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The Next generation air transportation system: An Answer to solve airport efficiency?

Daniel Bourgeois

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The Next Generation Air Transportation System:
An Answer to Solve Airport Efficiency?

by Daniel “Frenchy” Bourgeois

Masters of Science
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Graduation Requirements for the

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The Next Generation Air Transportation System: An Answer To Solve Airport Efficiency?

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8/9/2010
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Abstract:

The air transportation system has been receiving more and more passengers every day. With this influx of passengers, the system is having difficulty keeping up with the demand. In order to combat this problem, President Bush signed the Vision 100 – Century of Aviation Reauthorization Act. This act, in turn, established the Joint Planning and Development Office, tasked with implementing The Next Generation Air Transportation System (NextGen). NextGen will be a series of changes to the entire aviation infrastructure in order to make it more efficient, more technologically advanced, and more ecologically friendly. My previous research included an interview of a random sample of twelve pilots in order to determine their opinions of the NextGen system. These pilots acknowledged that NextGen is meeting expectations in many ways. However, although the air traffic system would be able to hold more traffic, NextGen does not account for airport arrival and departure rates. Because of what the pilots revealed, this thesis examines four airports; San Francisco, Minneapolis, LaGuardia, and the NYC Metroplex, to see if “NextGen can solely account for and correct bottlenecks in the National Aerospace System?” This study concluded that although NextGen does not specifically address airport arrival and departure rates, NextGen provides airports the ability to expand and increase airport capacity. However, the benefits do not help all airports equally, some benefit greatly while others improve little with the NextGen system.
Chapter One
Research Question:

In my senior project I researched how pilots felt about the Next Generation Air Transportation System. This topic is very important to the future of the airline industry in the United States largely because the current air transportation system will not be able to handle the forecasted increase in air traffic. Air traffic is expected to increase to over one billion passengers per year by 2015 and doubling the current levels of 769.6 million by 2025 according to the Bureau of Transportation Statics. The dilemma facing the airlines forces policymakers into taking some kind of action to try and correct the problem. The airline industry has almost eleven million jobs across 486 aviation occupations and contributes around 640 billion dollars to the economy every year. Pilots account for about 107,000 of these jobs, making them a very large sector of the economy (BLS 2009).

Pilots have the best vantage point to review information on how well the Next Generation Air Transportation System (NextGen) is performing. With the pilots’ insight, the study reveled other items that need changing. Policymakers who set the system up have overlooked something, or made an assumption that was not true. The issue that most pilots pointed out was that NextGen’s technologies were really going to make point to point flying much easier and more efficient, but it failed to address the fact that airports can only handle so much traffic themselves. Airports cannot take off and land unlimited amounts of aircraft, there are mandatory separation standards set, not by people but by physics. It is just not possible to stack planes on top of each other like cars at a long red light. In this thesis, I will see if these pilots are correct about the airport limitations to NextGen.
A pilot’s method of flying has been the same since WWII when radar was invented. World War II was the first war in which the airplane was a pivotal instrument for war fighting. Over the years technology advances in the private sector mandated by government led to the same advances in the military. After the war there was no sign of things slowing down. Some technologies, such as the radiotelephone will make the transition from before World War II to after, but the rest will be drastically changed. There are four separate paths that navigation will go through from the normal daily operation of pilotage:

1. NDB/ADF systems/Distance Measuring Equipment
2. VOR systems
3. ILS Systems
4. ATCRBS Transponders

The current way of getting around in the sky is by GPS based systems; the newest one is called the Automatic Dependent Surveillance Broadcast (ADS-B). It is a GPS receiver, with an air traffic controller’s radar display and continuously updating weather picture. In the Senior Project I argued that pilots, literally, have a front seat to the changes that are going to be made to the aviation system.
History Of Aviation Regulation Before NextGen:

The Air Commerce Act of May 20, 1926, was the cornerstone of the Federal government’s regulation of civil aviation

*This landmark legislation was passed at the urging of the aviation industry, whose leaders believed the airplane could not reach its full commercial potential without Federal action to improve and maintain safety standards. The Department of Commerce improved aeronautical radio communications, and introduced radio beacons as an effective aid to air navigation. (Federal Aviation Administration).*

In the 1940s, Franklin Roosevelt split the authority to regulate the National Aerospace System into two different agencies, the Civil Aeronautics Administration and the Civil Aeronautics Board. Each had its own responsibilities but, as World War II escalated the CAA extended its area of operation. “The approaching introduction of jet airliners and a series of midair collisions spurred passage of the Federal Aviation Act of 1958. This legislation transferred CAA’s functions to a new independent body, the (FAA) that had broader authority to combat aviation hazards (Federal Aviation Administration).” President Eisenhower appointed Elwood "Pete" Quesada, an Air Force general, to serve as principal advisor on aeronautics. This was the birth of the current Federal Aviation Agency. Congress finally changed the agency into an administration by giving them a place in the President’s cabinet in 1966.

The FAA has a relatively short history, and was barely in existence when new navigation technologies were invented and used. The Military on the other hand has been in existence a long time and they began funding for the airplane post World War I. When
the military buys an airplane they do not want to lose it, so they invest in navigation equipment in order to prevent loss of aircraft.

**NextGen:**

By 2025, U.S. air traffic is predicted to increase two to three times above the current the current passengers’ level. The traditional air traffic control system will not be able to manage this growth so the change to the system is mandatory (JPDO 2009, Pearce, 2006). If the government is going to stop congestion and gridlock before it starts and keeps the economy moving in a growing and upward direction, there must be focused action to improve air transportation for the future (Pathways, 2005). The Federal government’s action to help the air traffic control system is the Next Generation Air Transportation System, or NextGen. NextGen is about transforming our air transportation system so that it will accommodate the proposed doubling or tripling of demand in air traffic in the current system (Pappas, 1997). Fundamentally, NextGen is a 21st century, state-of-the-art, satellite based transportation system, with internet-like communications, and using advanced computer technology to get operations accomplished (Cox, 2008). NextGen's computerized air transportation network stresses adaptability by enabling aircraft to immediately adjust to ever-changing factors such as: weather, traffic congestion, aircraft position via GPS, flight trajectory patterns, and security issues (JPDO 2009, Sharman, 2008, Shouders, 2007).

Under the NextGen policy pilots would be responsible for collision avoidance and satellites would be used to navigate when in the air. The Next Generation Air Transportation System will incorporate new technologies into the industry. NextGen will
be system wide, affecting not only commercial aviation, but military and general aviation also.

There are about nine proposed changes that pilots will see overall. Four of them are technological. These four changes are the (1) Automatic Dependent Surveillance broadcast (ADS-B), (2) the Required Navigation Performance (RNP), (3) the Safety Management System (SMS), (4) and the Continuous Decent Approach (CDA). These new technologies will form the backbone of the NextGen system.

One of the main things that NextGen will accomplish is that it will rid pilots of the VOR checkpoint that they currently have to follow. As previously discussed currently, the only way pilots can get from one place to another is to fly to these “fixes.” The introduction of GPS technology is critical in making this change happen. A pilot will now know exactly where s/he is according to the GPS tracking equipment and can use other NextGen technology to plot out a course and then load this information into the auto pilot.

**Public Policy Questions Surrounding NextGen:**

The mandate to get NextGen going was the Vision 100 legislation signed by President Bush in 2003 (C.F.R. 18 Nov 2008). The legislation set forth the need to increase the efficiency of our nation’s airports and airways (Leader, 2007). This is the first navigation system that has been put into action by Congress. All of the rest have been just need. The reason for why this becomes a government problem to fix is explained later. Pilots had a rough job with some aspects of flying and so pilots along
with help from the private sector set forth to try and fix them by developing something, a
new procedure or new technology that helped to correct the problem. Navigation has
come a long way. In the past pilots looked out of the windows to see landmarks that they
recognized to navigate. Pilots today and into the future will rely more and more on a
multi-million dollar satellite based system that will allow a pilot to know the exact
position within a few inches while traveling at over 400 miles an hour.

Despite the current economic downturn and all of the current advances, delays
repeatedly impact passenger travel and the forecasts of future demand remain high. New
aviation modes are about to take flight, bringing even greater complexity to air
operations. Though staffed by a capable, dedicated workforce, our current air traffic
control system is not scalable or flexible to keep up with future demand. In addition to
improving efficiency and creating additional capacity, NextGen is also needed to provide
corresponding enhancements to safety and environmental performance. Pilots from my
senior project concurred that NextGen will be the greatest change to happen to the flying
community since the invention of the airplane itself. The main argument that the pilots
pointed out is that even though NextGen is supposed to be able to increase the air systems
ability to hold aircraft it seems like there is nothing being done to address the fact that
airports are working at maximum capacity and they will not be able to increase their
capability of accepting and releasing flights.

This thesis sets out to test the conclusions of pilots from my senior project. Or
more theoretically, are the perceptions of pilots correct in revising the aviation system?
Are the bulk of the airports in the nation constrained to a point where their ability to hold
more flights is impossible? Or, is there something that NextGen can do to help airports ability to hold more flights than the current level? In order to accomplish this we need to look at the most constrained airports in the nation, the large metropolitan hubs that airline carrier’s call home will be the focus of this study. Each airport is in a different region and has different factors that affect the airport in determining its capability. So we must perform a comparative case study via meta analysis of current levels of throughput through select airports to see if proposed NextGen changes will make a difference or not.

In the early years of American history, most political leaders were reluctant to involve the federal government too heavily in the private sector, except in the area of transportation. In general, they accepted the concept of laissez-faire, a doctrine opposing government interference in the economy except to maintain law and order. This attitude started to change during the latter part of the 19th century, when small business, farm, and labor movements began asking the government to intercede on their behalf, not only because the transportation section had so many more stakeholders than any other industry, but also the people felt that they were being taken advantage of from the industries that were serving them (Department of State). The transportation industry incorporates a large percentage of America’s assets like, airports, shipping ports, pipelines, public transit, highways, commuter and freight rail, trucking and bus lines, and even bicycle and pedestrian paths. Transportation industry impacts everyone and anyone who leaves their home. Congress first became involved with the railroads in 1887 with the Interstate Commerce Act. With this regulation, along with the Sherman Anti-Trust Act, the government successfully prevented large firms from controlling a single industry or in this case the railroad transportation industry.
The Federal Government needs to become involved in the case of implementation of the NextGen system in several ways. First, because if left completely left alone markets only work on market forces. Supply, demand, and the need to increase profits and reduce costs become the most important factors governing CEO’s decisions. Throughout this process of decision making ethics is often lost of foregone in order to expand or continue the status quo. To best show how this mind set was in action in the air transportation system I will show the story of the Comet, the world’s first jet powered airliner. Second, the amount of funding that is needed to implement such a system is not able to be paid by even the largest US companies. The top three, Wal-Mart, Exxon Mobil, and, Chevron combine total profits do not amount to the total price tag of NextGen. Third, fixing the National Aerospace System (NAS) will not only benefit the aviation industry. Fixing this will have spillover effects, both good and bad, onto other industries and boundaries as well. Fourth, civilians are not the only users of the NAS. The government in the form of the military also uses the system for operations. The government is also responsible for setting the laws and regulations that govern how traffic and airspace is used. Fifth, having a standard way of operation is essential for efficient flying so that one aircraft is not given precedence over another solely on business relations. All of these reasons will be explained further in chapter three.
**Road Map:**

The rest of the thesis will flow in the following ways. The next chapter will discuss the literature behind NextGen as well as the policies and issues that surround it. In the chapter following that we will go through the methods of study. There will also be a discussion on the limitations to this study. The principal area of analysis will be four case studies in which NextGen may or may not help increase capacity at select airports. From the cases we will provide policy recommendations.
Chapter Two


**Literature Review:**

From the laying down of the first railroad tracks, to the construction of the first interstate highways, to the development of the air traffic system, transportation has always been part of the key to unlocking America’s economic potential. Today, America’s air transportation system not only moves people and goods from place to place, but it is also essential to our way of life (Cox, 2008). The aviation industry includes approximately eleven million jobs across 486 aviation occupations (BLS, 2009) and contributes around $640 billion annually to the national economy. In today’s economy, this is almost the equivalent cost of buying 290 Air Force B-2 Stealth bombers. By 2025, it is predicted that the United States air traffic will increase two to three times from 2010 levels.

**NextGen:**

The traditional air traffic control system will not be able to manage this growth in demand for air travel so the changes to the system will be required (JPDO, 2009, Pearce, 2006). In order to prevent congestion and gridlock before it starts and keep the economy growing, a focused action must be taken to improve air transportation for the future (Pathways, 2005). This action is the Next Generation Air Transportation System, or NextGen. NextGen is designed to transform our air transportation system so that it will accommodate the proposed doubling in the use of the current system (Pappas, 1997). Fundamentally, NextGen is a 21st century, state-of-the-art, satellite based transportation system, with internet-like communications, that uses advanced computer technology to facilitate daily airport and flying operations (Cox, 2008). NextGen's computerized air
transportation network stresses adaptability by enabling pilots to immediately adjust to ever-changing factors such as: weather, traffic congestion, aircraft position via GPS, flight trajectory patterns, and security issues (JPDO, 2009, Sharman, 2008, Shouders, 2007).

NextGen is designed to transform the way America flies, and this new way of flying is best explained by the FAA’s Chief Operation Officer, Hank Krakowski,

When I think about NextGen I think about a time in the 1920’s...a pilot would load up the passengers, load up the cargo, they would take off when they wanted to take off, flew the route, altitude and the speed when they wanted to, and land at the destination. They would have no delay on getting to the gate, and never talk to anybody. To a degree that’s what we are trying to do with NextGen. (Krakowski)

By 2025, all aircraft and airports in U.S. airspace will be connected to the NextGen network and this will continually share information in real time to improve efficiency, safety, and absorb the predicted increase in air transportation (JPDO, 2009)(Stevens, 2006).

**Current and NextGen Technologies:**

**Technologies Prior to Takeoff:**

Currently, the way aircraft move on the airport service requires a great deal of radio communications. If a plane wants to move, the pilot calls ground control; ground responds to the request by telling the pilot when and where they can move. Everything that the ground controller tells the pilot is based on what he can actively see going on in
the field. The Surface Management System, SMS, is virtually able to look into the future and monitor ramp areas and extend coverage, thus improving situational awareness.

Technologies After Takeoff:

Aircraft in flight are tracked only by radar. There are thousands of radar stations throughout the US. These stations are called Very High Frequency Omi-directional Range finders. The VOR’s and radar paint a picture for Air Traffic Controllers, unfortunately this is not a picture of good quality. The radar picture that an air traffic controller gets is from the triangulation method, which involves three radar stations that receive a signal from a passing jet. The radar can indirectly calculate where it is, how high it is, and how fast it is moving and place it as a mark on the display screen. This is one of the reasons that separation standards are so far, and even farther in places where there is no radar coverage. The Automatic Dependent Surveillance – Broadcast (ADS-B) system uses GPS satellite signals to more accurately identify aircraft position, altitude, and speed. However, airplanes are not the only thing that this system will monitor. It will also show a pilot traffic information, not just his position in the sky but all the other aircraft in his vicinity. It will also show weather information, allowing pilots to navigate around bad weather.

Technologies of Oceanic Travel:

Currently there is only one way that the transoceanic flights are managed, by dead reckoning. Pilots fly paths that they devise in their flight plans, calculating for wind, fuel consumption, flight time, etc. There is no land to set up a radar station so the picture that
Air Traffic Controllers (ATC) gets is very limited. Transoceanic flight regulations are very strict. So to help this problem, Advanced Technologies and Oceanic Procedures (ATOP) were developed. The ATOP takes advantage of the digital communications rather than voice communications that are used today. The faster the communication, the faster the controller can process the information, and make transoceanic flights safer and more efficient.

Technologies in Approach:

There is a tiered approach to get into controlled airspace. The best way to explain it is to imagine a three tiered wedding cake placed upside down on the airport, or an upside down snowman. The uppermost tier is where the largest and fastest aircraft will orbit, and then each tier down is where slower and smaller aircraft will wait on priority to land. To even enter into the controlled air space the pilot must establish radio communications. The Continuous Descent Arrival System (CDAS) will change this problem. First, it will keep the aircraft flying at an efficient altitude and then allow the aircraft to descend directly to the airport and thus avoid and eliminate the tiered or step down approach. This not only saves time but it also reduces fuel and noise.

Secondly CDAS optimizes satellite based approaches called Area Navigation (RNAV) and Required Navigation Performance (RNP) which gives pilots a precise runway approach unlike the Instrument Landing System (ILS) that has a sever deviation and only works to get the pilot about 100ft above the runway. The RNAV/RNP system itself stretches out the two dimensional picture of the ILS into a four dimensional auto
flight path, the pilot can now descend from his cursing altitude to land right on the runway where before the pilot could not.

Another important technology that NextGen is going to tackle is called System Wide Information Management (SWIM). Basically the safe and efficient use of the air is dependent on the other technologies working in unison. SWIM is an information platform that will allow the other technologies to talk to each other. The implementation of NextGen will not happen overnight, and even if it did that would not be fast enough, as there will continue to be aircraft out there running on the old systems. So, NextGen technologies will need to communicate to new aircraft and to those with old systems.

**Non Directional Beacon/Automatic Direction Finder systems:**

Automatic direction baring finders are the oldest of the technologies. It is one of the first aircraft navigation aids that pilots get a hold of. “This system was widely used in the 1930s and 1940s. ADF antennas are easy to spot on pre-World War II aircraft, being circular loops under the rear section of the fuselage or above the cockpit (Reference.com).”

World War I was the first war in which significant numbers of heavier-than-air aircraft were used in combat. Planes on both sides had problems navigating in the dark and in bad weather, and communicating with each other while in the air. One of the key challenges during the War was to make the planes better than the defenses which were created to destroy them. Aircraft needed better ways of communicating and navigating.
Shortly after the war began “in 1914 Lawrence Sperry dramatically introduced his gyro-pilot to the world demonstrating a hands–off low–level flight of his Curtiss flying boat while his mechanic walked along the wings to show the plane's stability” (Hayden Publishing). Once planes had gyroscopes in them and could give accurate information to the pilots about flight attitude there were better navigation tools in the cockpit.

The last piece of the pie that is missing is the actual Automatic Direction Finding system. The military adopted this technology that was invented by a physicist named Reginald Fessenden. “Reginald Fessenden presented the theories of echo ranging that were later to be the basis of sonar and RADAR” (Hayden Publishing). But, before it can be the basis for ADF and RADAR systems this theory needs to combine with another recently invented technology called the Morris code. Morris code is a series of dots and dashes that represent letters of the alphabet. It is the broadcasting of Morris code that allows pilots to tune into a VOR station and know what it was by listening to the dots and dashes. The method of sending Morris code over the radio to relay information is long and tedious; a new way to get information to a pilot was needed.

“The need for the first voice transducer was evident and E. C. Wente invented the condenser microphone.” Although there was still more that is needed to be done to get a human voice passed through a radio, finally “George Campbell developed the first electrical wave filter in 1917, making communication channels possible.” Communication at this point is very short, because of the radios at the time are not powerful enough to create frequencies that will allow for distant communication. “Ernst Alexanderson got his high–frequency alternator up to 200 kilowatts” which finally aloud
for communication from stations to pilots over miles of airspace (Hayden Publishing). The wireless communication and navigation of the First World War begins with the combination of all of these theories, technologies and inventions.

Today Automatic Direction Finders works in conjunction with VOR stations where previously it was just distance measuring equipment. ADF’s would tell the pilot roughly where he was in relation to a Distance Measuring Equipment station. As traffic increased there were more and more problems that were being uncovered by the ADF network. “A typical DME transponder can provide distance information to 100 to 200 aircraft. Above this limit the transponder avoids overload by limiting the gain of the receiver. Replies to weaker more distant interrogations are ignored to lower the transponder load” (Hayden Publishing). This was a major breakthrough for pilots at the time it was introduced but now is outdated technology, because it was just a glorified radio compass. Today VOR’s prevail where DME’s used to.

**Very High Frequency Omnidirectional Range navigation system:**

“Very High Frequency Omnidirectional Range navigation system was probably the most significant aviation invention other than the jet engine (Wood).” VOR technology began about 1950 following the theory and design of quadrature navigational systems (Campbell). In 1949 the adoption of the technology by the military led it to spill over and be adopted my major airlines. When that happened the military improved on the system and got their own frequencies so that civilian pilots could not use it. In simpler terms it is a “hemispherical station heading indicator.” The VOR system now lets pilots
navigate from point A to point B accurately, rather than just knowing where they were as was the case with the NDB of years before.

