

Emergence and Impact of Secondary Airports in the United States

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As major airports in the United States have reached their maximum capacity and became congested, available capacity at surrounding airports has been utilized by the emergence of secondary airports. Given the expectation of a larger number of operations in the National Airspace System (NAS) in the upcoming years, this trend of secondary airports emergence is likely to strengthen. In order to understand the dynamics of the regional airport systems, a study of the factors that led to the emergence of secondary airports was performed. The distribution of population at the regional level, the existence and the proximity of a secondary basin of population close to secondary airports were identified as major factors. Ground access and airport infrastructure were also enabling factors. The nature of the regional airport system, in terms of “Hub” versus “non-Hub” was also identified as a contributing factor. The entry of a low cost carrier was determined to be the essential stimulus in the emergence phenomenon. These entries modify the airport dynamics resulting in the stimulation of both local and peripheral markets. Following the entry of a low cost carrier several other carriers, both legacy and low cost, enter and consolidate the growth of the emerging airport. As a consequence of the emergence of secondary airports and their integration into a region wide multi-airport system, they induce impacts on the NAS structure. Recent consolidations of TRACONS (Terminal Area Control) were identified as primary impacts. As there will be increasing pressure of demand on core airports in the upcoming years, the development of additional secondary airports will be required. The transition from a single core airport to region wide multi-airport systems and the emergence of new secondary airports in existing multi-airport systems, impose new constraints that need to be taken into account in the NAS improvements.

I. Introduction

As major airports in the United States have reached their maximum capacity and became congested, secondary airports have emerged at their periphery. These secondary airports have become increasingly popular, and now constitute viable alternatives for accessing metropolitan areas. In fact, most air travel ticket reservation websites offer the option of searching for flights availability to or from airports located within 50 or 70 miles of a major airport.

This secondary airport emergence phenomenon that has taken place in the last 25 years was a response to the capacity limits that were reached at major airports due to increasing traffic. Total passenger enplanements¹ have been multiplied by a factor of 2.4 from 294 million in 1978 when the airline industry was deregulated to 706 million in 2000. Furthermore, the demand for air transportation will grow in the upcoming years and this demand will ultimately materialize into an increase in total enplanements. However, as major airports are being run close to their limit capacity in terms of number of operations, one would expect the industry to react by using larger aircraft in order to accommodate the largest possible demand with the same number of operations. In fact, this expected trend is not observed. From 1990 to 2000, the average number of seat per departure constantly decreased, leading to an

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overall decrease of 12%. This trend was significantly strengthened after 2000 because major carriers have pulled their oldest and large aircrafts out of their fleets during the airlines downturn, starting early 2001, and exacerbated by September 11 into an industry wide crisis. In addition, regional jets are also responsible for this evolution. As a consequence, the average number of seats per departure decreased by 25% in two years. In addition, new developments in the air transportation industry, such as the future entry of very light jets, are suggesting that more operations will occur in the NAS in the upcoming years.

This growing demand for capacity will add more pressure on airports that are already facing capacity shortage. Increasing the capacity at these major airports would be the ideal solution. However, for various reasons ranging from land space constraints, environmental issues, ground access, expansion project length, political issues, etc, capacity expansion is limited. There are cases where this is possible and where plans, contained in the OEP², are scheduled for the upcoming years. However, the June 2004 FAA study³ of the 35 OEP airports capacity showed that even with the planned OEP improvements the capacity of several major airports will not be sufficient.

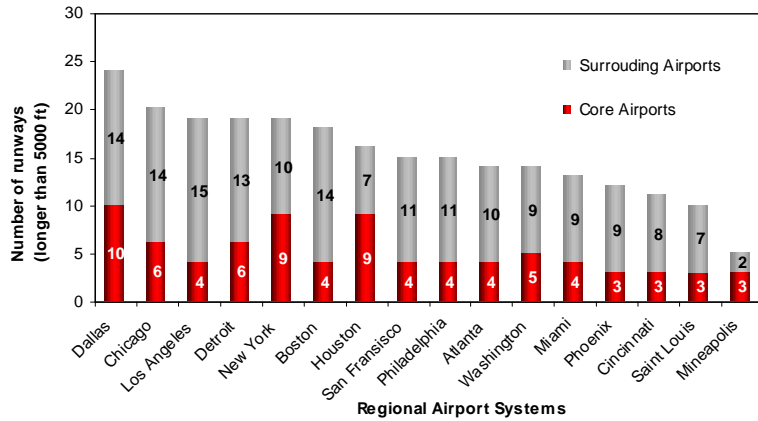


Figure 1. Runway capacity at 16 airport systems (runways longer than 5000 ft) ⁴.

Even though capacity is limited at core airports, there still exists available capacity at the regional level. Figure 1 shows the capacity, in terms of runways, at both core airports and at all surrounding airports within 50 miles of 16 core airports in the United States. This analysis shows that the available capacity at surrounding airports is twice the existing capacity at core airports. Therefore, by considering the capacity at surrounding airports, the overall capacity of the system can be significantly increased.

will increase the pressure on core airports, additional secondary airports will emerge in the upcoming years. Therefore there is a need to understand the dynamics of the emergence of these airports.

