traffic growth over the medium term.

In 2012, Washington Dulles Airport moved approximately 21.6 million passengers, down from the peak passenger rate of 25 million in 2005.

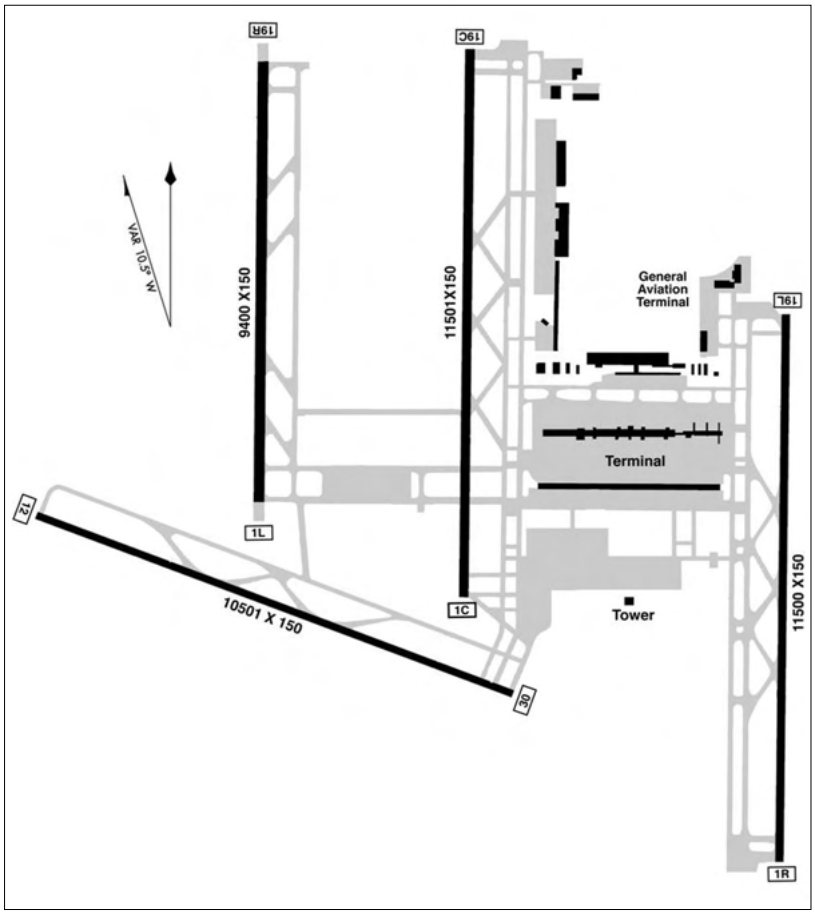

Figure A-18: Washington Dulles International Airport Layout

DALLAS FORT WORTH INTERNATIONAL AIRPORT (DFW)
DALLAS, TEXAS

Dallas-Fort Worth International Airport (DFW) is located between the metropolitan areas of Dallas and Fort Worth, Texas, taking up 17,207 acres and 26.9 square miles. DFW is the fourth busiest airport in the world in terms of aircraft operations, and the eighth busiest in terms of enplaned passengers.[250]

The airport is a hub for connecting flights, with 58 percent of its 2011 passengers connecting to another flight at the airport.[251] Between the years 2007 and 2010, total passenger traffic declined slightly, however passenger growth began building in 2011.

Twenty airlines serve DFW, including 11 domestic and nine international carriers. American Airlines is DFW's largest carrier, handling 82.4 percent of the airport's passengers in 2011.[253] American serves 145 domestic destinations and 41 international destinations from DFW.

Other airlines operating at DFW include Delta, Continental, United, and Alaska Airlines. DFW offers 41 international flights per day across four continents.[254]

DFW has four parallel runways, a fifth parallel shorter runway, and two additional runways arranged at a 45 degree angle, as illustrated in Figure A-20. DFW has plans to expand its landside capacity by 2010, with a seven-year growth plan, but also plans to add more international service in the next 20 years. Between eight and 15 new airlines are expected to begin service at DFW, servicing 26 new international destinations.[255]

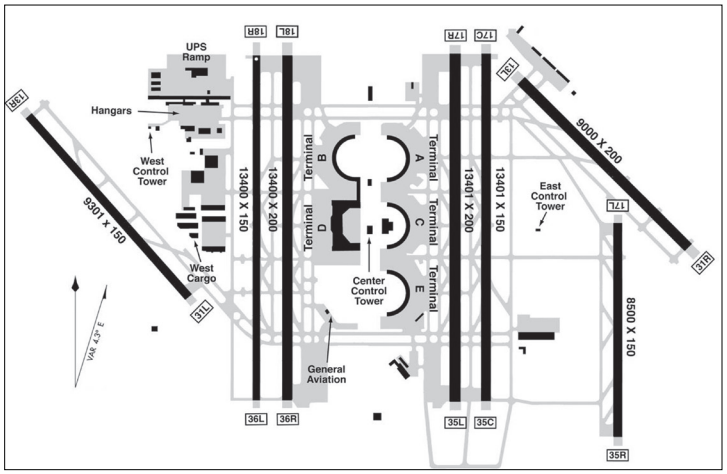

Figure A-20: Dallas Fort Worth International Airport Layout

Until recently, DFW's size has given the airport significant flexibility in capacity and future physical expansion. The airport is so large that it has its own area zip code.[256] The airport has a reputation for having minimal delay – between May 2012 and April 2013, 80.5 percent of DFW's flights were reported to be "on-time,' the second highest rate in the country. As such, the airport has not been designated for needing increased capacity – according to a recent DFW study the airport "has significant runway and terminal capacity…and will not need to add need facilities for many years."[257]