But the technology was not adopted until the adaptation of a British World War II invention, RADAR.

RAF Fighter command, under the leadership of Air Marshal Sir Hugh Dowding, had a sophisticated chain of radar stations and ground based observers, a radio based network of aircraft direction and control. RADAR stood for radio detection and ranging, it was a new technology that used radio waves to detect flying aircraft that gave the British advance notice and location of German bombing raids. (Kinney p. 60)

After the adoption of this system Air Traffic Controllers (ATC) could also locate American aircraft that were operating around the radar stations. The VOR stations played the part of letting pilots know where they were on a route, and radar let others know the same positions of those aircraft.

Pilots now had a way of instrument navigation. VOR’s worked like DME’s only there was one difference. Instead of transmitting one signal letting the pilot know where he was going, the VOR sent out two. One signal was stationary and the other was a rotating signal. When you fly to a station the phases of the waves travel at the same rate and are in phase. When you are flying tangent to a station or away from it, the waves become out of phase with each other and the difference in phase can be calculated. A pilot can not only tell where he is going but where he is relative to the station. Some airplanes are equipped with two VOR radios and can tune into two stations at the same time, this allows even more accuracy in location and destination.
This system also has flaws. One of the major things is that the only way that you can travel in instrument flight rules (IFR) is to or from these VOR stations. The processes of flying point to point, from and to VOR stations, pilots refer to as flying fixes. If you are trying to fly to a destination that does not have a VOR station the in IFR conditions it is near impossible to fly there. Also there is a limited amount of VOR stations throughout the US, so there are only so many ways to get from one destination to another. One of the major benefits of GPS based navigation is that it frees pilots from running these “Fixes” and lets pilots fly wherever they want from point A to point B in any manner rather than along these paths, this will be discussed later in this paper.

**Instrument Landing Systems (ILS):**

One of the most difficult tasks a pilot has to perform is to achieve a smooth and safe landing. Early pilots landed on an open field, facing any direction that gave them the best angle relative to the wind. But as traffic grew, and more aircraft began to use airports rather than farms or fields, landings became limited to certain directions. Landing aids were developed to help pilots find the correct landing course and to make landing safer. (Mola)

The Instrument Landing System was adopted by the Civil Aviation Origination after a series of events:

1. In the 1920s landing fields were marked with rotating lights so they could be found after dark.
2. In the 1930s, airports installed the earliest forms of approach lighting. These indicated the correct angle of descent and whether the pilot was
right on target. Their approach path was called the glide-path or glide-slope.

3. Gradually, the colors of the lights and their rates of flash became standard worldwide.

After the adoption of the ILS system airports all over the world started setting up these lights at the end of runways. There are different variations, there is the two color or the three color. Today these light systems are also out dated technology. It is still used at every airport as a backup and as a primary landing aid for aircraft that are not equipped for IFR operations. They are now called VSI (PRONOUNCED vassi) lights. ILS has taken a new meaning.

The new invention of the radio navigation discussed in the previous sections led to the ILS of today. The first radio ILS was hard to use, it used a low-frequency radio beam. These radio beams flared outward from the landing point like a V, so at the point farthest from the runway, the beams were widely separated and it was easy for the pilot to fly between them. But, near the landing point, the space between the beams was extremely narrow, and it was often easy for the pilot to miss the exact center point that he had to hit for landing (Mola). The second forms had a pilot tune into a certain frequency at a checkpoint far from the airport, and then use a stopwatch to descend at a precise rate to the touchdown area of the runway. This method also proved to be difficult.
Today’s ILS system incorporates the best features of both approach lighting and radio beacons with higher frequency transmissions. The ILS paints an electronic picture of the glide slope onto a pilot's cockpit instruments.

Tests of the system began in 1929, and the Civil Aeronautics Administration (CAA) authorized installation of the system in 1941 at six locations. The first landing of a scheduled U.S. passenger airliner using ILS was on January 26, 1938, as a Pennsylvania-Central Airlines Boeing 247-D flew from Washington, D.C., to Pittsburgh and landed in a snowstorm using only the ILS system. (Mola)

**Air Traffic Control Radar Beacon System:**

This technology is a direct result of military activity unlike the other technologies which have been driven privately on a necessity basis. The aviation transponder was originally developed during World War II by the British and American military as an "Identification friend or foe" (IFF) system to differentiate friendly from enemy aircraft on radar. Friendly fire is a term used when someone from one side of a fight, shoots, injures, or kills, someone from the same side of the fight. This became a large problem during the Battle of Britain because radar charts would show aircraft on a screen not knowing what, or who they were.

The concept became a core technology in the defense of North America during the Cold War. This concept was adapted in the 1950s by civil air traffic control using secondary surveillance radar (beacon radar) systems to provide traffic services for general aviation and commercial aviation.
How the system basically works is that an aircraft is located by radar and then the aircraft talks back to the radar site, transmitting a lot of data, like aircraft type and altitude information. There are some slang terms for it, pilots call it squawking. The squawk code to put in the transponder, the box that does the talking back, is given to a pilot on departure from the airport. This squawk is used for the duration of the aircraft's flight unless the aircraft is flying in VFR conditions and leaves controlled airspace, then the default code is 1200. All squawks are four digit numbers which are set by the pilot and then the transponder is turned on. A common mistake for pilots is to forget to turn the transponder to standby when on the ground. The transponder is echoing back your altitude information to an ATC and shows that the aircraft is flying even though it is on the ground. In this situation the controller now has to route planes around the “flying” aircrafts position even though it is there.

**Regulation Mandate That Created NextGen:**

The mandate to initiate NextGen was the Vision 100 Regulation signed by President H. W. Bush in 2003 (C.F.R. 18 Nov 2008). This document explains the need to increase the efficiency of our nation’s airports and airways (Leader, 2007). This regulation also set projects for the FAA to address. Some of the items that the FAA needed to address included the environmental impact of this project and improvements to airlines, safety, security, and research (Vision 100). The regulation also set the stage for creation of the Joint Planning and Developing Office (JPDO). The JPDO is responsible for creating and carrying out the integrated plan for NextGen which includes:
1. Overseeing research and development on the specific systems like ADS-B, RNAV, and CDA that make up the entire NextGen system,
   a. Creating a transition plan for the implementation of those systems.
2. Coordinating aviation and aeronautics research programs to achieve the goal of more effective and directed programs that will result in applicable research.
3. Coordinate goals and priorities within the Federal Government and aviation and aeronautical firms.
4. Oversee the development and use of new technologies to ensure that, when available, they may be used to their fullest potential in aircraft and in the air traffic control system.
5. Facilitate the transfer of the technology from research programs such as NASA and the DoD advanced research projects agency to federal agencies with operational responsibilities and to the private sector (Boehm-Davis, 2008).

The JPDO was also asked to look at externalities of the aviation community such as noise, emissions, fuel composition, safety, and also the possibility of making commercial space travel possible (Dwayer, 2006, Fallows, 2001). With incredibly fast paced technological advances made by NASA in space travel, this has led to the possible development of sub and supersonic planes that come out in the near future (Warwick, 2008). JPDO is an agency that is comprised of the FAA, NASA, the Department of Commerce, Department of Transportation, Department of Homeland Security, and Department of Defense. Currently NextGen’s pilot project is at a number of airports
across the nation, and the system is working to expectations. (Burkle, 2008, Krakowski, n.d). 

NextGen and The Joint Planning and Direction Office Objectives:

There are six objectives that the JPDO set forth to accomplish. They are to retain the United State’s leadership in aviation, expand the capability of the current air system, ensure safety is still in place, protect the environment, ensure national security, and ensure that the system itself is secure. In 2005 the JPDO set out on this task by developing a high level vision to communicate the principles to all of the related agencies. The most difficult part about NextGen is its scope and breath. NextGen encompasses all of the aerospace transportation industry, not just aviation or air traffic management or (ATM). Working with these multiple agencies is critical in getting the goals of NextGen accomplished. After meeting with these agencies the JPDO came out with a NextGen vision briefing. The NextGen vision briefing document details eight different capabilities the new system must have in order to accomplish the six goals that were set for the system.

1. Network-enabled information access;
   a. The network-enabled information access system will have a real time, instant information center, similar to the internet. The network should increase the speed, efficiently, and quality of information so that pilots and air traffic controllers, or ATC, can make better and faster decisions. With
better information all involved will be able to better assess risks; and, therefore, make the system safer.

2. Performance-based operation and surveillance system.
   a. This system will be a feedback system. It will deliver services on levels that the current state of the airways can handle. In other words, “minimum performance levels are expected to be required to maximize capacity in congested air space during specific periods of time” (ConOps, 2007).

3. Weather assimilation to decision making.
   a. Weather can help and/or hinder the air system. The current task is up to the ATMs to collect the right information and then give the information to the appropriate people. By being able to better apply weather information, it becomes an enabler to the system and will help minimize adverse effects of weather operation.

4. Layered form of security.
   a. Security needs to include a redundant system that is similar to the flight controls on planes. If one system fails, there needs to be another system that can complete the same task. There is no noticeable difference in the security system in that controls must be able to overlap and perform the function if one system fails. A layered security system will help reduce overall risk and a reformed security should help in getting people and goods through the gate faster.

5. Positioning, navigation, and timing.
   a. Positioning, Navigation, and Timing (PNT) is where the “rubber is going to meet the runway” as for visual differences. You will no longer see VOR
stations across the nation. In its place there will be satellites used for navigation. The current ground based navigation has not changed since the early 1950’s since radar and the jet engine went commercial. Satellite based PNT will ensure air craft operation in all weather conditions. Specifically, the new PNT will allow pilots to pick their own flight path.

6. Aircraft Trajectory-Based Operation.
   a. The basis for Trajectory-Based Operation (TBO) is a major change in how flight plans are thought of and submitted. Principally, the TBO states that there is the need for a four dimensional trajectory equipment, or 4DL, which will allow for better use of airways. It will eliminate victors, which are a sort of highway in the sky. It will create a real time dynamic highway that will pick faster and more efficient routes to destinations.

   a. This system will improve visual information. Pilots will be able to conduct operations without regards to direct line of sight. This EVO combined with PNT will allow aircrafts to operate on the airport surface such as taxiing, takeoff, and landing in low visibility conditions. Things such as sandstorms, white outs, heavy rain, fog, and haze, will no longer cause delays because the pilot will have the ability to see in these condition, whereas he cannot with the current system.

   a. With the increasing demand in air traffic, there is a need for changes to be implemented at the busiest airways and airports. New procedures and
improvements to positioning will help reduce spacing standards with aircraft in the air.

Even with the implementation of these changes and with the FAA’s creating better efficiency in flying, there are still other aspects that need to be considered. At some of the busiest airports passenger and cargo flow have to be maximized. A delay in New York can cause delays all over the country. These eight items will become the backbone for what NextGen will try to change in the current air transportation system. Although they are not spelled out to a tee on what has to be done, technology exists to successfully complete these tasks. NextGen is not yet fully implemented, but is scheduled to be completely operational by 2025. Currently, some of NextGen’s technologies are being implemented at select airports for testing while others like RNAV have been in place for many years.

NextGen Implementation Time Line:

The NextGen Implementation Plan timelines present commitments, activities to be completed by specific dates, and strategic timeframes for mid- and far-term operational capabilities. These strategic timeframes show the general period during which a new capability may be realized. Future NextGen Implementation Plans will develop greater detail about how these capabilities will be implemented, narrowing those timeframes to more specific dates (faa.gov 2009). NextGen is to be incrementally implemented over the next decade. There are many systems that must be built in order for everything to go according to plan, because there is no one system that can control
everything that NextGen needs to accomplish. There are three areas of implementation that break down the timeline.

1. Establishment of the infrastructure:
   a. Develop FY 06-11; Implement 08-13
      i. This section of the time line will deploy the basis for the software of NextGen this includes. New technology like the ADS-B, DataCom, RNP, and SWIM. Also, the rules and procedures for how these will work and be used will be established. Also, air space and route access information based on the RNP system will be up and running and ready for use as one of the first technologies to come online.

2. Primary NextGen operations:
   a. Develop FY 12-17; Implement 14-19
      i. At this point, now that some of the NextGen Technologies are becoming available online all aircraft should be equipped for NextGen. Airports and airspace will be able to handle increased operations and capacity. The next step is to improve safety, start to lower ATM workloads, make sure the system is secure, and also start to work out any bugs that the system may have.

3. NextGen super density operations:
   a. Develop FY 18-21; Implement 20-25
      i. In this step NextGen technology explores the limits of the current system and its capabilities. It will not try to expand
its networks and airports. The 4-D tracking system management will go from gate to gate instead of from takeoff to landing. Finally, there will be a restructuring of the current VOR navigation and radar surveillance structure to help support NextGen and allow it to be a backup system.

Below are some figures which help display some of the implementation of the three sections (faa.gov 2009):

Figure 1 The En Route Technology Implementation Time Line
Conclusion from Senior Project:

The detailed results and justification for researching pilots for the pilot surveys are placed in Appendix E: Results From NextGen Survey and Appendix F Previous Research. Everything that used to be the world of flying is going to be radically changed by 2025 when NextGen is finally in place. The process in which planes operate not only in the air but on the ground as well, will be changed. Passengers and cargo will be able to go from airport to airport faster and safer than ever before. “US commercial aviation ultimately drives $1.1 trillion per year in U.S. economic activity and 10.2 million US jobs (ATA testifies on air traffic modernization and NextGen).”
As the data indicates there are a lot of pilots that support the technologies that NextGen will provide. All of the pilots said “yes” or that they agree that just about all of the main technologies will benefit flying. The most important item from the data is that six of the pilots have never heard of NextGen and nine of the pilots have never used NextGen. Yet, all of them had nothing but good things to say about NextGen, which parallels the opinion of the pilots that did hear of NextGen and have used the systems. From the research we can say that there is no correlation between if the pilot had used or heard of NextGen and their opinion toward it. As we can see, in both situations, they were both good. We know that a pilot does not have to use NextGen to know that it is going to be beneficial to him or her.

One change that separates a good pilot from a bad pilot is the amount of stick time that they get. Experience plays a big difference in the skill level of a pilot. I asked this question in my survey, and it came back with something interesting. The hours that a pilot has flown did not affect the opinion a pilot had about NextGen. The veteran military pilot that has the most time in the cockpit with over 15,000 hours says that it is a good idea and so does the simple private pilot with only 19 hours. Knowing that time spent behind the stick does not matter then we can assume that this variable does not play a factor in changing pilot opinion about NextGen.

There are normally two different routes that you can take to become a pilot. There is the military or the civilian route. Either way you are a professional pilot. This may have played a factor in pilots’ opinion of NextGen because it was only the civilian pilots...
who had any experience with NextGen. We have to take their firsthand knowledge more heavily than we can the military pilots who have only heard about NextGen. There was one civilian pilot who did not think that one of the technologies would be beneficial to him. When he answered this question he said that “it would be too much activity.” However, this information was from one of the civilian pilots who did not have firsthand experience with NextGen technologies and the other pilots who did said it was great. For example, the 737 pilot who has NextGen experience stated “it works best when on the ground.” It is really back and forth on the specific matter.

On the whole, out of all the NextGen technologies, there were nine cases in which civilian pilots said that NextGen would lower expenses, sixteen cases in which NextGen would increase efficiency, and seventeen cases in which NextGen would increase safety. Some other general comments that were made by the civilian pilots raised a few eyebrows. In the comment section there were matching comments about NextGen only being as good as the airport arrival and departure rates are. This does make sense. There are only so many landings and take-offs that a runway can handle. Unless you build more runways there will be no way that you can have more traffic in and out of an airport, no matter how efficiently you move planes from airport to airport. We can conclude that there are some specific items that civilian pilots do not agree on; but on the system as a whole and the need for it, it is unanimous that it is a good thing. Because of their experience working with the system, they have pointed out a problem that NextGen needs to address. That is the arrival and departure rates of runways.
To be a rated pilot in the civilian or in the military sectors there are requirements that you must fulfill before you can obtain the rating. One thing that is interesting, that I did not know about going into the study, is that military pilots and civilians are commercially rated. Out of the twelve pilots that were interviewed, only five of them were not commercial rated. Eight of them did have a multi-engine rating. The commercial rating is only a few hours and another test away from the multi-engine rating.

Even though some of the pilots were categorized as a military pilot, they still held a civilian commercial rating. It is the ATP rating that allows a pilot to carry passengers. This is a rating that is equivalent to the doctorate degree of pilot ratings. This rating is also only reported by military pilots. With that said, all of the civilian pilots that I talked to were first officers, not captains. Even if it were the case that I talked to all captains, I do not think that this factor would have made a difference in the opinions about NextGen.

We can see from the data that all of the pilots who held ATP ratings still liked NextGen, and they also shared five cases of lowered expenses, ten cases of increasing efficiency, and seven cases of increasing safety just between the three of them.

Lastly age is just something that we acquire over the years. No one can accumulate this faster or slower than the next person. This factor did not play a role in the opinion of the pilots on NextGen. There was one case of a pilot stating that he did not agree with one of the specific technologies of NextGen. This pilot was in the youngest category 20-30. On the other hand we have two pilots who are in this category and said that all NextGen technologies would be beneficial. Statistically we would say that this data point would be an outlier and can be discarded because it does not fit the trend of the other data point in the same category. The qualitative data produced by this pilot is still
significant. This data does give depth and a greater understanding to the argument made by his decision to say “no” to one of the questions regarding the likeability of NextGen technology. With this additional understanding of why he does not like it, it does not fit with the other arguments that were made by people in the same situation as him. We can say that this variable, or factor, also does not affect pilots’ opinion of NextGen.

In conclusion, pilots like the idea and technologies of the NextGen system. The only factor that I have found to be significant is whether a pilot has had any hands-on experience with NextGen. This is something that is accounted for in many of the articles on NextGen. You can read, examine, and make inferences all you want, however, until you actually try it, your opinion is going to be different than someone who has actual experience in the system.

The bottom line is that we are at a pivotal moment for aviation technology in the United States. This is something that should not be over looked or even taken lightly. NextGen will improve efficiency and productivity, have well defined environmental benefits, have better operational integrity and customer satisfaction, better safety measures, and improved financial performance per dollar spent. According to pilots, NextGen should be pursued and implemented. Pilots like it and it really does make their jobs better and easier. This is proved in the testimonies of selected pilots.
Questions Raised From Senior Project:

After the pilot survey was conducted there were a number of questions raised that remained unanswered. The main issue raised by the pilots was the question of whether “There a bottleneck created at airports due to movement rate restrictions? Here I use the term “movement” as the airport’s ability to take off and land a number of airplanes. Each airport cannot land and take off an indefinite number of planes, it is just not possible. Another way to think about this is to think of a highway. The highway is congested to a point which makes the mean rate of speed far below the posted speed limit. Cars are backed up bumper to bumper and are moving slowly at this crawling pace. At first look the best solution seems to be to just make the highway wider. The wider the driving surfaces the more cars will be able to occupy the roadway, thus solving the congestion problem. Is making the road bigger the best answer? Is it the only answer? NO! There are several more ways to deal with the traffic problem. For example, you could create disincentives for driving, thus reducing the demand for driving and the amount of cars on the road. You could also create more roads, so now there are more ways to get to the same destination, if one road or segment becomes backed up there is a way to get around the blockage.

To a degree, this is what NextGen is doing, increasing the routes that planes can take to get to their destinations, this is only one of the major changes that NextGen will be performing. But, with an increase in the size of the road, or the number of air paths, does that mean that there will be no more congestion? Or does it just mean that congestion will be concentrated on the exits? No matter how large the road gets, or how many possible paths you can take to get to the same destination, if everyone is trying to go to the same
place and exit ramps are not increased as well, then a bottleneck is created at these points. According to the Federal Aviation Administration in 2007, nearly three-quarters of all delays in the U.S. could be traced to a problem in New York. The issue has received a lot of attention over the past two years, with mixed results. “On busy days, the lines of planes landing at LaGuardia Airport can still stretch unbroken in the sky for 40 miles…”, said Dean Iacopelli, an air traffic controller and union representative at the facility that handles approaches to New York. "All we can do is take them and space them out as close as FAA rules allow," he said. "It's not like you can put more aircraft in there. That's it. We're just maxed out (Caruso, 2010)."