The existence of available capacity at the regional level allowed the emergence of secondary airports. As growth in demand for air transportation

II. Emergence of Secondary Airports

A. Methodology

In order to identify secondary airports that emerged in the past few decades, case studies of regional airport systems around major airports have been performed. The main hypothesis is that secondary airports emerge around congested major airports. The 18 airports that had the highest number of delayed⁵ aircraft per 1000 flights in 2000 were taken as reference airports for the case studies. Using these reference airports, 16

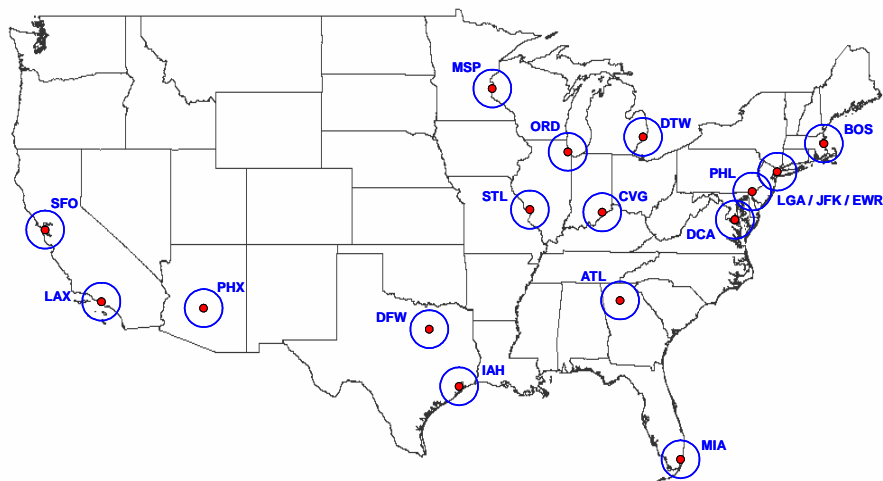


Figure 2. Airport systems selected for the case studies.

regional airport systems were selected for the study (Figure 2). A regional airport system was defined as all airports within 50 miles of a selected core airport. The reduction in number of airports from 18 to 16 airport systems comes from the fact that LGA, JFK, and EWR are part of the same system. Because of its historical predominance, La Guardia airport was selected as the reference core airport in the New York airport system.

The identification of secondary airports was performed by the systematic analysis of traffic at each of the 254 airports that are part of the 16 airport systems. For the purpose of this study, passenger enplanements were preferred over total operations since this measure is a better measure of commercial activity at an airport. In fact, using total operations would have led to difficult distinctions between airports with very different type of activities. For example, Van Nuys airport in California had as many aircraft operations as Boston airport but significant differences in passenger enplanements. Boston Logan handled 13.8 million passenger enplanements in 2000 whereas Van Nuys only had 626. This difference comes from the fact that Van Nuys is a general aviation reliever airport for the Los Angeles region, therefore showing large number of operations with little recorded passenger traffic. The historical passenger enplanements data from the Federal Aviation Administration Terminal Area Forecasts¹ were used for the identification of secondary airports. Available years of data range from 1976 to 2002[‡].

B. Results

1. Illustration with a case study: Boston regional airport system.

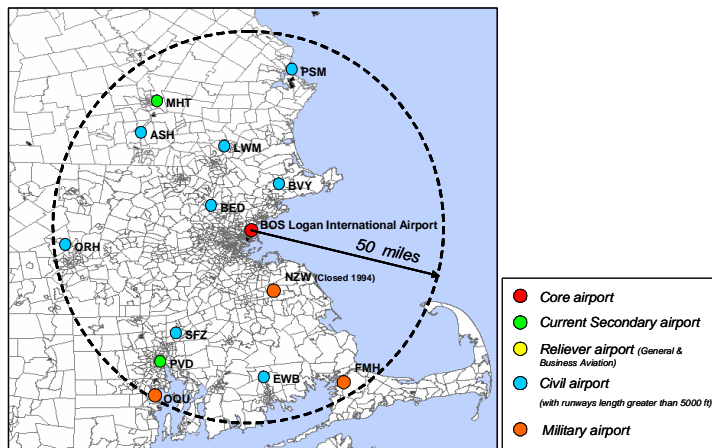


Figure 3. Boston regional airport system.

In fact, in the mid 1990s significant available capacity existed at airports around Logan (Figure 3). In the close periphery of Logan, Hanscom (BED) airport served mostly as a reliever airport for business and general aviation. In the 20 to 40 miles range, several civil airports, like Beverly (BVY), Lawrence (LWM) and Pawtucket (SFZ) were underutilized. In addition, the South Weymouth Naval Air Station (NZW) closed in 1997 and that featured two runways and over 700 acres of land, was an additional source of capacity. Multiple civil and military airports, such as New Bedford (EWB), Providence (PVD), Manchester (MHT) etc, were also located in the outer ring (35 to 50 miles from Boston city).

With the study of the evolution of the annual passenger enplanements for airports within 50 miles of Boston Logan

In the Boston regional airport system, Boston Logan International (BOS) airport is considered the core airport. Figure 3 shows its geographical location inside the regional airport system. In terms of traffic, Logan went through a phase of significant growth during the 1980s that slowed down in the early part of the 1990s. However, since 1997 the passenger enplanements have reached a plateau at a critical level (85%)[§] of its theoretical capacity (Figure 4).

Significant delays were recorded at Logan in the last part of the 1990s. In fact, it was ranked 5th in 2000 in term of fraction of delayed aircraft per 1000 flights⁵. Therefore, the level of service at Logan fostered the need for adding capacity in the system.

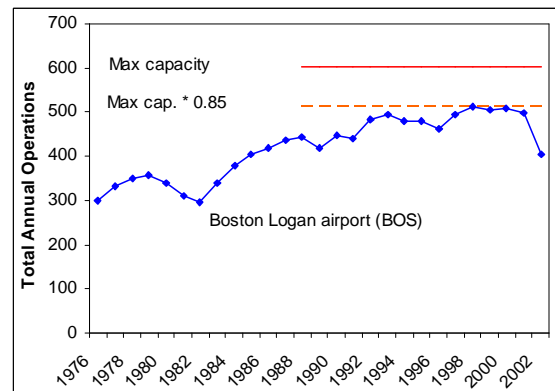


Figure 4. Total operations at Boston Logan (1976 to 2002).