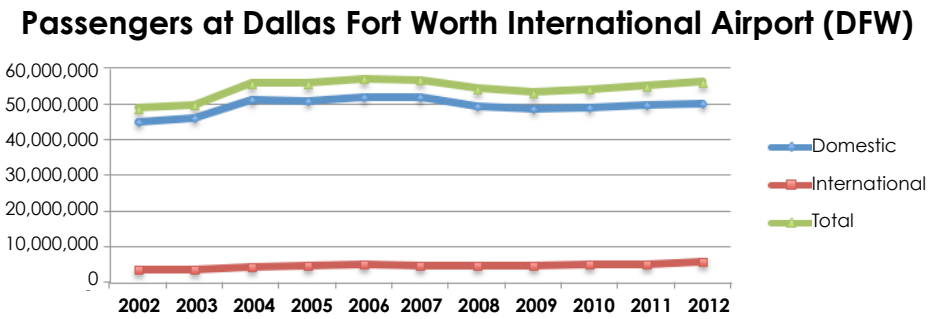

Figure A-19: Passengers at Dallas-Fort Worth International Airport (DFW)[249]

PHILADELPHIA INTERNATIONAL AIRPORT (PHL)
PHILADELPHIA, PENNSYLVANIA

Philadelphia International Airport (PHL) is located seven miles southwest of downtown Philadelphia, and is the primary airport serving the fifth largest metropolitan area in the nation. PHL is the ninth busiest airport in the United States and the eleventh busiest airport in the world in terms of overall passengers.[258]

As displayed in Figure A-21, domestic passengers make up the majority of the airport's passengers, and the share has not experienced much change since the early 2000s. Overall passenger growth at the airport plateaued during the 2007-2008 recession and has since experienced a slight decline, hovering around 25 million annually.

The airport is a hub for both US Airways and Southwest, and in 2012, Virgin American and Alaskan Airlines also added service to Philadelphia.[259] Though US Airways has operated as a hub at PHL for several years, the airline has begun discussions to remove its hub status at PHL as a result of its pending merger with American Airlines.[260] Philadelphia is a profitable hub for US Airways, who uses PHL to connect passengers between 88 domestic destinations and 26 international destinations.[261] To move passengers through the airport, PHL has six terminals and 129 gates. According to the FAA's 2007 Capacity Needs in the National Airspace System report, PHL was the fourth most delayed airport in the country in 2009, accounting for more than 8 percent of the delays in the nation.[262]

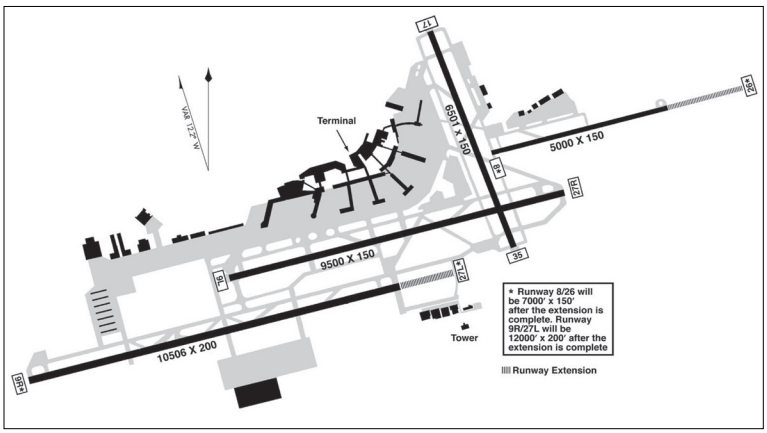

Figure A-22: Philadelphia International Airport Layout

In efforts to address capacity and delay concerns, PHL began the airport-wide Capacity Enhancement Program (CEP) in 1999.[263] The CEP underwent a 10-year planning process, and as a result, in 2001, two new terminals were constructed and existing terminals expanded. In 2010, the Terminal E expansion was opened, including seven new gates for aircraft. The current layout of the airport is shown in Figure A-22.

Since PHL has recently significantly expanded, it appears that the airport currently has sufficient capacity for passenger demand. However, significant growth at the airport is likely to quickly result in congestion. According to the 2007 FACT 2, PHL will need further capacity increases by 2035 even with scheduled capacity enhancement.[264] However, with a reduction of flights operating through US Airways, PHL may have sufficient capacity beyond for the foreseeable future.