NextGen’s main focus is not to construct new runways; its main focus is to concentrate on increased runway utilization and productivity (Planzer, N. 2009). There are some cases when it is realized that the construction of new runways and even new airports is needed to fully correct the congestion problems. The Integration Plan of NextGen is a strategy for airports and is titled “Develop Airport Infrastructure to Meet Future Demand.” This title expresses both the goal to enable airports to meet future demand and the approach to develop new infrastructures. As described in the Integrated Plan, the associated airport infrastructure will focus on infrastructure improvements and expansion of airports. But by omission, these plans seem to discount or reduce the ability to increase the capacity of existing airports by procedural changes alone. Such as those enabled by:
– The timely dissemination of precise information related to the position and velocity of aircraft, adverse weather, wake vortices, and the state of the air transportation system.

– Aircraft and ground facilities equipped to use this information effectively.

Building new airports and new runways especially if current procedural constraints on separation standards between runways do not allow new runways to fit on existing airport property, also it is extraordinarily expensive and can take decades to complete. For example, 9,000 ft. runways were constructed at the St. Louis/ Lambert and Atlanta airports in 2006, they each cost about $1.4 billion dollars (Everett, 2006). In many areas, land for airport expansions and new airports is simply unavailable. Environmental issues also limit the ability of airports to expand their infrastructure. Notwithstanding changes in demand, the air transportation system must continue to satisfy environmental requirements related to aircraft noise, local and global impacts of engine emissions, and water quality.

Efforts to satisfy higher demand should include a balanced strategy for improving technologies, operational procedures, and policies related to environmental performance of the air transportation system (Pathways, 2005). During the 1990s, environmental issues forced 12 of the nation’s 50 busiest commercial airports to cancel or indefinitely postpone expansion projects (General Accounting Office 2000). Solutions that increase the capacity of existing runways are potentially quite beneficial and the construction of new runways may not be needed in all cases. The large payoffs that would result would be from the ability to conduct independent flight operations on closely spaced parallel
runways in limited visibility using the current performance-based area navigation (RNAV) and flight management capabilities in many existing aircraft. But, eighteen of the nation’s 35 busiest airports are already at capacity limits or will reach capacity limits sometime in the next 15 years, other solutions will be necessary (Federal Aviation Administration 2004).
Chapter Three
Methodology:

One way to show that airports must meet higher demand is to conduct an airport-specific analysis of impediments to higher capacity at these airports. Another option would be to tailor the analysis to investigate solutions that are generally applicable in all applications or must be tailored to specific individual airports. The second option will tend to be more expensive than the first on a per airport basis, but both types of solutions should be considered. The most effective solutions are likely to involve an integrated approach that involves aircraft and Air Traffic Management (ATM) technologies, procedures, and standards, including those related to Required Navigation Performance (RNP) and Area Navigation (RNAV) capabilities (Pathways, 2005).

In this analysis I will concentrate on the second option of conducting research as a multiple case study that concentrates on four different airports San Francisco International Airport, Minneapolis St. Paul International Airport, LaGuardia International airport, and the New York City Metroplex, through a meta analysis. This specific case study allows me to concentrate on the factors and environment that differs in each airport and then I may establish a pattern of behavior to develop a theory. The use of a multiple case study helps explain the “how” and “why” for which the quantitative research methods are insufficient in elucidation. The case study will have more of a real life feel to the situation that becomes lost in just numbers and data points. There are several other typical arguments that would further the use of case studies in this instance; first there is a lack of a systematic way of handling of the data, a case study would just provide evidence as it acquired it. There are sequences of events that produce delays at airports but there is no pattern on how to collect such data. Second, there is no basis for scientific
generalization. The purpose is to generalize to theoretical proposition, not to postulate as in statistical research. In other words we want to back up our thesis with arguments which support it, we are not forecasting or making inferences as to what will happen next year.

We also need to pay attention to specific situations by limiting the scope and then suggest possible links between the phenomena, or if the same trend can happen on an airport by airport basis. Statistical analysis requires that the N value to be quite large, at least 30, in order for the results of the study to be statistically significant. Lastly it may take too long, or we may end up with unreadable documents. Time limits and formula writing in statistical research depend on the choices of the investigators and will normally represent their bias because they can hand pick the factors that govern their model. Whereas in a comparative case study we present the data as it is, trying to include as many factors and variables as we can in order to try and explain/understand what is going on at the cost of weakening the power of your theory.

Because we are going to try and replicate our logic from one airport situation to another and then try to deduce and reveal some kind of pattern or theory it becomes necessary to conduct a multiple case study. What we would like to do is to show my theory “identifies clearly the conditions when a particular phenomenon is likely to be found in similar cases and when it is not likely in contrasting cases for predictable reasons (Yin, 1994).” The information that results from a case by case analysis then becomes a vehicle for generalizing to the new cases. But, if empirical cases do not work as predicted, then modifications must be made to the theory or the unit of analysis, since modification of the case criteria selection only creates a bias model. Lastly, the number of
cases depends upon “the certainty wanted to achieve and the richness of the underlying theoretical propositions (Yin, 1994).” The selection of the four cases aims to provide more of a holistic view because the effects of NextGen is likely to be in a spectrum, from large benefit to some airports and no benefit to others. To show if this is, or is not the case we need to select airports that represent the same spectrum. Airports come in all shapes and sizes and are located in different regions, locations, and environments.

Deciding between the different forms of the multiple case study types is difficult. The decision depends on the richness of the rival propositions in theories related to the topic of airport capacity. The richest theories allow for an explanatory design, but this does not apply to this situation because there is limited information. NextGen is not yet implemented in full, so performing a post test to see the actual effects is not possible. Because we don’t have a pre and post test there is not a cause and effect relation. At this point in the preliminary we are only assuming what could happen, so the argument loses richness from no actual evidence. This loss becomes a limitation to the research, because we must assume that NextGen works perfectly. If we infer from the FAA’s track record then the implementation of the NextGen policy will be anything from smooth and seamless.

Moreover, the search for complementary and opposing theoretical propositions that can be elaborated on by case study questions is difficult because of the lack of research in this specific question of NextGen effects on airport capacity. A descriptive design would have a strong and extensive literature review; the thick description is needed to gain the frame of mind of the situation. A great example of a descriptive case
study would be the book *The Challenger Launch Decision: Risky Technology, Culture, and Deviance At NASA* by Diane Vaughn. There is a very comprehensive explanation of the culture at NASA to better understand what happened and “why” (Vaughan, 1997). The book is about the chain of events which led to the decision to launch the Challenger Space shuttle on January 28 1986. Vaughan looks beyond the “go”, “no go” decision, the bad weather, and faulty O-rings and looks more at the society of NASA. To fully describe the ambiance and culture that makes NASA lots of description is needed to understand that it was the political structure of normalizing high risk hazards. The thick description demythologizes the retrospective account of the challenger tragedy. Because the NextGen system is so new it would be hard to collect this information in the time this study was conducted, so it also does not fit this type. The exploratory case study is more aligned with the research question, time, and scope of this study. The construction of the four cases and their criteria which may increase capacity is based on only a single conceptual framework that of our aged and out dated air transportation system.

The four cases were not selected randomly, they were selected based on the same manner the topic was selected. The NextGen system is aiming at increasing the capability of our current air transportation system, so NextGen will have the greatest impact on the more congested airports. The airports were selected for their characteristics with respect to their current capacity levels. If the airport possessed an attribute or problem identified by the NextGen system is expected to fix, and it was at or near maximum capacity then it was selected to study. For example RNAV will allow more precise approaches in harsh weather conditions for closely spaces parallel runways. Airports like Philadelphia, San Francisco, and Denver International ONLY have parallel runways and both are at or near
maximum capacity, so they would make for good case studies to see if the implementation of RNAV increases capacity at these kinds of airports in harsh weather conditions.

Also if we select cases in this manner the flexibility of our study increases. Because, “the flexibility of a case study design is in selecting different from those initially identified, not in changing the purpose or objectives of the study to suit the cases” (Yin, 1993). The selections of the cases must be independent from our considerations of NextGen.

The unit of analysis is an actual “score” of information that is used in the study, it can be an individual, an organizational document, or even an artifact (Yin, 1994). The unit of analysis will be the number of flights an airport can land and take off in an hour. This benchmark is good for measuring the ability of the airport to move people. To do this we must ignore the size of each flight as some aircraft are larger than others and thus can move more people at a time. This information is not published and collecting it would require years of research and observations. Also it is more time that is available with the scope of this study. So we will rely on the airports ability to move flights, and because the two are directly related, we will assume that as the number of flights increase the number of passengers moved also increases.

In the “Airport Capacity Benchmark Report” the FAA has developed capacity benchmarks for 35 of the nation’s busiest airports to understand the relationship between airline demand and airport runway capacity. Capacity benchmarks are defined as the
maximum number of flights an airport can routinely handle in an hour, for the most commonly used runway configuration in each specified weather condition. These benchmarks are estimates of a complex quantity that varies widely with weather, wind direction, runway configuration, the mix of aircraft types, wake separation, miles in trail separations, and flight prioritization to name a few.

Capacity benchmarks assume there are no constraints in the en route system or the airport terminal area, for the purpose of this study, we will assume that NextGen is up and working efficiently. The benchmarks are the sum of takeoffs and landings per hour that are possible under the given conditions, if the demand is present. The benchmark capacity usually represents balanced operations, with equal numbers of arrivals and departures (Department of Transportation 2004). These benchmarks are based on routine operations at the airports, and therefore they might be exceeded occasionally under favorable conditions. Conversely, lower rates would be expected under adverse conditions, such as a lower capacity runway configuration or very low ceiling and visibility, or if demand is significantly less than capacity. There are three benchmarks that will be measured at each airport, reflecting three different weather scenarios (Optimum, Marginal, and IFR). The benchmark capacity is defined as the maximum number of aircraft that can be routinely and safely handled during each specified condition:
- **Optimum**: periods of unlimited ceiling and visibility, using visual approaches also referred to as Visual Flight Rule (VFR) conditions. (ceilings are above 3,000 feet AGL and visibility is greater than 5 statute miles)

- **Marginal**: periods when the weather is not good enough for visual approaches, but is still better than instrument conditions. (ceilings are 3,000 to 1,000 Feet AGL and/or visibility is 3 to 5 statute miles)

- **IFR**: instrument conditions (ceiling less than 1000 feet and/or visibility less than 3 statute miles), when radar separation between aircraft is required.

There is a lot of information on airport throughput. There is currently very little information however about the effects of the NextGen systems on increasing airport capacity. Because of this the only way to know “how” the NextGen system will affect an airport’s capacity is to perform a sort of patchwork research design. In conjunction with the case study we will collect information in a meta-analysis. This kind of analysis is the “syntheses of the evaluation research findings from others sources (Bingham & Felbinger, 2002).” Meta-evaluations are quite similar to literature reviews in that it is the culmination of the current state of knowledge. In this case, meta-analysis is used to provide information supporting a specific theoretical statement about the overall strength or consistency of a relationship within the case studies being conducted. As might be expected, calculating a meta-analytic summary is typically a much simpler procedure than performing a full quantitative literature review (DeCoster, 2004). One negative factor to point out is that an equally prepared researcher can disagree on the interpretations of research or others results the same way that I agree on them. I have
constructed this meta-theoretical method as carefully designed as possible in order to
defend itself against the more data based style theories and methods.

Because some solutions can work in all situations having large external validity
and some can only work in specific instances or have just internal validity we need to be
broad with our case studies. We will focus efforts on large, medium, and small airports
alike. All of which will need to be airports that are working at max capability because we
need to see if the NextGen technologies really help or not. If an airport is currently not
maxed then these technologies will only further help and benefits will be hard to measure
because there was not a worst case scenario to weight the benefits against. This scenario
may also show NextGen perpetuating or exaggerating benefits, when indeed it is helping
the same in all situations. What this thesis will do is to look at the numbers projected by
the benchmark report and compare it with other airports. What we are going to look for is
if NextGen alone will increase operations and if not, will the proposed solutions in each
case help increase movements in and out of the airport or is it just anecdotal. More
specifically what we are looking at is if NextGen is an efficient system in improving
airport efficiency by itself.

Case Reference: Aviation Industry Will Not Take Care Of Itself:

Understanding why this is a public issues was already explained, but what makes
this a policy issue? A better understanding of the Department of Transportation and its
role in regulating the aviation industry will shed light inside the policy process. One such
instance which demonstrates why there is a need for government intervention in this
sector is an incident which occurred involving the De Havilland Comet. This reference to this case describes the many reasons which force the government intervention into this private sector.

The Department of Transportation (DOT) is the governmental agency that oversees all issues related to travel whether it is by land, air, or sea. The agency was created by an act of Congress on 15 October, 1966 and finally began operations on 1 April, 1967. Its mission is to “serve the United states by ensuring a fast, safe, and efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future (Department of Transportation).” Its creation was badly needed, because in the early years of the 20th century aviation the government was not involved in broad transportation issues and there were many tragic accidents. Arguably one of the most famous of them all was the Comet.
The De Havilland Comet was the world’s first commercial jet airliner to reach production (The Avro Ashton and Vickers VC.1 Viking, fitted with Rolls-Royce Nene turbojets, and had flown earlier but were experimental models.) In the early years of its implementation into the flying world, the Comet had suffered several catastrophic well publicized accidents. The first few were runway overruns. This is a situation in which a plane fails to gain enough lift to get off of the ground and ends up overrunning, or driving the entire length of the runway, and then continuing on through the grass, mud, or airport fences. No one was hurt in these early accidents but the planes were totally destroyed. The accidents that made the Comet famous were British Overseas Airways Corporation (BOAC) Flight 781 and South African Airways Flight 201 in 1954. Flight 781 was leaving Rome, Italy when 20 minutes after takeoff it exploded in mid air, broke up, and fell into the Mediterranean Sea killing all 35 on board. A few days later Flight 201 was
on a trip to Cairo, Egypt when it crashed in the waters near Naples, Italy. Because of the incidents all Comet flights were now suspended until the problems could be found.

It was eventually found that the Comet was flying higher and faster than any prop plane could and the great changes of atmospheric pressure were wreaking havoc on the airplane’s hull. The aircraft would climb into the upper atmosphere where the pressure is significantly different from what it is on the ground, and the plane would then descend back into the high dense air for landing. This cycle of high pressure, low pressure, and high pressure had strong effects on the aircrafts external structures. Scientists finally figured this out by placing a Comet in a large tank of water, and then filling and draining the tank several hundred times to simulate the same effects that a normal flight would have. The is an excerpt from British records explaining the procedure,

_The Ministry of Civil Aviation decided upon a unique test to find out [what was going wrong with the Comet]. They built a tank large enough to hold one of the grounded Comets. The wings protruded from watertight slots in the sides of the tank. Then the tank and cabin were flooded with water. The water pressure inside the cabin would be raised to eight and a quarter pounds per square inch to simulate the pressure encountered by a Comet at 35,000 feet. It would be held there for three minutes and then lowered while the wings were moved up and down by hydraulic jacks. The hydraulic jacks would simulate the flexing that naturally occurs in aircraft wings during flight. This process continued non-stop, 24 hours a day. This torture test continued until the cabin in the tank had been subjected to the stresses equivalent to 9,000 hours of actual flying. Suddenly, the pressure dropped. The water was drained and the fuselage examined. The investigators were horrified to find a split in the fuselage. It began with a small fracture in the corner of an escape hatch window and extended for eight feet. Metal fatigue! Had the Comet not been under water, the cabin would have exploded like a bomb. (De Havilland Comet)
The conclusions were that these drastic changes in the pressure worked on two different features of the plane. The first problem was found with Flight 781, this variant of the Comet had square windows. The changing pressure would cause the metal of the hull to focus its flexing at the corner points of the windows, the windows eventually failed and the plane would instantly decompress causing it to implode and fall out of the sky. The second problem found was with Flight 201, this jet also had square windows but the problems it had were exacerbated by the fact that it was constructed with punch rivets. “The windows had been engineered to be glued and riveted, but had been punch riveted only. Unlike drill riveting, the imperfect nature of the hole created by punch riveting may cause the start of fatigue cracks around the rivet (Aircraft Accident Digests/NTSB).” So why is it that today you will never see riveted or square windows on airliners?

The Comet went through four different variants from the original models that crashed. In the early 1950s and 1960s eager passengers still flocked to fly on them. By the time of most of those Comet accidents occurred the United States had been developing the Boeing 707 and the McDonnell Douglas-8 both of which were faster but were equally as costly to operate. So operations of the Comet never really took hold in the U.S. Looking at the creation of the new aircraft, one may think that this is the market taking care of itself. The aviation firms recognized that the high risk of flying the Comet would deter customers and that they would have to create a newer and safer aircraft to keep the customer base. But, which is cheaper in the eyes of the firm, the research and development, the time, and the number of manufacturing plants, or capital intensity that is required to create a new aircraft from scratch? All of these stages of production have
very high costs and the value of a human life in comparison is very low. The value of a human life, to a firm, is calculated in different ways. It could be the amount forgone to compensate the surviving family members or it could be the amount in which the deceased person would have made through a normal working life time (Viscusi, 2008). Because businesses are always out to maximize profits they will pick killing humans over the development of a new aircraft because it is cheaper.

The main reasons that the Comet was not used in the U.S and led to the creation of new jets was because the accidents highlighted the need for better regulations in the design of aircraft with respect to fatigue, analysis, and testing. It was the U.S. Civil Aeronautics Administration (CAA), predecessor to the Federal Aviation Administration (FAA) that had misgivings about the square windows of the Comet several years earlier and refused to grant it an air-worthiness certificate so it could fly in the United States. This is one reason why the government needs to have interdiction in the transportation sector. “The U.S. [CAA] would not give the Comet permission to fly over the U.S., because of the square windows. Take a look at present day aircraft windows; they all have rounded corners (Battinus, 2003)!”

Externalities:

We can apply this same concept to the current government intervention in the implementation of the Next Generation Air Transportation System. Externalities are effects which are outside of the business transaction that have an impact on a third party. They can be positive or negative, but in either case the cost or benefit of these are not
captured in the price of the transaction. A classic example of a negative externality in the aviation community is the increase in global warming caused by Condensation Trails (Con-trails). National Aeronautics and Space Administration (NASA) scientists say contrails from jet exhausts create cirrus clouds, likely trapping heat rising from the Earth's surface. This theory is also supported according to a Reuters report which concluded the same (USA Today 2004).

In fact, those scientists say that it could account for nearly all the warming over the United States between 1975 and 1994. If that data is substantiated, that's not bad news for the planet, given that air travel has boomed since 1994. Even the International Air Transport Association (IATA), the body which represents the world's airlines, admits the planes cause some environmental damage (Mutzabaugh)

When you buy a ticket to fly from New York to Chicago 0% of that ticket price is going to toward countering the problems of contrails. But, if there was a fee, it is very likely that the price would be drastically different from what it is now. The government needs to be, and is the only candidate, able to enforce compliance from the airline industry to combat these problems. Positive externalities on the other hand only reinforce and further encourage government involvement in the aviation sector.

Traditionally, air travel has only survived largely through government intervention, especially for airports whether in the form of equity or subsidies, it is easy to notice how most airports are named for their location i.e., Greater Rochester International Airport or Cook County Airport, it is because the airport is owned by that county or state. The airline industry has had cumulative losses in its history, subsidies such as aircraft development and airport construction are necessary just to keep the
aviation sector afloat. But, it is the “… positive externalities, such as higher growth due to global mobility, outweigh the microeconomic losses and justify continuing government intervention” (Edemariam, 2006). A historically high level of government intervention in the airline industry can be seen as part of a wider political consensus on strategic forms of transport, such as highways and railways, both of which receive public funding in most parts of the world (Kay, 2005). The only way that the airlines can stay alive and stay competitive is by involvement from the state and federal government. So can we say that if left alone the airlines will invest in updating the current air transportation system to one that works better? No, probably not. The Government needs to intervene and mandate these changes because they will not happen on their own, or if left in the hands of private companies.

Market Failure:

The problems of the Comet, and also problems that cause global warming can be described as market failures. Externalities or problems could be much worse, and in the event of a market failure in the aviation sector no one would contest that government intervention is needed. The market failure that NextGen is combating is congestion and inefficiency. In this case it is possible that we have seen yet another chapter in the unending success story of “government-business cooperation." In the current situation what we have is the glaring problem of congestion and lack of efficiency, caused by the unchecked and selfish actions of capitalist greed. Now a wise and far-sighted government agency, seeing deeply and having only the public interest at heart, steps in and corrects
this failure, its wise regulations gently but firmly bending private actions to the common good.