[‡] In the current version of the TAF, year 2003 is still considered as a forecasted year and therefore was not utilized as historical data.

[§] The 85% capacity threshold is in most systems recognized as a critical threshold where significant levels of delays appear in the system.

airport, it was found that as a response to the congestion at Logan airport (BOS), Providence airport (PVD), located 45 miles southwest emerged in 1996 (Figure 5). Passenger enplanements have more than doubled in two years from 1 million (in 1996) to 2.2 million. Two years after the emergence of Providence airport, Manchester airport (MHT), located in the north west of the regional airport system also emerged as a significant player in the regional air transportation system.

Therefore, over the last part of the 1990s, the regional air transportation system has gone through significant changes and evolution. Boston Logan is still considered as the core airport. However, Providence and Manchester are now significant players, as they accounted for 25% of total passenger enplanements in the region in 2001.

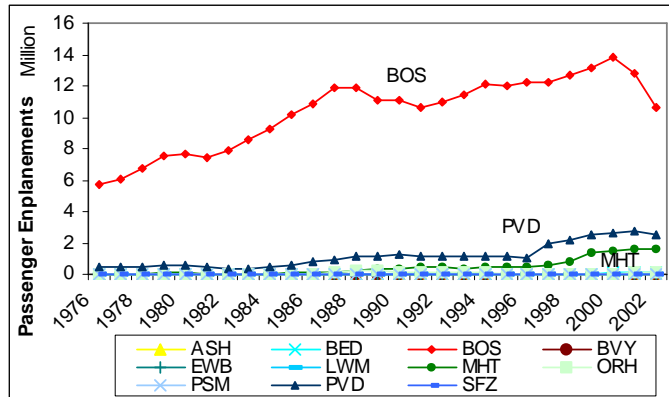


Figure 5. Passenger enplanements at airports within 50 miles of Boston Logan airport.

2. Results at the National Level

The systematic study of passenger enplanements and their evolution since 1976 led to the identification of 19 airports that emerged. Figure 6 shows the geographical location of the emerged airports.

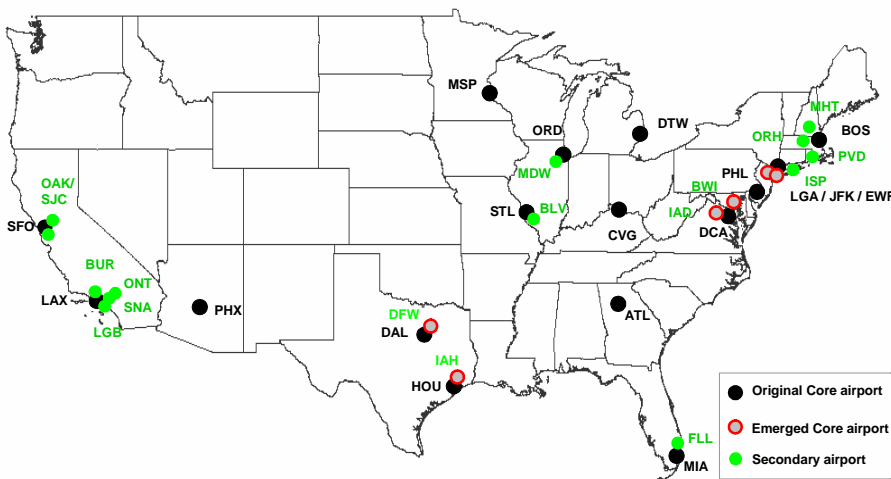


Figure 6. Core and secondary airports in the United States.

From the set of 19 airports that emerged around core airports, 6 were identified as emerged core airports. These airports emerged while an original core airport was already in place. They grew to a level where traffic now exceeds the traffic of the original core airport. Dallas Fort Worth, JFK, Newark, and Dulles are among those airports. From a regional airport system evolution perspective, Dallas Fort Worth and Houston International have had a special history. Initially, single core airports were serving the demand for air transportation of those metropolitan areas. However, in 1969 all scheduled flights were transferred from Hobby airport⁶ (HOU) to Houston International (IAH) which ultimately became the dominant airport in the region. Some traffic was however kept at Hobby, first serving as a general aviation airport and then regained scheduled traffic with Braniff, Texas International and Southwest. In the case of the Dallas regional airport system, DFW airport opened in 1974 and soon became the dominant airport in the region.

The remaining 13 airports are considered secondary airports. Manchester, Providence, Midway, Ft. Lauderdale, Long Beach, etc are among this category. Although, not all these airports are at the same stage in their life cycle and

Original core airports were the first major airports that were present when the regional airport system was still a single airport system. For example, Atlanta is the only major airport in its system and is therefore considered an original core airport. On the other hand, even though La Guardia is located in the New York multi-airport system and is surrounded by larger airports, this airport is still considered the original core airport in the region for historical reasons.

face the same development issues. Airports like Long Beach; part of the Los Angeles regional airport system, is a secondary airport but remains limited in terms of potential growth. This airport is currently slot restricted, with only 41 daily slots, due to noise constraints. Other airports like Mid America airport in the St. Louis region and Worcester airport in the Boston region are failed secondary airports. These airports received significant infrastructure investments that showed a willingness to transform the status of the initial airport with the goal of offering scheduled airline services. However, they are also characterized by the absence of service at the time of the study.

III. Factors influencing the emergence of secondary airports

In order to understand the dynamics of the system at the regional level, there was a need to identify the factors that led to the emergence of these secondary airports. Systematic studies of demographics, socio-economic factors at the regional level and infrastructure, in addition to business and airline operational behaviors at the airport level were conducted for all regional airport systems with secondary airports that were previously identified. The first aspect to be investigated was the role of the entry of a low cost carrier on the emergence of secondary airports.