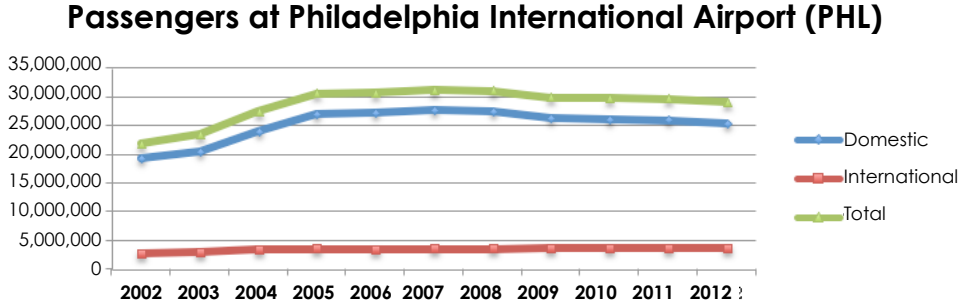

Figure A-21: Annual Total Passengers at Philadelphia International Airport (PHL)

BOSTON LOGAN INTERNATIONAL AIRPORT (BOS)
BOSTON, MASSACHUSETTS

Boston Logan International Airport (BOS) – located three miles to the northeast of downtown Boston – is the largest airport in Massachusetts, providing non-stop service to 32 international destinations.[265] BOS has experienced an overall passenger traffic increase between 2002 and 2012, and a steady increase in international passengers during the same period. The airport served close to 30 million passengers in 2012, and the large majority of passengers were domestic, illustrated in Figure A-23.

BOS serves as a hub for JetBlue (28.5 percent of passengers in 2012) and as a hub for the regional airline PenAir. Other airlines that service BOS include United (13.1 percent), US Airways (12.8 percent), American (12.1 percent), and Delta (10.8 percent).[267] A decade ago, American was BOS' biggest carrier, but has now shrunk to the fourth largest carrier at the airport as a result of focusing instead on other cities: DFW, MIA, ORD, LAX, and JFK.[268] If the US Airways/ American merger occurs, the combined carrier has the potential to be a major presence at BOS in the near future.

The airport borders the Boston Harbor, and as a result, has been limited for both runway and terminal expansion. In the early twentieth century, the airport authority ameliorated capacity problems by constructing an additional runway space on infill in the harbor. Since that time, expansion of runway and terminal facilities to match passenger demand has encountered environmental and political challenges due to the airport's location along a water body and within an urbanized area. Figure A-24 illustrates the current layout of the airport's six intersecting runways and five terminals.

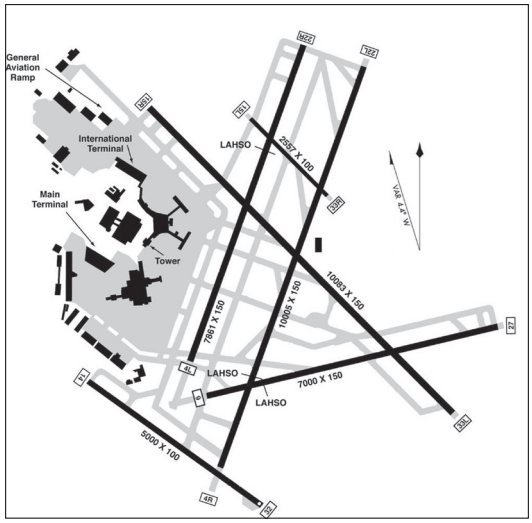

Figure A-24: Boston Logan Airport Layout

The FAA's 2007 Capacity Needs in the National Airspace System report does not project that BOS will face capacity problems in the next 20 years, after the completion of the Logan Modernization Project in 2006. Beginning in 1994, the airport began the project to improve the entire airport, particularly the roadways and terminals, to serve future passenger demand.[269] The project was completed in 2006, and included a new mass transit station, an accessible parking garage, a LEED certified terminal, and a two tiered road system.[270] Looking to the future of the airport, it is projected that both airside or landside capacity constraints will not pose substantial challenges to BOS in the near future.

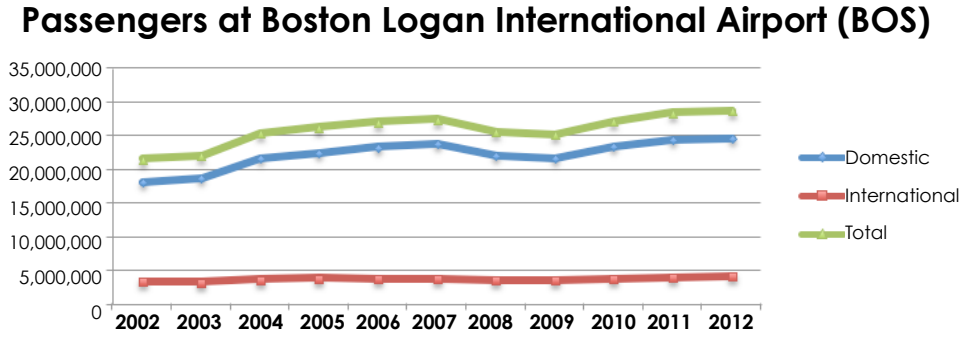

Figure A-23: Total Annual Passengers at Boston Logan International Airport (BOS)[266]

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