McGowon and Seabright 1989 argue that this market failure of congestion in aviation results from the market power and dominance of large multinational carriers flooding the system. They also point to congestion on the surface (ground) and in the air as another case of a market failure in aviation (University of Bath, 1993). “Over the last few years, air traffic delays have garnered increasing attention. The year 2000 produced record delays with more than one quarter of all flights arriving at least 15 minutes behind schedule” (Mayer, Christopher & Sinai, 2003). Basically the airline industry is facing the "tragedy of the commons." According to this hypothesis, congestion occurs because most airports allow unlimited landings and takeoffs and airlines schedule flights without valuing the fact that their traffic will increase travel time for other airlines (Mayer, Christopher & Sinai, 2003).

Things are only becoming worse, air traffic controllers at LaGuardia have to delay flights at the beginning of operations. When controllers get into work at 5AM to start operations, the number of departures that need to be controlled from the gate to takeoff is far above the airport’s capacity. So even before any flight takes on a passenger, or the captain of the flight takes his first sip of coffee, flights are getting delayed. When flights are delayed at a hub it creates a domino effect that multiplies throughout the system. Flight delays also seriously affect the economy in several ways. In 2009 delays in the nation's aviation system delivered a staggering blow to the economy, costing passengers, airlines and related businesses $41 billion, according to a Congressional study. "With
delays going through the roof and the economy squishy soft, delays' impact on the economy is very severe," said Sen. Charles Schumer, D-N.Y., chairman of Congress' Joint Economic Committee, which released the Congressional study (Levin, USA TODAY, 2008). Schumer called the impact on passengers and the overall economy a "$41 billion punch in the gut." The report released by Schumer's committee concluded that:

1. Delays cost the airlines $19.1 billion in increased operating costs. That represents far more than the $3.8 billion the airline industry earned in profits in 2009, according to the Air Transport Association, which represents large carriers.

2. Passengers lost the equivalent of $12 billion as a result of lost time due to flight delays. The actual costs of the congested aviation system may have been even greater because the calculation did not include losses from canceled flights or missed connections.

3. Other industries suffered estimated losses of $9.6 billion.

4. Delays forced airlines to use an additional 740 million gallons of jet fuel, equal to about 5% of total fuel consumption. That led to the emission of an additional 7.1 million metric tons of carbon dioxide, adding to the industry's impact on global warming.

5. Overall, delays accounted for almost 20% of all airline flight time last year, according to the report. (Levin, USA TODAY, 2008)
This data does not even account for all the delay costs; there are still things like the opportunity costs that are not accounted for. Opportunity costs of the thousands of consecutive hours lost sitting in a delayed or late plane. There are the missed business meetings, missed events, and stranded passengers who find out when their plane is delayed that the next flight out is not until the next day. Qualitatively and quantitatively the delays on the National Aerospace System (NAS) have atrocious effects to all stakeholders. Furthermore, numerous studies have documented the enormous contributions aviation makes to the U.S. economy and thus the rationale for pursuing public policies and facilitating infrastructure investments that enable aviation to grow and prosper. A 2002 study by Global Insight and the Campbell-Hill Aviation Group showed aviation’s total impact on the U.S. economy exceeds $900 billion annually (nine percent of the nation’s gross domestic product) and supports over 11 million American jobs (White Paper on Ensuring JPDO Success).

Additionally, investments in aviation infrastructure produce positive returns. For every dollar invested in airport and air traffic system improvements, up to $5 in benefits returns to the U.S. economy. Finally, the cost of allowing our aviation system capacity to continually fail to meet the systems demands far outweighs the costs of transforming the system. Estimates of the costs of flight delays and cancellations to our economy over the next 10 years range from $140-$170 billion (White Paper on Ensuring JPDO Success). If the main goal of a business is to obtain the highest profit possible then why aren’t proactive steps taken to preventing such profit consuming problems? Why is it the job of government to come in and take control of the situation when there is a market failure? The conclusion here is that government intervention in aviation markets is warranted.
under circumstances where markets fail to use the system efficiently. And as we have seen there are several market failures, in the form of externalities that are not being addressed. Once these failures have been recognized, policy officials may have a range of choices and approaches on how to address the issue through government intervention (Waves, n.d). Common options include regulation: tax incentives; subsidies; government provision of information; or even establishment of standards (Bardach, 2004).

In this case the government was to intervene in a very drastic way. The NextGen policy totally restructures the National Airspace System (NAS) which is not conventional in the other forms of government intervention. It can be argued that there are three other factors that warrant government participation in the NAS to warrant implementation NextGen through government intervention. First, the government in the form of military aviation, uses the current system so they have a vested interest to update it. Second, it is too costly, and will take too long to implement, for one single firm to conquer on its own. Third is the necessity of standardization among all users.

Government Use of the National Aerospace System:

Private industry is not the only users of the NAS. The government in many forms uses the infrastructure for its own benefit, purposes, or operations. By all means the NextGen system will be a public good that will be provided by the government because the private actors cannot work out the problems of congestion themselves. But, the government in the form of the military stands as a beneficiary as well in the matter of national security.
Another kind of direct correlation between the NAS and the government is that the NAS is controlled by the US government. In the US code of transportation laws it states in section 40103 that, “(1) The United States Government has exclusive sovereignty of airspace of the United States” (US Code: Justia. 2003). Since the government has exclusive responsibility to control the airspace, this creates a responsibility to ensure safety and security. For example they closed the NAS during the 9/11 attacks and diverted all flights to either Canada or Mexico. What the United States was closing was the Aerial Defense Identification Zone (ADIZ) this area surrounds the nation’s eastern, southern, and western borders. To cross this boundary and enter the US there are several requirements and limitations. This information is published, but is at times hard to remember. Most of the information is provided at the bottom of sectional charts, these are sky maps and they contain the information on when the no fly zone rules are in effect, and the controlling facilities which to contact to get further information. Some of the information is also published in the form of NOTAMS; these are “notices to airmen” which are read during the Automatic Terminal Information Service (ATIS).

These are hourly broadcasts of current airport information. An ATIS report also includes weather conditions, current active runways, and closed facilities like taxiways or VOR’s. But, these areas are breached quite frequently either accidentally or on purpose, and the consequences of doing so are very serious. They cost not only the government lots of time and money, but also cost the pilot who broke the rules. The FAA is a member of the national Capital Region Coordination center, this is a group compromised of representatives of security and military agencies to ensure that, in the event of a threat
from an unidentified aircraft, coordinated action can be taken to appropriately address the threat and keep the area safe. Here is one such account of such an occurrence...

...on 11 May 2005...in Washington D.C at 1128 the FAA and the NCRCC became aware of an aircraft entering the Aerial Defense Identification Zone (ADIZ) from the north east, approximately 44 miles from DC. The FAA’s watch officer for key communications contacted the Potomac Terminal Radar Approach Control which confirmed to the FAA that the unknown aircraft was not in communication with air traffic controllers, it had not filed a flight plan, and the transponder was not communicating a normal but unique code. At this point the aircraft was seen as a track of interest because it was flying parallel with the ADIZ, and was not concerned a immediate threat, so it was monitored closely... the aircraft suddenly turned southbound toward the capital, at this point the Customs and Border Protection Office of Marine Operations ordered the launch of its Blackhawk helicopter and Citation Jet aircraft...in addition two F-16 aircraft were scrambled from Andrews Air Force Base. The Blackhawk initially intercepted the air craft about 10 miles north of the capitol. When the aircraft continued to proceed south toward the capitol the F-16’s moved to intercept. The aircraft was visually identified as a high-winged, single-engine Cessna-type aircraft. Attempts by the Blackhawk helicopter to signal to the pilots of the Cessna and get them to communicate on an emergency frequency were unsuccessful. At 1200 the Department of Defense authorized the F-16 pilots to use flairs. The flairs were used when the aircraft was 6.7 miles from the capitol building. At this time the Secret Service and the US Capitol Police made the decision to evacuate the White House and Capitol. The Blackhawk continued to signal to the pilots to get them to communicate with them. Ultimately, the Cessna pilots were able to make contact with Citation on an emergency frequency and the Cessna turned west, avoiding the capital building. But, the Cessna proceeded through the prohibited airspace over the Naval Observatory, with the F-16s in escort the aircraft exited the airspace then Blackhawk rejoined the escort north... the Cessna was forced to land at an airport in Fredrick Maryland being escorted by the Blackhawk and the two F-16’s all the way to the pavement. Upon landing, the occupants of the aircraft were taken into custody by the FBI, Secret Service, and Maryland State Authorities for questioning. (States, Senate, Science Committee on Commerce, and Transportation, Congress. 2006)

You can see in this example how much is orchestrated in order to pull something like this off and how important it is that the government be watching the air space as a public good. No one entity could do this alone, it is only the reach of the Federal Government
that could pull something like this together. Also we can get an idea of how much money is spent in conducting such an operation. But this is not the only way that the government is involved in the NAS. Listed here are additional examples of how the government controls the NAS.

- There are also sections of airspace denoted as National Security Areas. These are sections of air space that are established around areas requiring special security precautions. These are places like government or military instillations, large power plants, and/or ammunition stores. Pilots are required to avoid flying low in these areas to prevent an accidental crash. The restrictions for these sections of the air space are also provided in NOTAM’s (Administration, Federal Aviation. AIM 2010 3-5-7).

**Figure 4 National Security Area**

- Furthermore, there are areas in which military training is conducted. These are called MOA’s or Military Operations Areas. They are established to allow military training activities which are normally far from residential districts in order to decrease the noise and nuisance from these operations, because in these areas high speed supersonic flight, quick aerobatic maneuvers, low level flight, and “lights out” night training are all permitted in these areas (Administration, Federal Aviation. AIM 2010 3-4-5). Strong sonic booms are also created when an
aircraft breaks the sound barrier which does tend to break the windows in homes and gives further reasons why these areas are far from where people live.

**Figure 5 Military Operating Area**

- Alert areas are established in areas in which a high volume of pilot training is involved. These student training areas have very high density traffic and pilots in these areas are also allowed to perform unusual types of aerial activities. Pilots who operate around these areas need to be extremely vigilant when scanning for traffic (Administration, Federal Aviation. AIM 2010 3-4-6).

**Figure 6 Alert Area**
• Prohibited Areas are areas in which any operations are prohibited. You may not conduct any flight through these areas under any conditions or circumstances. These are created for more specific security reasons, like Camp David for protection of the president and any foreign national he brings there. They are also established over some national park areas, (Administration, Federal Aviation. AIM 2010 3-4-2). Pilots drift into them because radar is not accurate. There are several prohibited or “no fly zones” throughout the NAS. These areas include flying over the Capitol building, Washington Monument, the Jefferson and Lincoln Memorials, and the Pentagon. There are also areas which extend to the White House, and the homes of the current President and Vice-President of the United States. The tricky thing about these no fly zones is that they extend to a larger radius around the homes when they are occupied by the politicians.

Figure 7 Prohibited Areas around capitol buildings

• These extensions of the Prohibited areas are called Temporary Flight Restrictions. Most of these areas are not charted and only some of the long term ones are.
Restricted and Warning areas separate civilian traffic from hazardous military activities. In these areas live firing of ammunition is often done. The difference between these and MOA’s is that restricted areas are not active 24 hours a day; they are only activated during certain times of the day (Administration, Federal Aviation. AIM 2010 3-4-3).

Figure 8 Temporary Flight Restriction For Camp David

Figure 9 Restricted (R-2908) And Warning (W-155A) Areas
Special Federal Aviation Regulation Areas depict air space that is subject to further specific regulations. One example of a SFAR is around the Grand Canyon. Flights below 18,000 feet mean sea level (MSL) are subject to more specific air traffic rules. The procedures vary, but in the Grand Canyon example there are special transition routes and altitudes rules that apply (Administration, Federal Aviation. FAR 2010 Part 91).

Figure 10 Special Federal Regulation Area For The Grand Canyon

The rest of the wilderness areas which are set up to further protect wildlife at wildlife refuges are Special Conservation Areas. These areas have very irregular borders and do not permit aircraft to fly less than 2,000 feet above ground level (AGL).

Figure 11 Special Conservation Area For Iroquois

Lastly, there are Military Training Routes; these are fixed “highways” that high speed military aircraft fly for training purposes. There are no restrictions to flying
civilian aircraft in these areas; you just need to be aware of low or high flying military aircraft (Administration, Federal Aviation. AIM 2010 3-5-2).

Figure 12 Military Training Route IR801

As you can see by the extensive examples provided the government has a very large hand in the NAS. So there is a Federal Government interest in updating the flying infrastructure through NextGen technologies. As was touched on earlier mistaken civilian aircraft flying thorough the ADIZ costs large amounts of money and time. Not to mention it may start a “crying wolf” pattern and real threats may be ignored for frequent misclassification of non-threats. Pilots drift into these areas at times by accident because their radar position is not very accurate. When Korean airlines Flight 007 was shot down due to it drifting into Soviet restricted air space Ronald Regan ordered GPS to be available for civilian use so that future navigational errors like this do not happen again (Ghosh, n.d).
NextGen further enhances the capabilities of the GPS system to help prevent such occurrences. Now that aircraft have a better idea of where they are in real time they can not only stay clear of the ADIZ but also all of the other controlled air spaces. NextGen’s data communications will also increase information flow over voice communications. As in the case of knowing where the President is to stay clear of TFR’s. Pilots frequently misread the information in sectional charts, or forget to get the NOTAM. In most cases the NOTAM is enacted on short notice preventing the pilot’s ability to properly plan ahead.

It can also be the case that he arrives after you have already departed and the TFR becomes active while you’re crossing it. The data communications would allow all aircraft in the area to be alerted of the change at the same time, rather than a flight service center having to call each one up, one at a time to advise them of the change. This keeps both the pilots and government officials safer. Another reason that the government also has a vested interest in updating the current aircraft navigation system is that aviation has many stakeholders. Other than the flying community there are a lot of people and interest groups that rely on the aviation system to stay running efficiently. If the government works hard and makes NextGen live up to its potential it will have more influence, power, and recognition than if it were to intervene in another market. People would recognize that if it could save the airlines, then maybe their trust in the government would be rejuvenated.
Extreme Cost:

The costs associated with the implementation of NextGen and all of its proposed changes is quite large. In fact it is so large that it is too much for any one aviation firm to accomplish on its own. To see the true price tag of NextGen see attached Appendix B: Financial Section. The current air traffic control system limitations have significant costs on our society in general, as well as the airline industry in particular. “The Joint Economic Committee estimates air travel delays impose a staggering $41 billion annually in costs on the U.S. economy (May, 2009).” In the 12-month period ending September 2008, “138 million system delay minutes drove an estimated $10 billion in direct operating costs for scheduled U.S. passenger airlines and cost airline passengers an estimated $4.5 billion in lost wages and productivity (May, 2009).”

These figures do not capture the total cost foregone. There are still the costs of extra gates and ground crews to passenger airlines and also the direct costs incurred by cargo airlines and their customers. If the airline industry does not look like it will survive, then the public will not invest in it, if these conditions remain. Then it will only be up to the government to invest in saving the airlines to keep the public investors from pulling out. Looking into the future, these problems will only compound themselves unless change occurs. By 2025, the Federal Aviation Administration (FAA) forecasts there will be approximately 30,000 more operations per day than the 2007 estimate of 44,000 daily operations (FAA Regional Air Service Demand Study).

The current ATC system cannot handle this projected future demand, even if the forecast is reduced to account for current economic or terrorist conditions. Even if the
forecasted growth is significantly reduced, today’s ATC system is so inefficient that it will not be able to handle a modest increase in activity. The airline industry is the foundation of the commercial aviation sector, which comprises airlines, airports, manufacturers and associated vendors. U.S. commercial aviation ultimately drives $1.2 trillion per year in U.S. economic activity and 11 million U.S. jobs which is roughly 5.6% of the Gross Domestic Product (Pipes, 2008). By any measure, the U.S. airline industry is a valuable national asset and its continued economic health should be a matter of governmental concern because of the airlines size and contribution (May, 2009).

The fragile state of the market in the U.S. airline industry is illustrated by an estimated loss of $8 billion in 2008 and that is on top of the $31 billion lost since 2000. Airlines reduced operations sharply and were forced to slash 28,000 jobs in 2008; additional reductions are already in place for 2010 and softening demand will require even further reductions as carriers continue to cut back operations (May, 2009). Should jet fuel or any other airline fixed price move sharply upward, the industry could easily see 2010 losses approaching the magnitude of losses in 2008. How would the private sector combat these problems? If we look to the news we can see how the airlines have tried to cope with their increased expenditures. Because of internet sites like Travelocity and Expedia the asymmetric flow of information on ticket prices has disappeared. It has become very transparent how much a plane ticket costs, on what day, and by what carrier. After the deregulation of the airlines by the government the only way that airline industries are able to keep passengers and turn a profit is to keep ticket prices competitive. That is to keep them as low as everyone else. Recently, it was reported that American Airlines is now charging eight dollars for a pillow and blanket (Hunter, 2010).
Airlines Themselves Try to Recover Losses to Stay Competitive:

We have seen various other charges that the airlines apply in order to raise revenue. Almost all airlines now charge for checked bags, the highest of them is about $270 for a one way trip. There are also fees for making arrangements by phone instead of online; which is now up to $80. Any kind of in-flight entertainment like the use of in-flight movie head phones or DirecTV use could be upwards of $50. They have gone as far as to place an increase on the fee incurred when you bring the family dog on the plane, the airlines say that this increase is used to deter customers from bringing the animals on board, but it is an increase in profit nonetheless because the increase in prices does not seem to deter passengers from doing so (Grant, 2010). “Successive fee hikes yielding ever-more money are the clearest proof of the success of the strategy, IdeaWorks Co. President Jay Sorensen said. And despite the grumbling, airlines have noted no serious consumer backlash (Grant, 2010).”

But, how long do the airlines think that they are going to get away with this? How high are the fees going to climb until the re-regulation of the airlines happens because the American public thinks that they are being taken advantage of? Or on the other hand, how do the airlines think they are going to get rich off of luggage and dogs? Combine the fact that the airlines made $740 million from these fees in the third quarter of 2009, $613 million was made from changes to reservations, and $601 from transporting pets (Grant, 2010). This is grossly short of the total price tag to overhaul the entire air transportation
system. For fiscal year 2011 the NextGen air traffic control technologies will receive $1.1 billion, an increase of $275 million, 32 percent, over the FY 2010 enacted levels.

*U.S. Transportation Secretary Ray LaHood [1 February 2010] said President Obama’s $79 billion budget for the U.S. Department of Transportation continues strong levels of investment for safety, the department’s top priority, along with critical investments for infrastructure to generate economic growth and support livable communities. (Alair, 2010)*

Ray LaHood also stated that “Aviation safety is a top priority.” There is no way that the private companies of aviation can afford the amount of money that it is going to take to implement NextGen over the years until it is fully implemented in 2025.

**Standardization:**

Lastly, there is a standardization problem. This is a problem of favoring one business over the other. If the air transportation was privatized, I already established that one form or even a conglomerate of firms cannot afford to implement the entire NextGen program alone, but what if it was the case that one firm implemented just an airport and the general surrounding areas with NextGen. The single firm would want to get the greatest benefits from the system while at the same time trying to minimize the benefits of others. This turns the situation into more of a competition. For example, say that it is American Airlines that updates the Greater Rochester International Airport with NextGen. What would happen when there is only one active runway and there is an American Airlines jet and a Southwest jet in the pattern, which would be aloud to land
first? Furthermore say that the Southwest jet is on time and the American Airlines jet is running late. What jet would be given preference over the other this time?