C. Entry of Low-cost carriers

It was found, from the case studies, that the entry of low cost carriers was correlated with the emergence of secondary airports. Figure 7 illustrates, with the example of the Boston regional airport system, the entry of Southwest airlines at both Providence and Manchester respectively in 1996 and 1998 and its impact on passenger enplanements.

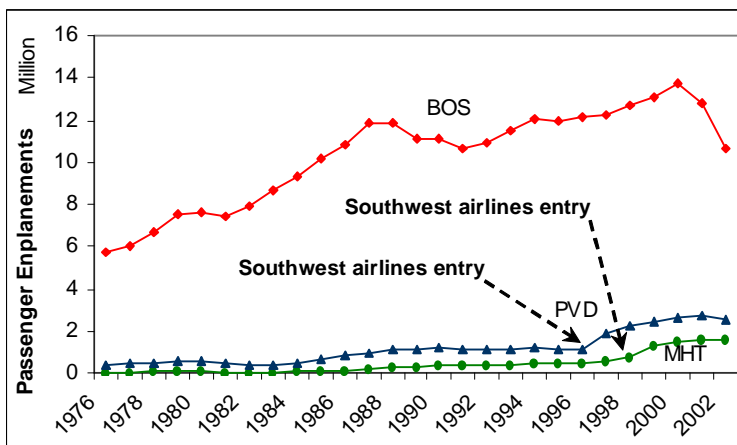


Figure 7. Impact of Southwest entry in New England¹.

The impact of those entries is clear. In fact, in the case of Manchester, the year to year growth in passenger enplanements was on average 6% from 1990 to 1997. After the entry of Southwest in 1998, this average year to year growth grew to 45% from 1998 to 2000. The same phenomenon occurred in the case of Providence airport where the year to year evolution of passenger enplanements jumped from stagnation (from 1990 to 1996) to an average of 35% year to year growth during the three years following the entry of Southwest. This analysis of the entry of low cost carriers has been performed for all airport systems in the original study.

low cost carriers. In the vast majority of the cases, Southwest was responsible for the emergence of the identified secondary airports. However, People Express was the first carrier to lead this dynamic with its entry at Newark airport.

Table 1 summarizes the entries of these

Core airport	Secondary airport	Low-cost carrier	Year of entry
LGA La Guardia	EWR Newark	People Express	1980
	ISP Islip	Southwest	1999
BOS Boston	MHT Manchester	Southwest	1998
	PVD Providence	Southwest	1996
DCA Washington National	BWI Baltimore	Southwest	1993
MIA Miami	FLL Fort Lauderdale	Southwest	1995
ORD Chicago O'Hare	MDW Chicago Midway	Southwest	1997

Table 1. Low-cost carrier entries at secondary airports.

From the observations and study of the regional airport system, the entry of a low-cost carrier was identified as a stimulating effect in the emergence phenomenon. In fact, before the entry of a low-cost carrier, secondary airports offered high fare service. However, the entry of a low cost carrier, with its low fares changed this situation. In the case of Manchester airport, where Southwest Airlines entered in 1998, the average aggregate yield at the airport level dropped by 27% between 1997 and 1999, while the enplanements increased by 154%. The impact of the entry of a low-cost carrier on fares was termed the “Southwest effect”⁷ in 1993, by the FAA Office of Aviation. However, this effect was only studied and demonstrated at the route level between airports that are part of the Los Angeles and San Francisco airport systems. In the case of both Manchester, and Providence the impact of the entry of a low cost carrier on the global level of service is clearly observed at the airport level.

In addition, several other carriers followed the entry to the initial low cost carrier, resulting in changes in the dynamic at the airport level. Figure 8 shows the number of departures per day out of Manchester airport from 1996 to 2003. It was found that following the entry of Southwest in 1998, several other carriers, such as Northwest, Continental, Delta and ACA, started service at this airport. These subsequent entries increased the level of competition at this airport. This behavior has also been identified at other secondary airports like Providence, Islip, etc. The increase level of competition at secondary airport is also a significant factor in the success of its emergence.

However, the entry of a low cost carrier which triggered the emergence of a secondary airport was the result of a business decision. This decision was based on endogenous and exogenous factors, whether strategic, societal, led by competitive behaviors, etc.

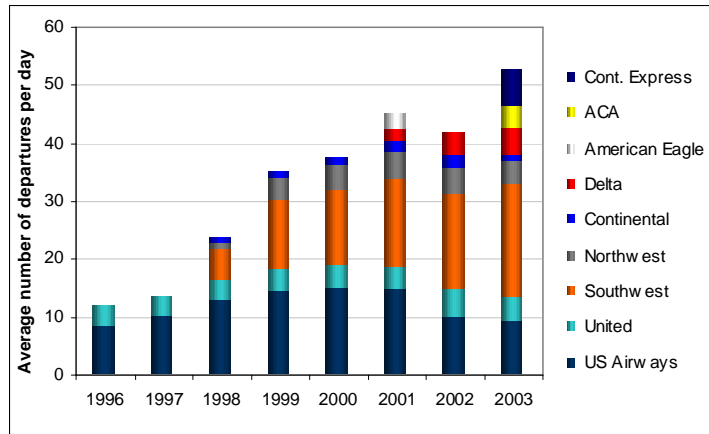


Figure 8. Traffic share⁸ of airlines operating at Manchester airport (MHT) from 1996 to 2003.

D. Distribution of population

From the study of airport demand models, the population and its distribution was identified as a potential factor influencing the success of the emergence of an airport. In order to validate this hypothesis for the case of secondary airports, two studies were performed.