It is extremely likely that the American Airlines jet would be given precedence and would be allowed to land before the Southwest jet would even though it is late. This situation now only further decreases the efficiency of the air traffic by creating two late flights instead of one. How else would Southwest try and keep flights into Rochester on time without competing with American flights? I speculate that it would be something like the cell phone companies have now. If the airlines were left to updating the traffic system they would build their own versions at their own airports. So instead of the state or county owning the airport it would be the aviation firm and there would be several different forms of NextGen just like how each cell phone company uses its own separate different towers. If you wanted to fly you would go to Southwest’s airport or American Airlines airport. This way they would be able to have the maximum benefit from their investment. They would be able to land their flights without having to be in competition with other flights. The same way that the cell phone companies have towers right next to each other. Rather than sharing the same network of communication towers, they all build, maintain, and use their own. Then one airline may outgrow a few others and start consuming other airlines. The single airline may continue to grow and take over all of them, and create a monopoly of the market. They could then take advantage of the customers and would warrant another market failure and need more government involvement to strictly regulate the market or break up the monopoly.
In this case it is evident that government involvement of standardization as preventative maintenance that now prevents this problematic situation from ever occurring. On a final note I would like to mention that just because the government is doing something it does not mean that they are the right person for the job. We should take this analytical framework and apply it to the current implementation of the NextGen system. Throughout this section I provided several reasons for why the government was the right person for the job; from the correction and protection of a fragile market to the incredibly high cost of orchestration.

**Weather And Its Effects On Flying:**

According to FAA statistics, weather is the cause of approximately 70% of delays in the NAS (Kulesa, G. (n.d.). Officially a “delay” is defined as a flight that is more than 15 minutes beyond or past its scheduled arrival or departure time. Currently there is also no standard to which airlines have to set their en route time. If the airlines always over estimated the flight time then technically delays would all but disappear. But there are several factors that force airlines to make the best guess possible. Things like the time of day, marketing strategies, and other factors such as weather that would not allow a flight to take a direct route to its destination. The Federal Aviation Regulations (FAR) and the Airman’s Information Manual (AIM) set very strict rules which govern VFR and IFR conditions.
Typically speaking it is the spring and summer months that are the worst time of year for weather related delays. “These months of the year carry hot and humid air, which produce dangerous thunderstorms, severe lightning, and turbulence (ATCMonitor.com).” Hot humid air is less stable and prone to spawn other harsh weather effects like hurricanes, tornados, and not to mention the hot weather increases the air’s ability to become saturated so visibility even on a good day can easily become hazy. This is not to be confused with what can happen during the winter months, there are equally as hazardous event which cause delays and problems in the NAS. In addition to weather causing delays, weather also causes accidents. While the National Transportation Safety Board (NTSB) reports most commonly that it is human factors that lead to crashes weather “is a primary contributing factor in 23% of all aviation accidents (Perrow, C. 1999).” The total weather impact is an estimated national cost of $3 billion for accident damage and injuries, delays, and unexpected operating costs (Kulesa, G. n.d.).
Weather delays comprise the majority of delays for any other reason in all seasons. Below we will go through each factor that will affect a flight from going to or getting from their destination because all of these factors play a significant role in the decision making of air traffic managers. They are the ones that translate the weather information, observations, forecasts, and other tailored products, into its impact on the NAS. Forecasted inclement weather conditions reduce the expected capacity in regions the weather is or is traveling. System capacities are therefore, in general, uncertain (Joint Planning and Development Office. 2006, May 13).

**Thunderstorms And Other Convective Weather:**

Hazards that are associated with convective weather include: thunderstorms, severe turbulence, intense up or downdrafts, wind shear, lightning, hail, heavy precipitation, strong low level winds, and tornados. These weather phenomena account
for many problems that plague the capacity of the NAS. The ability for the NAS to hold its maximum number of flights is drastically cut when these conditions roll into large hub areas. American Airlines estimated that 55 percent of turbulence incidents are caused by convective weather patterns and the National Aviation Safety Data Analysis Canter (NASDAC) found that between 1994 and early 2003, thunderstorms were lists as a contributing factor in 2-4% of all weather related incidents. Precipitation was listed also as effecting 6% of commercial air carrier accidents and 19% of commuter accidents (NASDAC n.d.).

Thunderstorms and it related phenomena can easily close airports because of their ability to degrade visibility and ceiling conditions so quickly. In their mature stage thunderheads can stretch miles into the sky and only be a few hundred feet off the ground. One good size storm can consume the entire controlled airspace that is allotted to an airport. On the ground hail and heavy rain can further close ground operations. Working together, ground and air problems, the airports ability to operate at maximum capacity is greatly diminished. The convective hazards can also play a role in the en route section of the NAS. Thunderstorms that are in-between destinations cause flights to be rerouted or even diverted to other airports increasing arrival times, distance traveled, and fuel consumed. As an effect operating costs go up, ticket prices need to follow suit and there becomes a loss of passengers as the laws of supply and demand take their toll. Finally, lightning and hail can damage aircraft, the damaged aircraft are then removed form operations and air worthiness status. This becomes both a loss to revenues because as long as the plane is in the shop it is not making money, and it also becomes a loss further because it costs money to fix a broken aircraft.
In flight icing is not only dangerous, but it has very harsh effects on the efficiency of flight operations. Planes are often rerouted in order to avoid icing, the delay that it causes is easily rippled through the hub and spoke model that the airlines use causing a domino effect of delay. More specific to icing there are two major factors that it plays on aircraft. The first is that structural icing on the leading edge of the wings and on control surfaces increases the aircrafts weight. An aircraft that is over weight fly’s different; it will stall at higher speed and if the weight is aft of the planes center of gravity, it will not be able to flair when it reaches ground effect. The ice will also clog pitot and static ports giving pilots false readings on climb and decent rates, aircraft speed, and altitude. Also, perhaps most important, the ice will reshape the wing, causing it to form a shape that does not fly! The second danger ice imposes is that it can get into the engine. Ice formed in the carburetor or in the intake ports of fuel injected air craft will rob performance and cause a reduction of power.
On a good note most commercial aircraft operate at altitudes that are too high for structural icing. More often at the higher altitudes it is too cold for ice to form, or there is not enough moisture that high up. It is the shallower altitudes which are more prone to icing, and every aircraft must pass through it twice, on ascent and decent through terminal areas. The NTSB indicated that in-flight icing was a contributing factor in approximately 11% of all weather related accidents among general aviation aircraft. These are aircraft flown by private and recreational pilots; these are not larger commercial aircraft. On the large aircraft however, ice was sighted to cause a problem on 6% of all weather related accidents (NASDAC n.d.). The famous crash in 1994 of American Eagle Flight 4184 that crashed near Roselawn, Indiana, that claimed over 60 lives was because of structural icing (Safety Foundation 2008, February 6).


**Ground:**

Aircraft are no different to any other structure that it left out doors in the winter months. Ice can build up on aircraft just as easy, and getting it off is a top priority. Freezing conditions cause ice to accumulate on control surfaces, instrument orifices, propellers, engine inlets, just about any exposed surface. “Even a very small amount of ice on a wings surface can increase drag and reduce an airplanes lift by 25 percent. This type of [ground ice] has been a cause or a factor in 10 commercial aircraft takeoff accidents between 1987 and 1997 (Kulesa, G. (n.d.).”

Along with effecting aircraft, ice can also affect the airport surfaces. This meteorological condition more closely represents the airports ability to work at its maximum capacity. Because it is more than likely that aircraft are not wholly coming from just the effected area. Harsh winter weather tends to be localized in regions of the country than effect the entire nation all at once, so a flights cone and go out of the freezing temperatures, they have the ability to escape the conditions where the airports do not, they have to stick it out through the duration. Boarding gates, taxiways, and runways can quickly become unusable as deep snow and ice block the pilots ability to see the ground and use the brakes and because of this airport operations and thus the capacity is sharply reduced.

**Turbulence:**

One thing that most airline passengers forget to remember is that the air mass that the aircraft is moving through is also moving itself. This moving air mass flows in ways
that are quite similar to moving water; the only difference is that we can not see the air currents like we can see water currents. Air currents move in all directions, but mainly they move out of high pressure locations to low pressure and the uneven distribution of heat on the earth’s surface drives these locations of pressure and thus drive the air currents. Flying rapidly from one current to another is what leads to the feeling of turbulence. Most pilot refer to this sensation as “hitting a hole” or “hitting a speed bump,” but this description do not account for how turbulence really works, the jolt comes from aircraft crossing the barrier between different air currents. There are several causes which create turbulence:

- **Convective Currents:** these result from the sun heating the ground causing the air on the ground to heat and then rise into the cooler air above it. In most cases the moist air rises and cools forming clouds. Clouds look peaceful and calm, but inside they are raging with activity and pilots fly just above them because that is where the air is smooth and convection stops.

- **Obstructions to wind flow:** anything which blocks wind flow will cause turbulent flow of air around it. The main cause of this type of turbulence in the aviation community is the turbulence caused my mountains blocking a wind running parallel to the ground. One way to easily spot this is by the lenticular cloud that is formed from the high speed winds being forced up one side of the mountain. Pilots need to be extremely vigilant in maneuvering away from these areas because this kind of turbulence has been know to cause extreme damage to aircraft. These clouds are also formed when very high speed aircraft break the sound barrier.
Wind shear: this occurs at the boundary between winds that are in different directions or at different speeds, or even both at the same time. It is really common to happen at low level temperature inversions, or at the boarder of weather fronts. This effect is dangerous for pilots when trying to make a landing, a sudden shift in the wind direction could cause a low and slow aircraft to suddenly lost lift and fall out of the sky. Large aircraft also run into wind sheer when they are crossing the jet stream at high altitudes.

For the most part turbulence is not a real hazard to airplanes. Aircraft can fly through turbulent air and when it does it will normally give the airplane a shake, it may also rock the wings all because the air that it is flying through is moving in several different directions. The erratic movements that cause the aircraft to jostle pose no real flight safety concerns. Aircraft are manufactured to sustain several G forces in all directions.
and can stand the punishment, even if it causes the wings of the aircraft to bend and warp slightly.

However, there are times when turbulence can cause major problems, and not only cause delays at airports causing restrictions on the benchmark rates, but they also cause en route delays. Turbulent air that associates itself with severe thunderstorms can be so powerful that it can literally rip an airplane apart.

**Figure 17 Photograph Of A Aircraft Missing An Engine Which Had Been Ripped Off By Severe Thunderstorm Turbulence**

Also, when an airplane flies downward into air that is also moving downward the plane will fall even faster. Anything that is not secured to the aircraft during this rapid decent will fly around the cabin. Drinks, luggage, air crewmembers, and even passengers who do not wear their seat belt, or just have them on loosely will be thrown to the roof as the plane falls faster than them. Although injury from turbulence is rare, you should realize that walking around an airplane cabin is not as simple and safe as walking around your living room (Richmond, R. (2010). The rapid decent at altitude is not that big of a
deal, but when you are several hundred feet above the ground, taking off or landing, the sudden loss of altitude becomes a real danger. The main reason for turbulence on the ground stems from concepts that we have all ready mentioned. Things like strong thunderstorms which cause wind shear, and wake turbulence from large heavy aircraft taking off or landing. In any case turbulence plays a major factor in airports capacity and efficiency because it accounted for 74.2% of accidents in commercial aviation (NASDAC n.d.).

**Ceiling And Visibility:**

Between the NASDAC reported that between 1994 and 2003 ceiling and visibility conditions accounted for 39.1% of commuter and air taxi accidents. Low ceilings and poor visibility are safety hazards for all types and categories of aircraft. Low ceiling and poor visibility accidents occur when pilots who are not properly rated or are flying and aircraft not equipped with the necessary equipment and instruments to encounter such conditions, resulting in loss of control or controlled flight into terrain (CFIT). CFIT is a collision whereby an airworthy aircraft, which is under the control of a pilot, is inadvertently flown into terrain, an obstacle, or even water. All commuter and commercial aircraft have the capability to fly in IFR and other low visibility meteorological conditions. They have all the necessary instruments, procedures, and pilot expertise to do so. In part 121 and part 119 flight rules that govern air carriers and commercial operations only sighted 3 accidents between the 1994 and 2003 time period (NASDAC. (n.d.). This number represents that low visibility and low ceilings do not effect operations to as great extent as does other factors.
Low ceilings and poor visibility are not only safety concerns but they can also have an adverse effect on commercial and military aviation along with airports acceptance rates. It is true that just about all commercial and military flights are equipped with all the necessary tools to fly in IFR conditions does not mean that they work all of the time. There have been plenty of stories of pilots climbing into their cockpits and having multiple pieces of inoperative equipment. This may seem scary, but the FAA does allow for several devices to be broken or out of service at once, as long as it does not interfere with the safe operation of the flight. More specifically section 91 of the Federal Aviation Regulations (FAR) states that,

*A pilot is authorized to use an approved Minimum Equipment List issued for a specific aircraft ...[the pilot] must use that Minimum Equipment List to comply with the requirements [of safe operation]... A determination is made by a pilot, who is certificated and appropriately rated ..., or by a person, who is certificated and appropriately rated to perform maintenance on the aircraft, that the inoperative instrument or equipment does not constitute a hazard to the aircraft. (F. A.A. (2009)*

All in all reduced ceilings and poor visibility can reduce the capacity of an airport and can produce air and ground delays. The delays causes by the bad visibility conditions can be diversions, cancellations, missed connections, and even extra operational costs.
Volcanic Ash:

Volcanic ash is comprised of a conglomerate of materials. The lighter of them normally have no trouble reaching the upper atmosphere where most airlines fly causing havoc. The ash does not pose its greatest threat by just being an optical inhibitor, but as an engine killer. Volcanic ash normally contains glassy materials, such as silicates, whose melting points are 600 degrees Celsius to 800 degrees Celsius. Since internal temperature of a in-flight jet engine exceed 1000 degrees Celsius, glassy particles in volcanic ash inhaled by the engines instantly melt. In the course of exhaust, the glassy materials are rapidly cooled down in the turbine chamber, stick on the turbine vanes, and disturb the flow of high-pressure combustion gases (Wert, R. (2010, April 15). So, when they are ingested by a jet engine, they melt and collect on the internal structures of the engine robbing it of its performance, or even its function. The need to completely avoid these ash clouds then becomes high because of the possibility for its devastating effects. Avoidance may just be a diversion, but when the ash is not localized the avoidance means cancellations of flights and closings of airports all together.

At the time this thesis was written is when a mountain in southern Iceland erupted and caused several problems for several countries. “The shutdown of air travel is the most extensive since the terrorist attacks in the United States on September 11, 2001,” said Maureen McLafferty, the manager of British airways in Chicago, after telling passengers that all of their flights to London have been canceled (VOA News. (2010, April 17). But the larger problem is in the European continent. Air travel throughout Europe is still disrupted as the volcano continues to emit ash. “Most European nations
have completely closed their airspace, while others have enacted partial closures.

Thousands of flights have been canceled, stranding hundreds of thousands of passengers and costing airlines hundreds of millions of dollars. Officials expect air travel to be disrupted for several days [because] experts say it could continue to erupt for weeks or even years. (VOA News. (2010, April 17).”

**Figure 18 This Image Shows The Effected Areas From The Ash Cloud At Different Flight Levels Over Europe And Western Russia On April 15 2010 At 1800z**

In conclusion there are several meteorological conditions that effect air travel and airport capacity benchmarks. Some cause more problems than others, because of our ability to deal with them. Things like ground ice and poor visibility conditions do not hamper airlines as much as volcanic ash or thunderstorms. But several NextGen technologies, which we will not get into, will help mitigate some if not most of the problems caused by the more dangerous meteorological conditions. These technologies
will not only help with flight planning and en route travel, but it will also help with airport capacity. The purpose of this section is to give the reader a better understanding of how weather adversely affects the benchmark rates of an airport not to describe how new technology such as Required Weather Performance (RWP) works.

In short, the new weather-dependent technologies will be able to control wake turbulence procedures to reduce arrival/departure separation and increase airport capacity. These procedures require wind and wake observations and forecasts on the glide slope, at the threshold, and along departure paths. Better wake predictions enable more proactive vs. reactive planning. Improved lightning detection and prediction make ramp operations (e.g., refueling) safer and increase airport efficiency. New and improved weather observation information will make snow removal and deicing operations more efficient, leading to improved airport operations during winter weather events (Joint Planning and Development Office. (2006, May 13). Finally, the 4-D trajectory and weather information data links will provide pilots a better view of what is happening outside of the cockpit and allow pilots to take faster and more efficient diversions around or through storms.
Chapter Four
Case Studies:

The following four cases of San Francisco International, Minneapolis St. Paul International, the New York Metroplex, and LaGuardia International are used in explaining the potential benefit of the NextGen technologies in correcting the major problems which inhibit airport capacity. Airport capacity is one of the many reasons for delay in our NAS. Delays will cause the system to shut down even if the proposed benefits en route work as expected. If airlines can now get from place to place quicker and more efficiently, but fail to get the plane on the ground and exchange passengers in a timely manner then the benefit from the efficient trip is lost and the situation becomes a zero sum game. The airports were chosen because they stand to gain or lose the most from NextGen. There are some aspects which will transfer between other airports. For example, some airports will get a mix of benefits because of the factors that govern them are causing the restrictions to their capacity. In other words the case studies have external validity because several airports possess the same characteristics, for example Denver International Airport also has all parallel runways and it would also be a great case study to see the effects of NextGen. The main reason that the airports were picked was because of the available data which was published about them.

The case study on San Francisco International looks at the problems caused by Closely Spaced Parallel Runways (CSPR), wake turbulence, and weather. The runways work well in visual weather conditions where pilots can maintain spacing from each other without the guidance from ATC. But when weather conditions become less than optimal the use of the CSPR is limited because of the imperfectness of the current ILS systems.
Throughput is still hindered further by wingtip vortexes. NextGen, to an extent, can help get around this problem, keeping airport capacity as high as it is during VFR conditions.

The case study of Minneapolis St. Paul International looks at the airports ability to expand. One of the main arguments behind the NAS capacity debate is that airports do not have enough surface area. The argument is that even if there are more runways built, their presence makes no difference. If the runway is built to intercept another then only one can be used at a time unless Land and Hold Short Operations (LAHSO) are conducted, and even this is impossible in all cases. Also, in most cases it is impossible for the airport to expand. The locations of some airports are in large metropolitan areas where expansion means that other buildings would have to be displaced. There are also several coastal airports that would have to expand into the water, this creates several more challenges to pilots to make sure they get the plane on the runway and not overrun it on any side. Another great problem for airport expansion is the time and money it takes for a runway to be built. In most cases it takes federal funding, and extensive agreement among various interest groups and local parties to get a new runway put in.

The third case concentrates on New York City’s metroplex. These are terminal areas in which several airports are in close proximity to each other. Across the country there are about 31 terminal areas in which airspace congestion is so large that special attention and rules need to be placed on them. This situation is that the capacity of each individual airport is really high because of the size and capability of each airport working alone, but when the airports are placed together and work as a system their capacity becomes only as high as the slowest airport because they share the same airspace. So, the
problem stems from the efficient use of the airspace and not because of operations conducted at the airport itself. This case study looks at how NextGen will be able to make efficient use of departure and arrival patterns of interlocking airports.

The final case, LaGuardia airport, which is a part of the NYC metroplex, suggests that NextGen cannot help every airport in the NAS. In some cases there is just no way to increase capacity at the airport. Airports in congested areas that only have single runways are the largest contributors to this problem. In all he FAA recognized 14 airports in which capacity increases would still be needed even after NextGen technologies are implemented. They have no possibility for expansion therefore they are limited to the speed and ability of the pilots flying to the airport. Even if the air congestion is fixed by NextGen by unscrambling the chaos of the metroplex, does not mean that ground congestion of the airport it self will be fixed. Their only hope for success is NextGen’s ability to have a relaxation in separation standards which would allow for more flights per hour.

It is important to note is that the case studies only capture the most significant circumstances in which airport congestion limits its capability. There are several other reasons why airport congestion occurs. One is the way in which airlines schedule flights. Airlines will purposely schedule more flights than the airport can physically perform causing delays right from the start. They also load flights on the same hours of the day, creating rush hours and leaving other times completely open. One potential way to increase capacity would be to evenly distribute a realistic schedule for the airport. Some argue that the size of the airplane causes congestion at airports. Frequent flights of small
aircraft are not as efficient as a single large jet doing a single flight. If you get more passengers on a single flight then demand is met without increasing any other infrastructure. There are several other factors which are hard to combat, like the security of the airport. If people could get from the curb to the gate faster there would be an increase in airport capacity because of the more efficient movement of people. There is also the problem of the hub and spoke model itself that causes system delays, runways and taxi ways need repair and thus need closing, and even noise abatement. Things of this nature which cause delay are unavoidable and too expensive to eliminate. In most cases there is an acceptable level of delay according to airport operators because of these odd factors which cannot be easily corrected.
San Francisco International:

Figure 19 Airport Diagram Of San Francisco International Airport

SAN FRANCISCO– San Francisco International (SFO)
San Francisco International airport is an important example of how a new NextGen technology will allow airlines to land consecutively at closely spaced parallel runways. Currently, the flights per hour are limited in less than ideal weather conditions. NextGen will allow an increase throughput in marginal and IFR conditions. To give an idea of how often SFO is effected, back in 2000 there were 24,478 flight delays and 70% of those delays were due to weather, making it the fifth most delayed airport that year. That number is up from the year prior. From 1999 to 2000 there was a 19% increase in delays per 1000 flights and the number becomes more staggering if we broaden the years. From 1997 to 2000 delays at SFO were well over 50% which means that things are getting steadily worse (Evans, 2002).

![Figure 20 Percentage Increase in Number Of Delays Per 1000 Operations For The 15 Most Delayed Airports In The US, 1997 – 2000 (Evans, 2002)](image)

The high increases in delays due to weather from 1997 to 2000, followed by even more delay increases in 2000, only further paint a grim picture for SFO’s future. The
national average for the percent of time under IFR conditions is 17%, at SFO it is almost 30%. Adverse weather also plays a key role in decreasing capacity at SFO as well as it does at other airports in the nation (Evans, 2002). SFO is in the Bay Area, this is an area which is known to have cycles of bad weather, so they are accustomed to this issue, Phoenix on the other hand is not. When weather conditions start to stray from VFR, even to MVRF, the airport is hit harder than an airport that is routinely prepared for such events.

![Figure 21 Percentage Of IFR Conditions In June 2000 (Evans, 2002)]
So in order to make better sense of this data and to account for the other factors we will normalize it. By multiplying the results of the two charts in Figure 21 and Figure 22, and then dividing by the average of the 31 busiest airports in the country, yields a metric to describe the impact of adverse weather on the airports which is shown in Figure 23. As can be seen, the most impacted airports are San Francisco, Boston, and Dallas/Ft. Worth, which are all greater than 150% of the average (Evans, 2002).
Why are the top airports on that list and what is something that they all have in common? San Francisco, Boston, Dallas, and Newark although not even close to each other; are each affected by different climates. But something significant that they all have in common is that they all have Closely Spaced Parallel runways. Adverse weather conditions have a significant effect and impact on airports with CSPR’s.

The capacity benchmark for San Francisco International Airport today is 105-110 flights per hour (arrivals and departures) in optimum weather conditions. The rate then decreases in marginal conditions to 93-81 flights per hour, and falls again in IFR conditions to 69 flights per hour, for the most commonly used runway configuration in these conditions. Planning is underway for an extensive reconfiguration of SFO, with several alternatives under consideration. These changes could significantly increase the benchmark capacity at SFO if they are implemented. However, environmental studies are...
required before the FAA issues a Record of Decision (ROD) for any new runways. So the possible changes that could have happened were not included and therefore the effect of any reconfiguration was not included in this analysis. In other words, SFO has other runways than what is depicted in the airport diagram, but those runways other than the closely spaced parallel runways were not considered in the analysis of this study. Their ability to land and take off aircraft was ignored. Planned NextGen technological improvements at SFO include Cockpit Enhanced Flight Rules (CEFR), which would increase the benchmark rate by as much as 7 percent in many conditions by allowing equipped aircraft that are on arrival to maintain their own visual separation. Also, the technology that we will be concentrating on are the RNP procedures for approach guidance (RPAT) which would allow paired approaches to the parallel runways. SFO is not unique, “overall, airports with CSPR account for 66% of the average daily delay hours (Audenard, Cheng, & Lunsford, 2009).

Over half of the airports with the highest delays in less than visual approach weather conditions have parallel runways spaced less than 4300 feet apart. Currently, there are 231 airports in the U.S. that have at least one set of parallel runways, including 33 Operational Evolution Plan (OEP) airports which outlined the nation’s busiest airports. (Haltli, Brennan)

What this means is that the bulk of our nation’s busiest airports have this same problem of having parallel runways that cannot be used when weather conditions become adverse. NextGen has the potential to correct the bulk of the problems at 33 of our nation’s largest airports, increasing their capacity and easing congestion in the NAS.
Currently the FAA restricts operations on runways that are closer than 4300 feet apart. There are several dangers that will affect safety and the FAA always plays it on the safe side so these operations are not conducted. During low visibility conditions like MVFR and IFR the lateral dimensions of the current ILS approach system are not specific or accurate enough to keep aircraft from crashing into each other. Therefore when conditions get worse, the airport arrival rate or capacity is drastically affected. There are three goals that the FAA is trying to attain by creating the new RNP technology:

1. **Increase capacity**: the new RNP/RNAV and CSPO will reduce the impact of lower visibility conditions by closing the gap in visual and instrument conditions.

2. **Reduce Delay**: the reduction in planes stuck in the pattern will decrease the delays that result in the airport bottleneck from closing runways in instrument conditions.

3. **Maintain safety**: there must be an acceptable level of safety when operations increase or stay the same as weather conditions worsen.

This case study presents an overview of each enabling activity under the CSPR initiative. The enabling activities are focused on increasing airport arrival capacity while maintaining an acceptable level of safety in reduced visibility conditions. The local effect of increasing capacity will ripple through the NAS as reduced delay (Federal Aviation Administration 2009). When parallel runways are separated by at least 4300 feet, aircraft can continue to arrive independent of each other, an independent approach path is
represented in Figure 24. This is also true in instrument conditions; aircraft can guide themselves to the runway with ATC help with no risk of encroachment on safety.

Figure 24 The Independent Operations Of Closely Spaced Parallel Runways (Federal Aviation Administration 2009)

Runways that are closer than 4300 feet can still operate but require additional surveillance from ATC and increased pilot training to conduct independent operations. The minimum distance is 3400 feet in which independent operations can be conducted because at this distance the ILS localizers have to be offset by 2.5 to 3 degrees which causes an overlap in the signal, as seen in Figure 25, this overlap would cause planes to cross paths, converging on different runways.

Figure 25 ILS Localizer Overlap (Federal Aviation Administration 2009)
All four commercial runways at SFO are less than 3000 feet apart. So when harsh meteorological conditions appear the active runways fall from three to just one. This results in airport capacity being cut drastically because of landing rates which further result in delays and inconvenienced and disgruntled passengers. In good weather conditions the airport works normally because in good weather the FAA allows operations to be conducted on CSPR which are just 750 feet apart. During the bad weather conditions don’t work with the current navigation system, it is not accurate enough to keep the planes separated.

The problem is the angular nature of the ILS localizer as depicted in Figure 25, which is typically 3 to 6 degrees wide, depending on runway length. For approaches to parallel runways spaced 4300 ft apart, the two ILS localizers will overlap on the approach outside of the Final Approach Fix. The localizer signal also degrades the farther away from the source, hindering an aircraft’s ability to precisely track the course centerline. Although special equipment and procedures allow independent approaches to continue to parallel runways; however, such solutions are expensive and not applicable to airports with runway spacing below 3400 ft which is the case in SFO. (Federal Aviation Administration 2009)

So how will NextGen fix the problems of the CSPR and increase airport capacity during dire weather conditions? There are four problem areas but we will concentrate on only two of them because they are specific to this case.

1. **Area Navigation (RNAV)/Required Navigation Performance (RNP)**

   **approach procedures:** this is the satellite approach procedure that is the heart of the NextGen system. This is far more accurate than the ILS system that is
currently in use. Satellite operations are accurate to the inch rather than the 10’s of feet with ILS. In Figure 26 we can see that an RNAV approach is much more accurate and has little to no overlap. In contrast to ILS approaches, RNAV/RNP approaches can be developed for nearly any runway end, and requires no or limited ground infrastructure (Williams, & Porter, 2008).

Figure 26 The Area Of Operation For RNAV Approaches (Federal Aviation Administration 2009)

2. Course Deviation Error Data Collection and Analysis: “The FAA, industry, and international authorities still use the severity and likelihood standards for course deviations that were set in the 1960s. These standards were used to develop all of the parallel approach procedures that exist today. At the time these estimates were made, little or no data was available (Massimini & McNeill, 2008).” Below is a figure which depicts the lateral course deviation between CSPR.
Here we can see that the lower plane over corrects itself right into the approach path of the upper aircraft. Data collected from FAA reports are contributing to revise the independent approach separation standards to help make the 1960 standards more efficient. The more efficient standards could relax surveillance of aircraft from ATC, controller displays, and other monitoring requirements.

The next two standards discussed above are easier to address because they involved circumstances that can be readily controlled with new technology. For example, RNAV procedures are currently in use at several airports, the only thing that is keeping it from being used at all are a few pieces of equipment. The separation standards are set by the FAA so they can be changed when warranted. However, issues that involves or has to deal with wake turbulence. Wake turbulence is turbulence that forms behind an aircraft as it passes through the air clean and heavy. It is most pronounced and causes the most problems for other aircraft when other aircraft are taking off or landing. This turbulence includes various components, the most important of which are wingtip vortices and jet wash.
Using new understandings of wake behavior the FAA’s Wake Program Office has developed new operational procedures authorized under FAA Order 7110.308. This national rule change authorizes five U.S. airports Boston, Cleveland, Seattle, Philadelphia, and St. Louis International airports (KBOS, KCLE, KSEA, KPHL, and KSTL) to run dependent parallel approach operations to specific runway ends spaced closer than 2500 ft down to Category I approach minima (Federal Aviation Administration 2008).
In addition to FAA Order 7110.308, other operational concepts based on new understandings of wake vortex behavior are being developed. These include Wake Turbulence Mitigation Arrival Procedures (WTMA-P) and Systems (WTMA-S). WTMA-P utilizes procedural adjustments at airports with staggered thresholds to achieve separation from wake vortices. WTMA-S uses a decision support system and wind forecast algorithm to predict when runways will be free of wake vortices for arrivals (Audenaard, Cheng & Lunsford, 2009). This NextGen technology and new procedures will help in visual conditions where pilots can keep visual separation from other aircraft. There are currently regulations that govern how a pilot has to fly when following a large heavy aircraft to the runway. The main rule is to land past the heavy craft and to take off before the heavy craft. This avoids dangerous wake turbulence.

Figure 29 Dependent Operations To CPSR

Figure 30 Aircraft Maintaining Visual Separation To Avoid Wake Turbulence (Federal Aviation Administration 2009)
The last problem is how to deal with the wake turbulence in IFR conditions? There are several NextGen technologies that will help with this problem. The precision Ground based Augmentation System or Space- Based Augmentation System (GNSS) will allow simultaneous ILS approaches. This along with the Automatic Dependent Surveillance- Broadcast will provide pilots with precise position and velocity of other aircraft so pilots can navigate clear of each other. Aircraft pairs will maintain a defined longitudinal spacing for the entire approach using cockpit-based tool sets and share information via ADS-B (Mundra & Hammer, 2000). These are advanced concepts and procedures and will take pilots some time to get used to, and acquire the skills needed to become proficient. The new tool sets are the new technological instruments that pilots will be provided with, these include the ADSB, Cockpit Display of Traffic Information (CDTI), and weather displays. The ADS-B and the GNSS will counter any problems that other aircraft pose to a safe landing. It will in essence place the aircraft in a safe zone and keep other aircraft out by monitoring when there is a possibility for wake vortex creation, or the chance of a drastic wind change that would cause extreme course deviations.

Figure 31 The Safe Zone Created By New NextGen Technology
The future of procedures at SFO may include paired approaches to the main parallel runways, based on these changes arrivals to either both runways, or departures from both runways can currently happen because some parts of NextGen are all ready in place. For data collection however, we conceded the old way that SFO could utilize its runway configuration, by using one of the paired runways for arrivals and the other for departures before the implementation of NextGen. With these new NextGen technologies and procedures both parallel runways can now be used for arriving or departing aircraft, or the mix of the two at the same time depending on the work load of the airport at that specific hour. Nevertheless, the runway configurations that are currently used most often at SFO are one for departing and one for arriving aircraft. SFO would not yet utilize these new procedures, of landing both arriving and departing aircraft together, and so they did not affect the benchmark rates.
Minneapolis St. Paul International:

Figure 32 Airport Diagram of Minneapolis-St. Paul International Airport
Minneapolis-St. Paul International Airport (MSP) is another good example to apply NextGen possibilities because it involves a new runway. In the San Francisco case we saw how the new NextGen technology’s can help a great number of national airports operating with parallel runways without changing the airport’s infrastructure. MSP’s airfield is the world's eighth busiest. A record 541,093 aircraft takeoffs and landings occurred at MSP in 2004. Operations levels for the first nine months of 2005 were up 0.6% from the same period of 2004. The new runway cost $624.3 million to develop. Of that, $420.3 million came from passenger facility charges, $127.3 million came from federal and state aid, $72.9 million came from bond sales, and $3.8 million from Metropolitan Airports Commission revenues (New, Fourth Runway Operational at Minneapolis-St. Paul International Airport. - Free Online Library). NextGen’s focus is not on building new runways and changing the airports infrastructure. These are done at the local level so the development or transformation of an airport hinges on the efforts of the local decision maker of the areas that the airport serves. But, new runways will be proposed by NextGen because of their known success to increase airport’s capacity, and will more than likely be built.

Today, the planning, environmental review, design, and construction of a runway is roughly a seven to twenty year process at a major airport. Construction of new runways and increasing other airport infrastructure is one of the largest critiques of NextGen largely because it is the one that makes the most sense to the most people. An airport cannot get more planes on the ground if there is not enough ground for them to land on. In this case study we will examine if adding a new runway really expands airport capacity or if the changes are just anecdotal.
The capacity benchmark for Minneapolis-St. Paul International Airport today is 114-120 flights per hour (arrivals and departures) in optimum weather conditions, in other words when visual approaches can be conducted. The benchmark rate falls to 112-115 flights per hour in marginal visual flight rule conditions, and falls again to 112-114 flights per hour in IFR conditions, for the most commonly used runway configuration in these conditions (Department of Transportation 2004). These benchmark rates represent balanced operations, with equal numbers of arrivals and departures per hour. Greater total throughput or the airports ability to get flights in and out of the airport may be possible during arrival or departure peaks through the creation of a new runway which was created and finished in 2005. The new runway is shown in Figure 32 as the only black runway. In Figure 33 below is data concerning the capacity of MSP with the addition of a new runway.
As we can see from the data there is a drastic increase in the throughput of the airport in all weather and visibility conditions. The new runway 17/35 (highlighted in blue) increases the airfields capacity by about 25%. Today there are approximately 37% percent of departing flights and 17% of arrivals that use this new runway. On a brisk morning in October of 2005 the metropolitan airport commission chairwoman Vicki Tigwell cut the ribbon opening the runway for use. Tigwell even noted that, "Increased
airfield capacity provides opportunities for more air service and reduces the likelihood of flight delays. The new runway is the last major project in our 2010 expansion program, strengthening the airport's ability to expand the region's economy for decades to come."

Also Chris Blum, the FAA Great Lakes Regional Administrator noted that,

_New runways such as this one at Minneapolis are key solutions to helping the FAA improve airport capacity and efficiency issues here in the Midwest and across the nation, with this runway addition, Minneapolis travelers can look forward to a more efficient air system and the continuation of the FAA providing the safest air traffic control operation in the world._

About one-third of all aircraft operations will occur on the new runway; roughly two-thirds will still take place on the airport's parallel runways, 12L-30R and 12R-30L. The placement of this new runway does not interfere with any other runway so it can be operational all the time unlike runway 4/22 which crosses two other runways. Because this runway crosses others it is not able to be active all of the time. Aircraft are not allowed to occupy an active runway at the same time.

_Not all airports have the ability to build new runways, some are in congested metropolitan areas or in rough geological locations and don’t have any chance of expanding. Other airports are just too poor and cannot afford the price of a new runway. The bulk of the airports in the US are subsidized by the federal government and can afford a new runway, but not all. Some airports on the other hand have seen the large benefit that adding new runways does to capacity and as a result these jealous airports have become very creative in how to find the room in order to do so. Places like San Francisco International Airport (SFO) have come up with an idea how to make runways_
in its location. Other airports could follow suit and become more creative on how to construct runways in overcrowded areas to help the airport increase its capacity.

Figure 34 San Francisco International Airport (On Left) Proposed Runway Expansion (On Right)
New York City Metroplex:

Figure 35 The Eleven Main Airports Which Make The NYC Metroplex
The FAA has not only recognized 35 single airports that are drastically in need of capacity increases, but they have also recognized that the bulk of these airports are in close proximity to each other. “The Maximum capacity of the NY system will be lower than the sum of maximum capacities of the individual airports. This capacity gap is due to the interaction between operations from different airports (Donaldson, A., Bonnefoy, P., and Hansman R. J.).” In other words it is this close proximity of the airports that restrict their performances. Individually they would do much better, but because they interact with each other they create a system which is inefficient. There are several of these systems in the NAS; they are referred to as metroplex’s. The largest of these are in the Dallas/Fort Worth, San Francisco Bay, and New York City areas. Arguably the most significant and most congested of these metroplex’s is the one located in the NYC metropolitan area. Each of these airports are capable of achieving capacity increases by conducting the operations and infrastructure improvements mentioned above but they cannot do so as a whole and achieve any more throughput. The problem is due to limited airspace. Aircraft must be so far from each other to navigate safely though the NAS. The approach and departure paths of the three major port authority airports (Kennedy, LaGuardia, and Newark) plus their surrounding airports such as Teterboro and Westchester create a large barrier to further growth.

Currently, the methods of navigating aircraft through this congested environment are extremely labor intensive and very complex. Departing aircraft have to be literally threaded through the approach path of other aircraft just to leave the terminal aerodrome. In some cases entire runway complexes cannot be used during certain weather conditions, and even using the NextGen systems to place aircraft in the closest possible sequencing
for an airport would directly conflict with the procedures of another airport (Butler, 2008). This reaction effect can shut down airports and runways completely. Below Figure 36 represents the interactions that the NYC metroplex has.

Figure 36 The Current Approach (purple) And Departure (green) Routes For The NYC Metroplex

This spaghetti seen in Figure 36 is the actual flight paths in and out of the NYC metroplex on March 1 of 2003. This is a great representation of what is going on with the interaction problem. A flight coming into JFK can be blocking a flight into LaGuardia, which can also be in the way of a flight departing for Newark.

NextGen can correct this haphazard pilot/controller chaos with satellite technology. RNP, previously discussed, can set way points in space so that pilots can fly
a specific route in the sky. The routes are specific to altitude as well as latitude and longitude. Think of these routes like roads in the sky that pilots can fly. These routings can be designed to follow any path desired—curved, angled, and at various altitudes—so there is no reason that the path for one runway at any airport can interfere with the path of another (Butler, 2008).

**Figure 37** A 3D Picture Of The Current Approach Paths In The NYC Metroplex (Green represents high level and red shows low level approaches)
This is again the current picture of the routes that are taken by flights in and out of the NYC metroplex. The next figure represents the changes that are possible with the RNP technology.

Figure 38 Possible RNP Paths In And Out Of The NYC Metroplex (blue is departures and orange is arrivals) (Oswald, 2008)

Figure 38 shows how precise and repetitive this technology can be. Every aircraft follows the same path, and with separation constraints loosened, the ability for high volume traffic is possible (Oswald, 2008). The preciseness of the navigation allows for the narrowing of the existing arrival and departure corridors. The new technology will
define new procedures for each metroplex. Ultimately there will be better separation between aircraft from aircraft rather aircraft from airspace, which the current system does (Oswald, 2008). These paths are not static; they can be changed for runway closings, wind corrections, weather, and even obstacle clearance.

Where routings must conflict because of physical constraints, the position of each aircraft can be predicted and each aircraft sequenced so that separation standards are maintained without having to manually route and reroute each aircraft. This can have very beneficial impacts on noise, emissions, fuel usage, and on pilot and controller fatigue. (Butler, 2008)

This technology will be able to be applied to all metroplex’s across the nation. Future users and operators will look back in amazement at past procedures and wonder how they were even manageable. Below we can see one possible configuration change with respect to the changing conditions in the NYC metroplex.
Source: Donaldson, A., Bonnefoy, P., and Hansman R. J (both figures)
These pictures suggest possible routings of aircraft through the NYC metroplex in the future. Every airport could have a custom made approach and departure pattern. These patterns will eliminate the interaction problems caused by metroplex’s. These routings may also have some positive externalities. The RNP paths could force aircraft to start assents further away from the city and reduce noise. The specific RNP paths will increase the capacity of the system, as well as that of the individual airports.