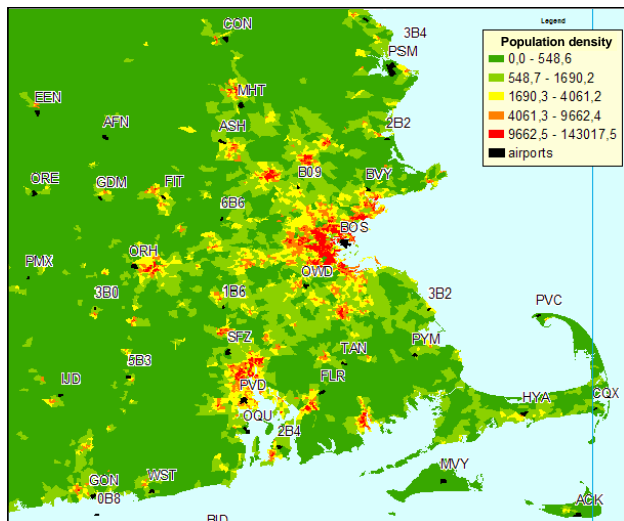


Figure 9. Distribution of density of population around Boston Logan airport.

Using ArcGIS⁹ database of population, a systematic study of the distribution of the density of population was performed for all airport systems where secondary airports were identified. As show on Figure 9, in the case of the Boston region, Logan is located in the center of the densely populated Boston metropolitan area. From the secondary airport perspective, both Providence and Manchester airports are located close to medium to high density of a smaller basin of population.

The study was extended to the distribution of population around both core and secondary airports. In order to compute the distribution of population around specific airports, U.S. Census Bureau¹⁰ tracts were utilized. The database, based on the year 2000 census, contained 65,443 tracts covering 50 states and the District of Columbia. Using all relevant tracts, identified by the relative location of their centroid to airport position, population distribution was plotted for each identified core and secondary airports.

As shown on Figure 10 representing the distribution of population around Boston Logan airport, the population is concentrated within 20 miles, where there exists a basin of 2.7 million inhabitants.

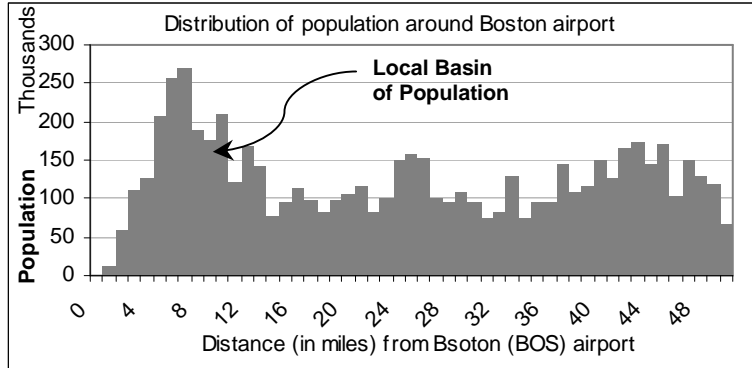


Figure 10. Distribution of population around the Boston Logan (BOS).

On the other hand, the distribution of population (Figure 11) around secondary airports is slightly different. The large portion of the population is at the 30 to 50 miles range and still corresponds to the core metropolitan area basin of population. However, there exists local basin of population in the closer range 0 to 20 miles of a secondary airport. A basin of 1.3 million inhabitants, almost half of the Boston population basin, inhabitants surrounds (20 miles) Providence airport.

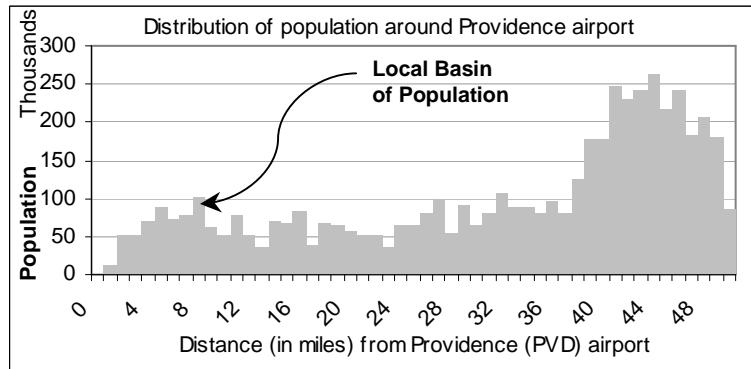


Figure 11. Distribution of population around Providence airport (PVD).

region. However, the study was performed for all regional airport systems where secondary airports were identified. Figure 12 shows the population within 20 miles for a set of 23 airports, divided into three categories: core, successful secondary and unsuccessful secondary airports. From the comparison of population within 20 miles of airports between successful and unsuccessful secondary airports, it was found that the lack of sufficient population, in the case of Mid America and Worcester airports was one of the factors that contributed to their failure.

It was also found from the analysis of demographics that both distribution and size of basin of population are factors that contribute to the successful emergence of a secondary airport.

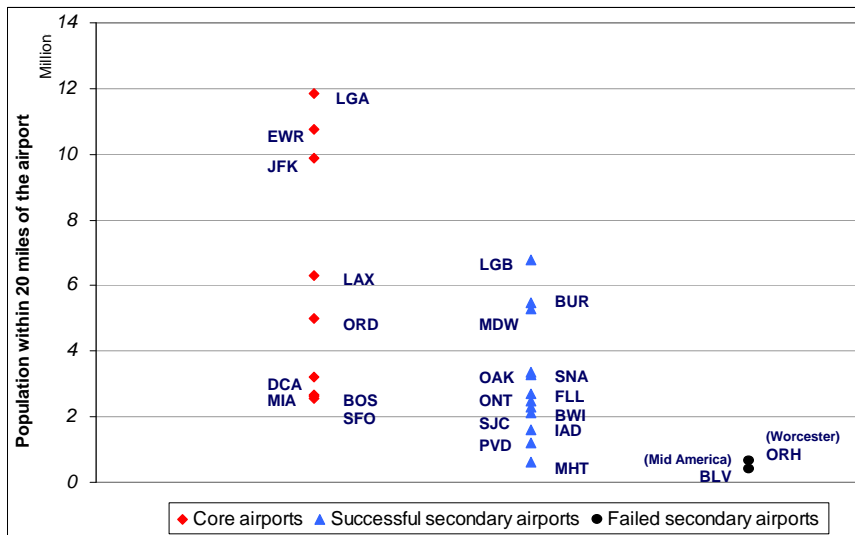


Figure 12. Population within 20 miles of three types of airport.

E. Airport infrastructure

Runways are the most constraining element in an airport system, as it defines the type of aircraft allowed to use this airport. Typically, wide body aircraft require a 7000 ft to 10,000 ft runways. As the size of the aircraft gets smaller, runway length requirement become less severe. Narrow body jets can operate at airports featuring runways from 5300 ft to 6900 ft. Interestingly, even though they can carry less passengers than narrow body jets, regional jets require runway lengths to range from 5000 ft to 6800 ft. Turbo props can operate at airports with smaller runways (3500 ft to 4500ft). Therefore, these aircraft performance requirements limit the access to airports where infrastructures are sufficient. Figure 13 shows the comparison between available runway lengths at all airports

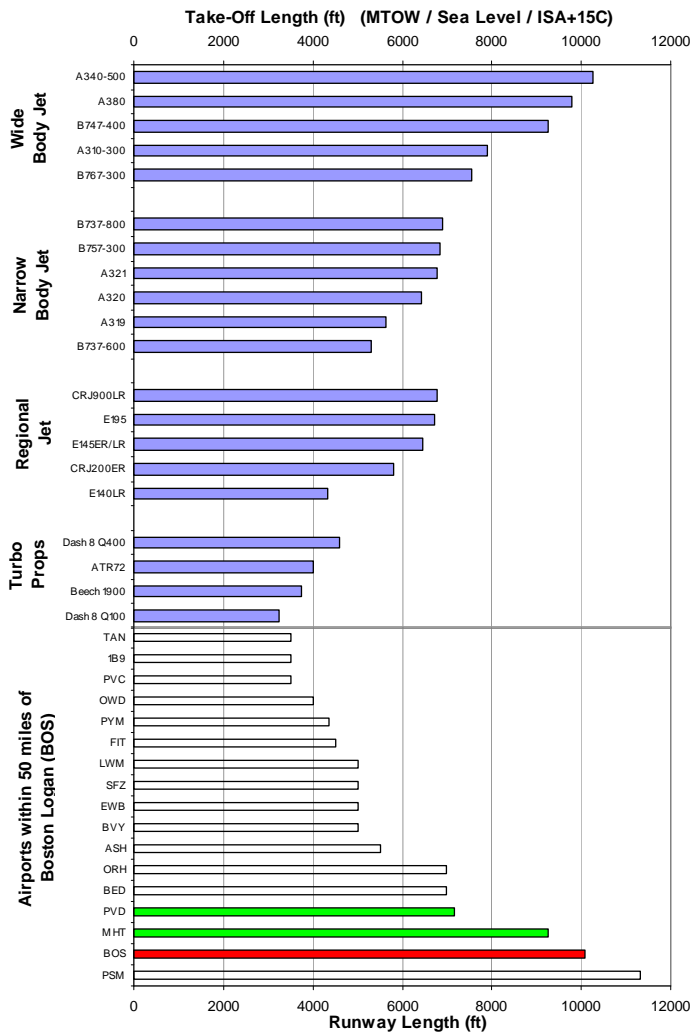


Figure 13. Take off field length¹¹ and runway length⁴ (case: Boston region).

within 50 miles of Boston Logan, and the take-off field length of four categories of aircraft. Boston Logan (BOS) and Pease (PSM) are able to handle most wide body aircraft and all smaller type of aircraft. The next group of airports composed of Manchester (MHT), Providence (PVD), Bedford (BED), and Worcester (ORH), with 7000 ft runway length, can't handle wide body aircraft, however narrow body and smaller aircraft are able to operate at these airports.

The remaining airports do not have suitable runways for narrow body jets. However, 6 airports offer sufficient infrastructure to host turbo props. Figure 13 only shows the analysis for the region around Boston. However, the same analysis has been performed for all airport systems with identified secondary airports. From all secondary airports that were studied the runway length ranged from 5700 ft in the case of Santa Anna airport to 12198 ft for Ontario airport.

The level of infrastructure in terms of runway length does not need to be extremely high since Santa Anna airport is able to handle 4 million passenger enplanements per year with only one usable runway of 5700 ft^{**}. Therefore the current set of airports, which possess one or more runways with length greater than 5700 ft constitute, potential secondary airports for the future.

** This airport also has a second runway, but due to its length less than 3000 ft is not usable by turbo props, regional jets and larger aircraft.

F. Nature of the regional airport system: “Hub” vs.”Non Hub”

Once secondary airports were identified, a study of their role in the nation air transportation network was performed. The distribution of secondary airports in the Continental US (Figure 14) shows that the vast majority are located on the coasts.