Pilots, controllers, and ground personnel will all have greater situational awareness with the moving displays of the ADS-B and ASDE-X to allow for the specific routes taken through RNAV paths. Aircraft will now be safer now that they will not have crossing approach and departure paths. Also, because of the moving maps and shared information between controllers and pilots, the separation standards will be loosened. In other words aircraft can now fly closer together, the closer together they fly is less time that is wasted waiting to take off, taxiing, or waiting for aircraft to exit active runways. Generally, safety in the skies of the metroplex would be increased with NextGen technologies and procedures.
LaGuardia International Airport:

Figure 39 Airport Diagram Of LaGuardia International Airport

NEW YORK – New York La Guardia (LGA)
LGA is in the NYC metroplex, consideration for this airports capacity focuses on ground limitations. Airports are not only constrained by clots in the skies, there are also instances where capacity is hindered by complications on the ground. The capacity benchmark for New York LaGuardia Airport today is 78-85 flights per hour in optimum weather conditions or when visual approaches can be conducted. The benchmark rate is 74-84 flights per hour in marginal conditions, and 69-74 flights per hour in IFR conditions, for the most commonly used runway configuration in these conditions. Throughput may be less when conditions force the use of other configurations but does not really matter because LGA only has two runways making only four possible configurations (Department of Transportation 2004). LGA has several problems. It is one of the most delayed airports in the US based on the FAA OPSNET reports. The traffic that is scheduled for LGA meets and exceeds its optimal weather conditions capacity for nearly 8 hours every day, and then exceeds its IFR or adverse weather capacity for 12 hours of the day (New York LaGuardia Airport 2008).

The capacity is insufficient to meet demand on just about every day. In good or bad weather, fifteen percent of all flights are delayed more than fifteen minutes. Average delays for the airport can range from 47 to 52 minutes regardless of weather conditions. Not to mention that if the situation is left unchecked the problems are only going to compound, the future demand is forecasted to grow seventeen percent over the next ten years (Terminal Area Forecast Report). In the near term there are no planned infrastructure improvements mainly because there is no room to place a new runway or a new terminal. The use of more efficient ground controlling devices, and more closely
spaced movements and operations in and out of the airspace will only marginally increase the airports throughput.

The single-landing-runway airports such as LaGuardia, find that using more efficient ground controlling and spacing devices is the most promising method of improving capacity. Using these NextGen systems to control the ground and spacing issues to place aircraft in the closest possible sequencing while at the same time managing wake turbulence to ensure that the spacing is done safely. Additionally, NextGen technologies can also reduce delays in sequencing takeoffs on intersecting runways like Land and Hold Short Operations (LAHSO) which will be discussed later in this document. The FAA estimates that LaGuardia peak-hour capacity can be increased by only 10 percent using these methods, or roughly about nine flights per hour. Over a year this is approximately 59,000 flights not currently using the nation’s most constrained airport. This type of improvement can also be expected at other similar airports with single runway configurations such as Reagan National and San Diego. Also, because approaches can be flown more precisely and wake turbulence can be better managed, larger aircraft can be used with closer separation than current operations, thereby expanding the number of passengers able to fly out of LGA.

LAHSO can increase airport throughput. These operations allow active runways that intercept to be used at the same time. Basically, it works just like it sounds, a pilot will land and hold short or stop before coming to the interception of another runway. At LGA there is plenty of room to conduct these operations, but in 1999 LGA banned these
operations which resulted in a reduction of about six arrivals and departures per hour.

The reimplementation of the LAHSO will replace those missed flights.

The limited landing capacity of LGA makes it a weak point in the system. For the most part the changes that NextGen provides are minimal as seen in Figure 40.

Figure 40 NextGen Calculated Capacity Changes (Department of Transportation 2004)

<table>
<thead>
<tr>
<th>Weather</th>
<th>Scenario</th>
<th>Configuration</th>
<th>Procedures</th>
<th>Benchmark Rate (per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimum Rate</strong></td>
<td>Today</td>
<td>Arrivals on 22</td>
<td>Visual approaches, visual separation</td>
<td>78-85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Departures on 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency of Use: 25% in Optimum conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ceiling and visibility above minima for visual approaches (3200 ft ceiling and 4 mi visibility)</td>
<td>New Runway</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occurrence: 81%</td>
<td>Planned improvements (2013)</td>
<td>Same</td>
<td>85</td>
</tr>
<tr>
<td><strong>Marginal Rate</strong></td>
<td>Today</td>
<td>Arrivals on 4</td>
<td>Instrument approaches, visual separation</td>
<td>74-84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Departures on 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency of Use: 37% in Marginal conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Below visual approach minima but better than instrument conditions</td>
<td>New Runway</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occurrence: 10%</td>
<td>Planned improvements (2013)</td>
<td>Arrivals on 22 Departures on 13</td>
<td>Visual approaches, visual separation</td>
</tr>
<tr>
<td><strong>IFR Rate</strong></td>
<td>Today</td>
<td>Arrivals on 4</td>
<td>Instrument approaches, radar separation</td>
<td>69-74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Departures on 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency of Use: 48% in IFR conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instrument conditions (ceiling &lt; 1000 ft or visibility &lt; 3.0 miles)</td>
<td>New Runway</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occurrence: 9%</td>
<td>Planned improvements (2013)</td>
<td>Same</td>
<td>69</td>
</tr>
</tbody>
</table>
LGA will not benefit significantly from NextGen technologies, it will only be able to increase capacity is to regional operations and standards that is once it is deemed legal. Also it will have to make scheduling more realistic to the airport’s capability. This will increase flight time and reduce created delays at the airport. This is an important example that shows if infrastructure is not increased along with NextGen technologies there is a small likelihood that capacity and throughput for the airport will increase. The FAA and GAO acknowledge that after all changes that NextGen will make are implemented, LGA will still need improvements to increase capacity. In total, 14 airports were predicted by the GAO and FAA to need additional capacity, or will face significant capacity challenges in 2015 and 2025 even after the planned NextGen improvements do occur. According to FAA, some airports are already significantly capacity constrained, and increased demand is expected to increase delays going forward. Six of these 14 airports will be significantly capacity constrained as early as 2015, according to the report, see Figure 41 (GAO 2009).

The FACT 2 study was designed to produce a conservative list of congested airports, according to FAA officials, and identified those airports that will have the greatest need for future additional capacity. FAA officials noted that airports not designated as capacity constrained by the study may also have capacity issues in the future and may need capacity-enhancing projects. (GAO 2009)
Conclusion of Findings:

We can see that throughout the cases there is a spectrum of benefits that NextGen will provide to the NAS; from great benefit to no benefit. There are hundreds of airports in the country and many of them will receive some kind of benefit. NextGen will help fix the problems caused by harsh weather, closely spaced parallel runways, and congested airspace. NextGen will increase the airport’s ability to move aircraft and passengers through the airport and across the country. Although many airports possess some of the same characteristics, NextGen solutions will still need to be tailored to each airports unique operational and regional issues. Things such as procedures development, the creation of infrastructure, and environmental evaluation will have to be looked at specifically on a case by case basis.
In addition, the NAS is controlled and operated by the federal government so decisions that can be made and implemented by the federal government easily work, but airport solutions to the congestion problem require local knowledge, involvement, and support. An airport, unlike the NAS itself is owned at the local level. The time and resources needed to prepare and evaluate local solutions, need to be done locally.

<table>
<thead>
<tr>
<th>Case Study Airport</th>
<th>Problem</th>
<th>Can NextGen fix this problem?</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>Closely spaced parallel runway operations</td>
<td>Yes</td>
<td>NextGen technologies will allow pilots to control their own aircraft in all weather conditions eliminating the problems of ATC and ILS overlap.</td>
</tr>
<tr>
<td>San Francisco</td>
<td>Wake turbulence</td>
<td>Yes</td>
<td>ADS-B will display and warn pilots about dangerous potential for wake turbulence and show a safe area for aircraft operations</td>
</tr>
<tr>
<td>Minneapolis St. Paul</td>
<td>Lack of landing surface area (Lack of runways)</td>
<td>In some cases</td>
<td>NextGen does not build new runways, the decision is done at the local level. The ability for the local political figure to get money from NextGen is possible. Also, not all airports have the ability to expand.</td>
</tr>
<tr>
<td>NY Metroplex</td>
<td>Intercepting approach/departure paths in congested airspace</td>
<td>Yes</td>
<td>RNAV and RNP procedures require aircraft to fly more specific routes which streamline traffic patterns.</td>
</tr>
<tr>
<td>LaGuardia</td>
<td>Small airport servicing a large metropolitan population</td>
<td>No</td>
<td>There is no possibility of making large increases in capacity through NextGen initiatives only small incremental boosts.</td>
</tr>
</tbody>
</table>

In the SFO case study showed how closely spaced parallel runways, which are closer than 4300 ft, will no longer be a problem after the implementation of RNAV approaches. These are more specific and more precise than the current ILS radar.
approach procedures. The ADS-B will allow pilots to fly dependent and independent approaches to parallel runways as well while maintaining a safe distance from wake turbulence. SFO will not be the only airport to benefit from NextGen technologies as there are 231 other airports across the nation have parallel runways, 33 of those are large hubs that have average delays greater than 51 minutes.

The Minneapolis-St. Paul airport had an additional runway installed in 2005. This was a runway that was placed at the end of the air field so it did not cross any other runways; it also was not parallel to any other runway. This uniqueness proved to be very beneficial to MSP. It radically increased the capacity of the airport, and now because of its success it is now planning on adding on an extension to runway 22 to further increase its capacity. Not all airports will have the luxury of being able to add additional runways. One new construction procedure that NextGen will open is a concept called “paving down the middle” which is a term used to explain how adding a new runway in-between two parallel runways is now possible.

The metroplex situation is easily corrected with the RNP and WAAS procedures. Specific points at which aircraft can depart and enter the traffic pattern creates a situation in which pilots know where to look for traffic. Where pilots know to look for traffic the more controllers can depend on them to make it to the runway themselves. Also the interaction between airports is decreased because paths and altitudes can purposely be assigned to specific airports. This would resolve the chaos that is caused by having major airports so close together.
Airports like LaGuardia gain the least from NextGen’s benefits. The only benefit that it will receive is the relaxation in the separation standards which controllers use as a buffer. The tightening of this constraint allows planes to fly closer together, the closer they fly the faster they can get on the ground. The only other benefit that is shared by all airports nationwide is the increased ability to land aircraft in less than optimal conditions. There will be little increase in the capacity in good weather, but the reduction of the losses in poor weather, that would have happened if NextGen was not implemented, is perhaps a great capacity increase.

The end goal of an airport in the new NextGen system is quite easy. All they have to worry about is accommodating the current and future of aviation activity safely, efficiently as possible, and securely in a cost effective and environmentally responsible way. This is accomplished by:

- Increasing capacity through infrastructure changes and policy changes,
- Improving the operational reliability by creating new and up to date technologies,
- Enhancing operational and developmental flexibility by including federal and local decision makers together on airport decisions,
- Reductions in environmental impact by making the system more efficient, reducing noise and fuel consumption,
- Improving access for passengers,
- And improving customer service for everyone
Chapter Five
Conclusions & Policy Recommendations:

One of the more overarching concepts in air transportation revitalization is that the predicted growth in aviation demand is based on passenger demand and not on aircraft operations. If current demand is met by the current capacity, then the situation is acceptable. It is also satisfactory to allow capacity to increase while demand stays fixed. The problem starts when demand increases while NAS capacity stays static. If the FAA were to miss something in their analysis of the future demand in aviation and the real trend is really less than what is predicted, then the status quo would be met and the money, time, and effort spent in implementing the NextGen system would have been futile. Although more of the concentration and focus of NextGen has been on the navigation, communication, and procedures of the NAS, airport congestion has moved off center stage as a critical factor of the congestion problem.

In part, this problem has developed because of the interdependence of the airports, and the borderline jurisdiction of the airports themselves between national and local policy. Delays and cancellations at major hubs like La Guardia, O’Hare, Newark, and Atlanta can ripple through the hub and spoke system and cause problems at airports that otherwise would not have problems. Another issue that has been overlooked is the process of getting passengers from the curb and into the airplane. The security checks that have come about because of the attacks on our airlines from terrorists have also have caused a bottleneck. As security increases, the time frame that airports and airlines tell passengers to arrive in also increases.
The factors that inhibit capacity due to weather concerns are dealt with well through NextGen. The NextGen Weather Concept of Operations lays out several circumstances and decision making scenarios which will no longer become a problem for NAS capacity. For example, there will be more precise forecasting of the timing and location of weather that will present hazards to blocking arrival and departure routes or weather systems that shut down airports. Also airport operations will increase to keep pace with the increased traffic flow. Runway snow removal, aircraft de-icing, and treatments for off normal weather like cosmic radiation which could cripple a GPS satellite all will be increasingly dealt with.

Weather and airport capacity are often linked, as illustrated in the case study of San Francisco International Airport, since bad weather and IFR conditions can further erode maximum operations in and out of an airport. Airports having closely spaced parallel runways that are too close for simultaneous use in harsh weather can only have one of the two runways used at a time, thereby reducing the number of aircraft that can land and take off at a time. FAA’s data shows that in bad weather, 22 of the 31 airports that contain CSPR have at least three 15-minute periods when demand exceeds capacity (United States General Accounting Office, 2001). To put that in a better perspective, the average runway acceptance or arrival rate is 40 flights per hour per runway. So, if the average airport has 3 runways then that would be 60 flights a day or 1800 flights a month that 22 of the 31 busiest airports in America could move where currently it cannot.

An additional measure of capacity identified was the NAS ability to hold aircraft in the sky. Strict FAA separation rules govern how close aircraft can be to each other. In
areas where aircraft can be tracked by radar the separation standards are slightly closer than in areas where they cannot be tracked, such as areas over the ocean. The new GPS flight flowing in areas where radar can’t reach and the greater precision of GPS over radar allows the separation standards to become tighter and more flights can be held by the same amount of air space. Now metroplex areas can hold more flights in their controlled air space, and with pilots being able to vector their aircraft around other air traffic they will share the burden of navigating the air space along with air traffic controllers.

Mentioned earlier, runway addition significantly increases the airports’ ability to move passengers. Even in the case where runway addition is possible, other factors make that alternative less desirable. Some airports are surrounded by development that is extremely difficult and expensive to displace. For example, a new 9,000 ft runway is currently under construction at St. Louis Lambert Field and will cost roughly $1.1 billion, in large part due to the required displacement of over 2,000 homes, businesses, churches, and schools around the airport. Similarly, a new 9,000-foot runway under way at Atlanta Hartsfield will cost an estimated $1.3 billion, again largely due to the costs of relocating structures and highways. By contrast, the new 16,000-foot runway at Denver—where ample open land is available—will cost just $171 million (United States General Accounting Office. 2001). The addition of a new runway is one of the best ways to increase an airports capacity. For some airports the cost is great, and for others construction is impossible. In any case the new runway becomes well worth the cost.
It is difficult to predict the long term impact of NextGen. It is clear that it will help with airport capacity as well as the capacity of the entire system by imposing new procedures, technologies, and new infrastructure. NextGen will revolutionize the entire aviation system and bring it up to date with the rest of the world. The number of passengers is proposed to increase more than 40% or to more than 1 billion passengers annually by the end of 2010. The FAA also suspects that the airlines will increase their fleet 50% or by 2,600 jets to keep pace. With this expected increase, the aviation system also is improved. NextGen is the solution and will provide benefits to just about all airports. However, as seen in the LaGuardia case study it cannot help all airports and will not work in all situations, but it will make a difference. But what will happen to the system in the long term? What will happen after all the changes are made, will there still be congestion problems?

Perhaps, another way to explain this issue is by using the analogy of a hybrid car working. We are currently on the brink of running out of oil, which means that one day there will be no more gasoline to fuel any vehicle. To combat this problem, like NextGen, the hybrid car makes more efficient use of the fuel to do more on less. The same way NextGen will make the use of airspace, runways, and terminals more efficient with what is currently there. But the car still uses gas even though it uses less than before. The day that the oil does run out the more efficient car will still not work. Even if the NAS is 100% efficient and passenger demand still increases will the airlines be able to keep up or will they be maxed out because of their limited ability to expand? The most delay prone airports can cause havoc on the rest of the system. The old adage of “a chain only being as strong as its weakest link” becomes true for the NAS as this situation mirrors that of
the hybrid car. Below in Figure 42 are the most congested airports and their proposed increases.

**Figure 42** Projected Capacity Increases At The Most Delay Prone Airports. (United States General Accounting Office 2001)

<table>
<thead>
<tr>
<th>Airport</th>
<th>Ranking by delays per 1,000 operations (2000)</th>
<th>Projected percentage increase in capacity through 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York - La Guardia</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Newark International</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Chicago O’Hare International</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>San Francisco International</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Boston Logan International</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Philadelphia International</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>New York - Kennedy International</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Airports are like fingerprints in the sense that most of them share major characteristics even though they are all unique in their own specific cases. For instance, the loop and the arch in finger prints or having CSPR or being in close proximity to a city for airports, upon a closer examination we find that there are subtle differences. Each fingerprint is unique to the owner and each airport, although looking like or set up like another airport, does not operate in the same way. These specific attributes that airports have will make NextGen affect them in different ways. So the long and short term effects will be different. Airports need NextGen solutions tailored to their unique operational issues like procedure development, infrastructure, and environmental evaluation. Unlike many other components of the NAS, airport solutions require local knowledge involvement and support. Time and resources are needed at the local level to prepare and evaluate local solutions.
Moreover NextGen itself will be a limited resource through money in the short run. In the long run companies will make more money that will allow them to buy into the technologies and share in the benefit that NextGen offers. In the short run then it would be necessary to prioritize the attributes and see which characteristics and airports should be “fixed” first.

Table 2 depicts the list of the studied airports and the major problems that they have in limiting capacity from the maximum capacity that NextGen could deliver. The final column talks somewhat about the potential benefit that would have on airport capacity for the amount of time, effort, and cost put in.
Table 2 Are Airports Bottlenecks?