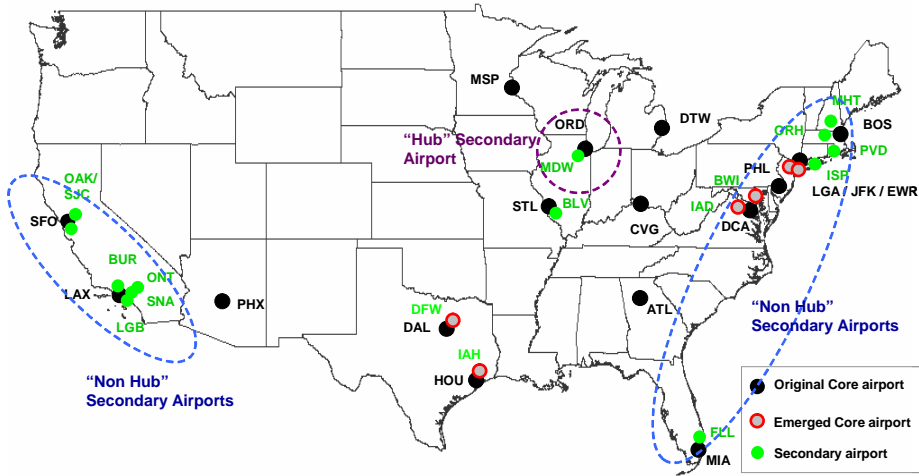


Figure 14. “Hub” and “Non-hub” regional airport system.

airport relies heavily on connecting passengers. The case of the St. Louis region illustrates this dynamic. In fact, the failure of Mid America airport is partially due to the fact that Saint Louis is transfer hub with 64% of its passengers connecting. In addition, a low cost carrier (Southwest with 13% of the traffic) already operates at Saint Louis (the core airport), which makes it difficult for a secondary airport to be significantly more competitive.

There exists a partial exception with the case of Chicago Midway airport, which is inland, located close to a major hub airport (Chicago O’Hare). However, a strong local demand supports viable operations at both airports. In addition, the replication of hub operations at the secondary airport is possible since ATA is running hub operations at Chicago Midway.

From comparative studies of the passenger enplanements that were performed for all 16 regions, the nature of the regional airport system was highlighted with the case of Atlanta airport. Figure 15 shows the enplanements at the regional level for both single airport and multi-airport systems. The single airport systems are distinctly segregated into two subsets. Atlanta with almost 40 million enplanements needs to be separated from the group of airports with enplanements below 18 million per year. A threshold, around 17 to 18 million enplanements per year, seems to exist between single and multi-airport systems like Phoenix (PHX) and Boston (BOS).

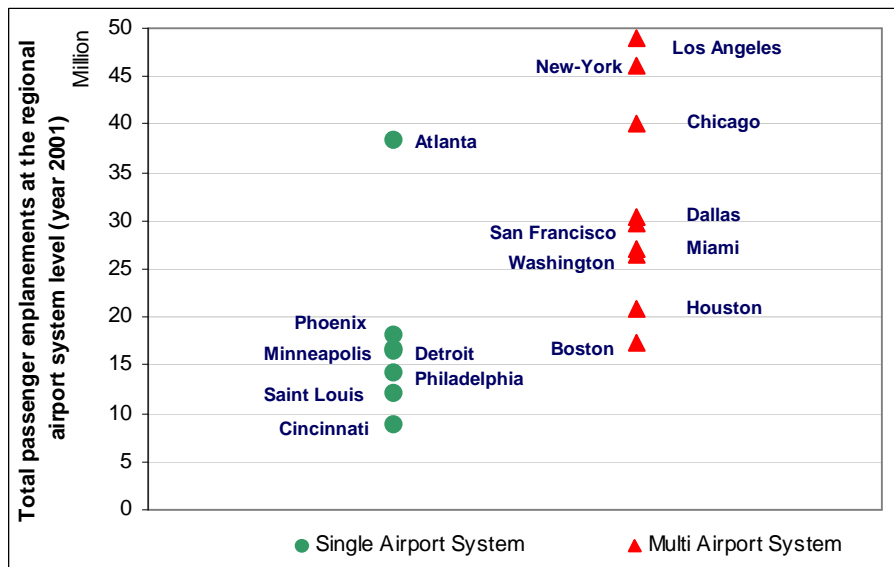


Figure 15. Passenger enplanements¹ at the 16 single and multi-airport systems.

It was found that the emergence of secondary airports is more likely to happen at a “Spoke” regional airport system rather than at a “Hub” airport system. It is thought that a secondary airport is less likely to emerge close to a major hub since it is more difficult to compete with the core airport, in terms of service. This is especially true when the local demand is not strong and the core

airport relies heavily on connecting passengers. The case of the St. Louis region illustrates this dynamic. In fact, the failure of Mid America airport is partially due to the fact that Saint Louis is transfer hub with 64% of its passengers connecting. In addition, a low cost carrier (Southwest with 13% of the traffic) already operates at Saint Louis (the core airport), which makes it difficult for a secondary airport to be significantly more competitive.

However, Atlanta has almost 40 million enplanements, well above the threshold where a second airport becomes viable. Atlanta is a major Hub, with 62% of connecting traffic. In this case, the nature of the core airport seems to play a role in the development of the regional airport system.

G. Level of delays at secondary and core airports

A systematic analysis of delays has been performed at both core and secondary airports for all 7 airport systems.

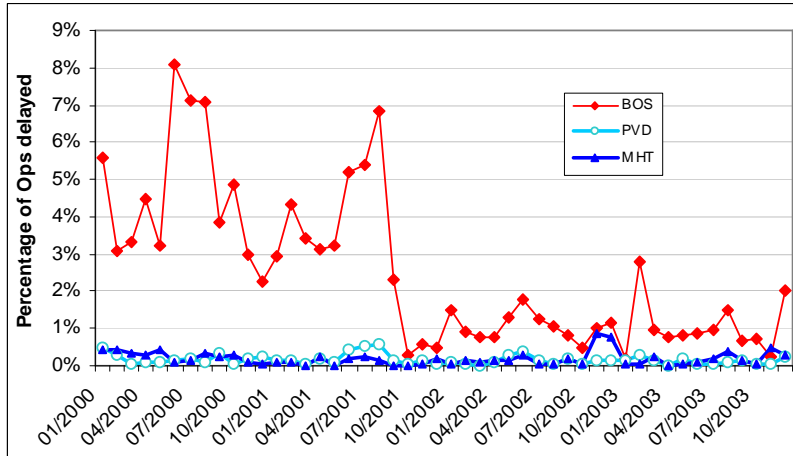


Figure 16. Percentage of operations delayed at BOS, MHT, and PVD¹².

2000 to 2003, MHT, PVD are considered secondary airports, since they respectively emerged in 1996 and 1998.

In the case of the Boston region study, the impact of the traffic decrease at Boston Logan airport in September 2001 is substantial. Even with this traffic decrease and level of operations lower than pre-September 2001, delays are still higher at the core airport than at secondary airports.

Figure 17 shows, the fraction of operations delayed for both core and secondary airports in 7 regional airport systems where secondary airports have been identified. It was found that over all case studies, the fraction of operations delayed at the secondary airports were lower than at core airports. From an airline management perspective, this measure is critical since these externalities are directly related to the costs endured by the airline. Since delays are lower at secondary airports, airlines and especially low cost carriers, seeking low cost structures, are likely to be interested in entering underutilized airports that would ultimately become secondary airports.

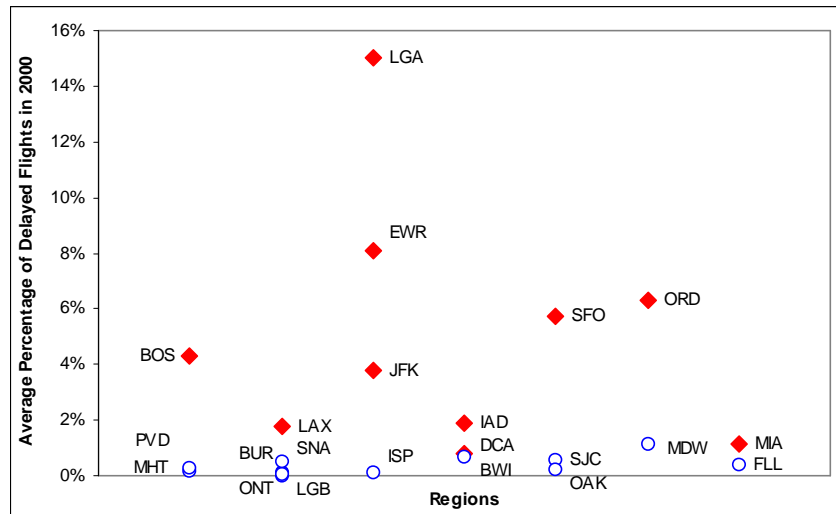


Figure 17: Average percentage of delayed flights in 2000 for airports at 7 regions¹².

IV. Implications of the Emergence of Secondary airports

The spread of operations has great impacts on the way the airspace is managed. Once traffic grows at secondary airports, interactions between airports appear and airport operations become dependent. In the case of the Boston region, since both Manchester and Providence are about 50 miles away from Boston Logan airport and traffic at secondary airports remains limited, the interactions are still weak. However, in the case of multi-airport systems

where airports are more closely located, this dependence increases. The airports in the New York airport system face operational constraints due to these interactions.

The impact of the emergence and growth of secondary airports is illustrated by the recent consolidation of TRACONs (Terminal Radar Control). In 2003, the Potomac TRACON in Washington was the result of the merger of 4 single airport TRACONs that became inefficient because of the greater interactions between Washington National, Washington Dulles, Baltimore and the Andrews Air Force base airports, due to the large increase in operations at both Dulles and Baltimore. The same merger phenomenon also happened in February 2004, in the Boston region, where both Boston and Manchester TRACONs merged in order to run more efficient operations at both airports. Therefore the impact of emergence and growth of secondary airports forces the National Airspace Structure (at least at the TRACON level) to become more centralized. Not only interactions appeared inside regional airport system but as multi-airport systems tend to spread laterally in addition to being closely located to each other, as this is the case in the North East of the United States, inter-dependence will appear between systems. A new level of centralization may be needed to manage these inter-related multi-airport systems.

V. Conclusion

As major airports in the United States reach their maximum capacity and become congested, available capacity at surrounding airports was utilized resulting in the emergence of secondary airports. These airports have proven that there are viable options for increasing the capacity of regional air transportation systems. As traffic is expected to grow in the upcoming years, the pressure on original and emerged core airports will become greater. In addition, current secondary airports will grow to a point where they will also become congested. New secondary airports will be required to accommodate this growth. Therefore there was a need to understand the factors that led to the emergence and the dynamics of these airports.

It was found that the distribution of population at the regional level and the existence and proximity of a secondary basin of population close to secondary airports were major factors. In terms of airport infrastructure current successful secondary airport showed airports with runway length as low as 5700 ft are potentially secondary airport candidates. The nature of the regional airport system, in terms of “Hub” versus “non-Hub” was also identified as a contributing factor, where the emergence of a secondary airport is more successful at a “non-Hub” rather than at a “Hub” regional airport system. Most importantly, the entry of a low cost carrier was determined to be the essential stimulus in the emergence phenomenon. These entries modify the airport dynamics, in terms of fares and new destinations, resulting in a stimulation of the local and peripheral markets. Following the entry of a low cost carrier several other carriers, both legacy and low cost, enter and consolidate the growth of the emerging airport.

However, the transition from single core airport to region wide multi-airport systems and the emergence of new secondary airports in existing multi-airport systems, impose new constraints that need to be taken into account in the NAS improvements.

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