<table>
<thead>
<tr>
<th>Case Study Airport</th>
<th>NAS airport with similar characteristics</th>
<th>Problem</th>
<th>Can NextGen fix this problem?</th>
<th>How</th>
<th>Benefit Vs. Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>• Fort Lauderdale • Detroit • Salt Lake City • Phoenix • Memphis • Raleigh-Durham • Minneapolis St. Paul • Portland • John F. Kennedy • Indianapolis • Detroit • Orlando • Boston • Philadelphia • St. Louis • Dallas Ft. Wroth • Pittsburgh • Atlanta • Huston • Las Vegas • Newark • Los Angeles (As noted previously 200+ airports in the NAS have parallel runways this list only encompasses major airline hubs)</td>
<td>Many U.S. airports depend on parallel runway operations to achieve capacity necessary for day to day operations. In the current airspace system, instrument meteorological conditions reduce the capacity of parallel runway approach operations spaced closer than 4300 ft. apart, or 3400 ft. where Precision Runway Monitoring (PRM) is applicable. The lost capacity costs the airline industry hundreds of millions of dollars each year. Its impact on other businesses and personal inconveniences to travelers is significantly costly but difficult to quantify.</td>
<td>Yes</td>
<td>NextGen technologies will allow pilots to control their own aircraft in all weather conditions eliminating the problems of ATC and ILS overlap.</td>
<td>Large benefit per cost, the strongest and fastest way to increase airport capacity at airports with these characteristics.</td>
</tr>
<tr>
<td>City</td>
<td>Airports</td>
<td>Issue</td>
<td>Yes/No</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>--------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>San Francisco</td>
<td>Detroit, Orlando, Boston, Philadelphia, St. Louis, Dallas Ft. Wroth, Pittsburg, Atlanta, Huston, Las Vegas, Newark, Los Angeles</td>
<td>Wake turbulence (wake vortex rules become an issue with runways spaced closer than 2,500ft.)</td>
<td>Yes</td>
<td>ADS-B will display and warn pilots about dangerous potential for wake turbulence and show a safe area for aircraft operations.</td>
<td></td>
</tr>
<tr>
<td>Minneapolis St. Paul</td>
<td>Atlanta, Charlotte, Chicago, Houston, Las Vegas, Los Angeles, Minneapolis, New York, Philadelphia, Phoenix, San Diego, San Francisco, Seattle, South Florida, Washington-Baltimore</td>
<td>Lack of landing surface area (Lack of runways)</td>
<td>In some cases</td>
<td>NextGen does not build new runways, the decision is done at the local level. The ability for the local political figure to get money from NextGen is possible. Also, not all airports have the ability to expand.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The benefit for cost is marginal. Wake turbulence is that strong of a capacity inhibitor in airports that do not operate with CSPR, on the other hand airports that do, this tech would play a larger role in effecting capacity.</td>
<td></td>
</tr>
<tr>
<td>NY Metroplex</td>
<td>Metroplex Areas:</td>
<td>Intercepting approach/departure paths in congested airspace</td>
<td>Yes</td>
<td>RNAV and RNP procedures require aircraft to fly more specific routes which streamline traffic patterns.</td>
<td>Congested airspace is shared by several airports at the same time, benefit to the airspace would trickle to the composing airports. Small investment in a small area could affect ten’s of class B and C and countless GA airports.</td>
</tr>
<tr>
<td>---</td>
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</tr>
</tbody>
</table>
| • Seattle  
• Minneapolis  
• Chicago  
• New York  
• Philadelphia  
• Washington DC  
• Atlanta  
• Miami  
• Huston  
• Dallas  
• Phoenix  
• Las Vegas  
• San Francisco  
• Los Angeles  
• San Diego | | | | | |
| LaGuardia | • Atlanta  
• Fort Lauderdale  
• John F Kennedy  
• John Wayne/ Orange County  
• Long Beach/ Daugherty Field  
• McCarran International  
• Oakland  
• Midway  
• Newark  
• Philadelphia  
• Phoenix  
• San Diego  
• San Francisco | Small airport servicing a large metropolitan population | No | There is no possibility of making large increases in capacity through NextGen initiatives only small incremental boosts. | Lots of costs would have to be applied to places like LGA in order to get their capacity above current levels. |
Recommendations For New Policies:

This research has shown that NextGen may do great things in the short run. It is unlikely to be sufficient enough on its own to resolve congestion problems in the long if demand continues to grow past projected levels. Aviation stakeholders and aviation decision makers should consider other measures to alleviate delay. Below are several options proposed by the GAO which may help and correct problems in the not to distant future. None of these options are new concepts nor are they anything that is not currently possible to accomplish (United States General Accounting Office 2001).

- **Prioritize**: Federal funding for anything is limited. With unlimited demand and only a fixed supply prioritizing which aviation problems get fixed first becomes a necessity.

- **Adding Airport Infrastructure**: Building more airports in the same metropolitan area will help alleviate congestion at one airport. Secondary airports can better distribute air traffic. In the MSP case study the airport was able to accomplish increased capacity by just adding one new runway, the addition of a completely new airport would further capacity for the city even more.

- **Managing Demand**: Mandate the number of take offs and landings that can be conducted during peak travel hours as to not flood the system. In the LGA case study I found that there no NextGen technological system that found change capacity. Because technological progress can not help that airport perhaps social mechanisms need to be in place in order to increase capacity.
– **Transportation Alternatives**: Use of high speed rail, busses, or even expansion of technology of the automobile to make more viable substitute modes of travel. Metroplex’s become congested easily, finding new ways of travel to closely neighboring city’s may alleviate some of the congestion that was shown with the New York City Metroplex case study.

**Recommendation #1:**

The largest ability to quickly increase capacity with out expelling a large significant cost is dealing with the CSPR problem. First, we would have to identify airports that have CSPR, they should be addressed as having the highest priority. Fixing CSPR airports would significantly increase the overall capacity of the NAS because so many major hub and non hub airports currently have this runway problem.

Second, any airport that has the ability to construct new runways, should. New runways have a large cost in order to construct, let alone to get through the local legislature. On the other hand, new runways have an extremely significant effect on capacity. The large cost, large benefit justification could stem from the fact that in time, the runways could “pay for themselves” in opportunity costs. The runways would increase operations above current levels. The increase in operations would increase profit, which the airport would not have had without the new runway. Eventually there will be a break even point in which the money made from the new runway exceeds the cost incurred from the runway.
Third, addressing wake turbulence would be crucial if we believe that CSPR and the construction of runways are the first two. One technique to increase airport surface area is called “paving down the middle.” The previous distance that parallel runways had to be from one another is quite large, now that CSPR problems are dealt with new runways can be built in-between the large gap which separates current parallel runways. Doing this creates three parallel runways where one is paved down the middle of the first two.

Fourth, the congested airspace of the metroplex’s must be addressed. These areas normally reside over the largest Class B airspaces like New York, Southern California, Detroit, and Miami. The largest Class B airspaces are at major cities not by coincidence but because they are favorite destinations, and service large populations. Fixing this problem would only have a large benefit to small amount of commercial airports.

Lastly, we would have to deal with situations like LaGuardia in which the only thing to do is to make practices of operating the airport more efficient. For example, closing the distance of in tail separation between aircraft on final approach, decreasing this distance would allow aircraft to land faster and not waist time in-between flights where a ready runway is not being used.
Recommendation #2:

Another option is to increase the number of airports, and planes, in such a way that dissolves the hub-and-spoke model, this way delays and cancellations cannot cause a domino effect throughout the system. Building new airports in the same metropolitan area will help overall capacity especially in airports that don’t have the ability to expand. Airports like Dallas Fort Worth and Dallas Love Field are examples of how this is working currently, where one airport fails, the other one is only 14 miles away and can pick up operations that are being conducted. MSP was able to expand its capability greatly by putting in a new runway. The addition of an entirely new airport would quite literally double the capacity of the destination.

Another option is to create gateway airports. This would be the development of a few airports located on the fringe or just outside of major congested airports and regions that would serve as transfer points for passengers connecting to other locations inside the congested area. A final option would be to create more regional airports. There are several regional airports in the southern California area, where flights are restricted to other southern California airports and don’t leave the state. The furthering of this notion could prove very beneficial. Regional airports are located within 50 miles of some other large metroplex hubs, these airports can be used to take advantage of unused system capacities.
Recommendation #3:

The LaGuardia case showed that technology can not solve all aviation problems. Where technological solutions to increase capacity failed social policies may help. One major reason that LGA has become so busy is because airlines over schedule flights, so much so that it is more than the airport itself, running at maximum capacity, can hold.

Managing demand is an administrative and public policy way in which system capacity can be limited. One option is to create a market based approach that would cause efficient use through the transfer of funds. If the FAA were to charge a fee for landing or taking off it would slowly bring flights into line with the airports available capacity. If they were to set the fees higher during peak travel times then it is less likely that airlines would schedule flights for that time and the flights for that day would be more evenly distributed throughout the day. Or it would force them to use alternate airports to get the same amount of flights out at the same time. It also may force airlines to adopt larger aircraft, because the larger the plane the more passengers which can be take taken in a single trip. These are not the only other areas in which social policies can affect airport capacity, according to the Dallas/Fort Worth Airport Board there are five other areas in which technology has a hard time solving problems where the possibilities for increasing capacity exist.

1. Terminal operations and design
   - Passenger processing
   - Gate management
– Curbside management

2. **Ground access**
   – Improved parking management
   – Improved curbside management
   – Better multimodal networks

3. **Airport operations and maintenance**
   – Enhanced ARFF response
   – Enhanced winter operations
   – Airfield and facility maintenance

4. **Safety**
   – Avian radar and FOD detection
   – Airside vehicle tracking

5. **Security**
   – Passenger and cargo screening
   – technologies
   – Biometrics

**Recommendation #4:**

Transportation alternatives is a normal economic substitution or tradeoff argument. Substitute goods are two or more products that are related to each other in such a way that if you increase the “cost” of one good the result will be a shift of demand to the other good, so that the second becomes more appealing than the first. “Cost” is used in this sentence as an opportunity cost more than a monetary const. On average it is much cheaper to get a plane ticket to travel long distances than it is to drive a car, a bus ticket is
cheaper than both. But most people prefer to fly because it is faster, and more convenient than the alternatives. However, as the air transportation system becomes more and more congested and more and more stressful consumers will start switching to the alternative modes of transportation.

Perhaps building high-speed rails between areas that are within 200 miles of each other will take pressure off of people that take routine flights, like officials who travel frequently between Washington DC and Boston for example a high speed rail here would help alleviate the Washington DC metroplex. Such trains could travel up to 200 Mph, and such rail has been successful in Europe and Asia (United States General Accounting Office, 2001). The rails connecting the nearby airports which create metroplex’s create better freedom of movement in-between destinations and flights don’t have to be predisposed to one airport.

**Future Questions:**

**Pilots’ Ability:**

The goal of the Next Generation Air Transportation System (NextGen) is to significantly increase the safety, security, and capacity of US air transportation operations. One condition that is sure to change is the layout of the flight deck. The flight deck is the area in which the aircraft is operated by the pilot, co-pilot and in some cases the navigator and flight engineer. With new NextGen technologies needing new cockpit displays the flight deck will become even more cluttered than it all ready is. One question
that is raised is, how do we expect the pilot’s ability to multi-task to keep up with the influx of devices in the flight deck and their ability to make decisions?

The plans for NextGen development have been driven largely from technology, and it seems that human factors, such as the ability to multi-task during critical stages of flight, do not appear to be considered as a motivating force. Because of this there may be many vulnerabilities in pilot error. All of which may be strong enough to jeopardize the very goals that NextGen is trying to solve. “While past research has applied human factors expert opinion to identify general NextGen human factors issues, as yet, little NextGen-specific human factors analysis has been performed and, to [my] knowledge, no one has attempted to create a reasonably comprehensive list of human factors issues related specifically to the NextGen flight deck” (Funk, K., Mauro, R., & Barshi, I. (2009).

For example, one such instance I ran into while researching for this thesis was that pilots have a hard time “monitoring and maintaining situational awareness over long and boring periods of nominal operations under automatic pilot control” (Sheridan, T.B., K.M. Corker, & E.D. Nadler (2006a), Sheridan, T.B., K.M. Corker, & E.D. Nadler (2006b). One possible solution that was offered was to have a possible need to impose activities for the purpose of maintaining alertness, this way the tediousness of straight and level flight for hours becomes disrupted. The disruptions might be able to keep the pilot in an active state of situational awareness.
There also may be the possibility for pilot responsibility to go the other way.

NextGen may not make a pilot’s job of flying easier; it may instead make it harder.

NextGen may create situations in which motoring requirements become too extensive.

Fatigue, exhaustion, stress, and inability to multi-task lengthy check lists cause pilot failure and I don’t think this is something that NextGen meant to cause. How will NextGen deal with this situation?

Although human factors research and design are mentioned in several JPDO research documents, it is not apparent however how exactly NextGen planners intend to address pilot multi-tasking issues. I am concerned that human-centered design will not be a development priority and that NextGen engineers will rely on their intuition rather than on a comprehensive set of human factors tools and guidelines when designing pilot-system interfaces and tasks. “Unless pilot roles, responsibilities, authority, and procedures with respect to collaboration and, especially trajectory negotiation, are clearly defined, designed, and trained, there will be operational confusion, misunderstandings, delays, and errors (Funk, K., Mauro, R., & Barshi, I. (2009).”

**How To Deal With General Aviation Aircraft:**

Large airlines and the military are not the only users of the NAS. Small aircraft flown by private, recreational, and student pilots also flood the system. These small aircraft at times have their own airports in which to conduct operations. Most of the time these aircraft operate at airports with large commercial jet traffic as well. Large airports such as class B, C, and D have runways specifically for jet and general aviation (GA)
aircraft. Of the airports that are studied in this thesis only one, MSP has a GA runway, in the NYC Metroplex encompasses several GA airports including Stewart International. These facts lead to an interesting question of, how is NextGen going to deal with GA traffic with the possibility of limiting capacity?

While aircraft are in the traffic pattern waiting to get clearance to land, smaller slower traffic gets the right of way. Because of this large jets could be delayed because of smaller traffic operating at or around airports. The FAA’s mission is to provide a safe and efficient airspace system for everyone. In order to accomplish this mission the FAA uses airport system planning to better understand airports and their needs; such as design, technology, infrastructure, repair, and most importantly capacity. The Airport and Airway Improvement Act of 1982 directed the Secretary of Transportation to prepare, publish, and revise every two years a national airport system plan – the National Plan of Integrated Airport Systems - for the development of public-use airports in the United States. This is a system that emphasizes system planning and development to meet current and future aviation needs; it includes development considered necessary to provide a safe, efficient, and integrated airport system meeting the needs of civil aviation, national defense, and the United States Postal Service (APPENDIX B, 2009).

One such report published by the National Plan of Integrated Airport Systems and the Government Accountability Office (GAO) recognized the GA community and the effects that it has on airports. It stated that “…development and planning at regional airports include special studies whose scope of work does not fully correspond with the elements described in the airport system guidance (GAO 2009, December 1).” Special
studies include work in general aviation in pavement management, economic impact, surface access, environmental impact, and possibility as use as a reliever airport. The significance of the impact of GA on regional airports is shown in a 10 year study of Philadelphia’s airport; the cost of the GA study there has ranged from $410,310 to $189,170 this information. The Terminal Area Forecast report which is produced by the FAA each year forecasts the projected expected operations demand on a airport by airport basis, each Terminal Area Forecast has separate forecasts for GA operations. If several agencies have recognized the need and importance for GA why is there no analysis on the NextGen will deal with this aspect of the NAS on airports?

**Conclusions:**

The solutions offered may have adverse effects back toward the hub and spoke model because airlines would try and fill the planes to full occupancy; half-full planes are not economically efficient. Another way to control capacity is through regulations. The government could use command and control regulations for:

(1) restrictions on the number of takeoffs and landings (slots) during peak traffic periods, (2) voluntary flight schedule adjustments to even out peak periods of demand, (3) restrictions on the use of smaller aircraft at busy airports, and (4) more flexible policies governing airport gate access and airlines’ control over airport capital development projects. Two of these measures—slot control and voluntary schedule adjustments—are being used to a limited degree at a few U.S. airports, such as Newark (voluntary schedule adjustments) and New York’s La Guardia and Kennedy airports (slot control) (United States General Accounting Office 2001)

FAA’s Next Generation Air Transportation System is a positive step in addressing needed capacity-enhancing actions. But if the recent economic slump and the challenges posed by the September 11 terrorist attacks turn out to be only a temporary pause in the
growth of air traffic, the plan will fall far short of meeting the system’s growing needs for the long term. Unless passenger traffic remains at the current reduced levels over the long term, which seems unlikely, bolder more controversial measures, such as new airports and administrative and market-based approaches and transportation alternatives, will have to be considered. Exploring such measures is important because several of the nation’s key airports cannot significantly add to their capacity.

Eventually airports that either, currently have enough capacity, or can add a runway to increase capacity will have to consider other measures such as these alternatives. The current drop in air traffic represents an opportunity to develop plans for keeping the air transport system ahead of the curve of potential future growth. A carefully considered blueprint is needed to guide future actions for the next years after the full implementation of NextGen. Selecting a set of measures to solve the nation’s flight delay problem involves difficult choices with considerable impact on the interests of the various stakeholder groups such as the flying public, airlines, airports, and their nearby communities. Moreover, because of the interdependence of airports in the system, a national perspective is needed which would consider the needs of the entire system while also considering the individual needs and circumstances of various locations because of the verity of situations in the NAS. For some parts of the country, these exclusive needs and circumstances require special consideration of their possible solutions.

The Department of Transportation and Congress both have key roles to play in bringing about needed changes to sustain a safe, sound, properly managed, and affordable air transport system. Because of the breadth of its management of all transportation modes, DOT is in a unique position to lead this effort. DOT’s recent efforts are a start toward developing such a strategic planning effort, but additional steps will be needed to provide
the kind of necessary blueprint for the future. DOT needs to work closely with the Congress in formulating its approach, because ultimately Congress may have to make difficult choices that will please some stakeholders and displease others (United States General Accounting Office 2001)
Appendices
Appendix A: Glossary Of Abbreviations

A
ACARS – Aircraft Communications Addressing and Reporting System
ACTD – Advanced Concept Technology Development
ADF – Automatic Direction Finder
ADIZ - Aerial Defense Identification Zone
ADS-B – Automatic Dependent Surveillance-Broadcast
ADS-C – Automatic Dependent Surveillance-Contract
ADS-R – Automatic Dependent Surveillance-Re-broadcast
AGL – Above Ground Level
AI – Aeronautical Information
AIM – Aeronautical Information Management
AIRE – Atlantic Interoperability Initiative to Reduce Emissions
AMASS – Airport Movement Area Safety System
ANSP – Air Navigation Service Provider
AOC – Airline Operations Center
API – Application Programming Interface
ARTCC – Air Route Traffic Control Center
A-SMGCS – Advanced Surface Movement Guidance and Control System
ASDE-X – Airport Surface Detection Equipment Model X
ASAS – Airborne Separation Assistance Systems
ASIAS – Aviation Safety and Information Analysis and Sharing
ASPIRE – Asia and South Pacific Initiative to Reduce Emissions
ASSAP – Airborne Surveillance and Separation Assistance Processing

ATC – Air Traffic Control

ATCRBS – Air Traffic Control Radio Beacon System

ATCT – Airport Traffic Control Towers

ATIS – Automated Terminal Information System

ATL – Atlanta International Airport

ATM – Air Traffic Management

ATOP – Advanced Technology and Oceanic Procedures

ATOS – Air Transportation Oversight System

ATSAP – Air Traffic Safety Action Program

AWIM – Airport Wide Information Management

B

BLS – Bureau of Labor Statistics

BOAC – British Overseas Airways Corporation

C

C&A – Certification and Authorization

CAA - Civil Aeronautics Administration

CAASD – Center for Advanced Aviation System Development

CAST – Certification Authorities Software Team

CATIII – Category Three Landing

CATM – Collaborative Air Traffic Management

CAVS – CDTI Assisted Visual Separation

CDA – Continuous Descent Arrival
CDM – Collaborative Decision-making

CDAS – Continuous Decent Arrival System

CDTI – Cockpit Display of Traffic Information

CEFR – Cockpit Enhanced Flight Rules

CLEEN – Continuous Low Energy, Emissions and Noise

CMD – Commanded Speed

CMU – Communication Management Units

CNS – Communication, Navigation and Surveillance

COI – Communities of Interest

Con-Trail – Condensation Trail

CPDLC – Controller Pilot Data Link Communications

CSMC – Cyber Security Management Center

CSPO – Closely Spaced Parallel Runway Operations

CSPR – Closely Spaced Parallel Runways

D

DA – Decision Altitude

DataCom – Data Communications

DHS – Department of Homeland Security

DME – Distance Measuring Equipment

DoC - Department of Commerce

DoD – Department of Defense

DoJ – Department of Justice

DOT – Department of Transportation
EFB – Electronic Flight Bag
EFVS – Enhanced Flight Vision Systems
EMF – Event Management Framework
EMS – Environmental Management System
ERAM – En Route Automation Modernization
ETA – Estimated Time of Arrival
EVO - Equivalent Visual Operations

F
FAA – Federal Aviation Administration
FAF – Final Approach Fix
FANS – Future Air Navigation System
FAROS – Final Approach Runway Occupancy Signal
FAS – Final Approach Speed
FBI – Federal Bureau of Investigation
FDMS – Flight Deck-Based Merging and Spacing
FIS-B – Flight Information Services-Broadcast
FMS – Flight Management System
FOC – Flight Operations Centers

G
GA – General Aviation
GBAS – Ground Based Augmentation System
GLS – GPS Landing System
GNSS – Global Navigation Satellite System / Ground bases Augmentation System /
Space based Augmentation System

GPS – Global Positioning System

GPWS – Ground Proximity Warning Systems

H
HF – Human Factors

HUD – Head-up Display

I
IARD – Investment Analysis Requirements Document

IATA – International Air Transport Association

ICAO – International Civil Aviation Organization

IFF – Identify Friend or Foe

IFR – Instrument Flight Rules

ILS – Instrument Landing System

IMC – Instrument Meteorological Conditions

IMEX – Information Management and Exchange

INFOSEC – Information System Security

IRU – Inertial Reference Units

ISS – Information Systems Security

ITP – In-trail Procedure

ITWS – Integrated Terminal Weather System

J
JFK – John F Kennedy International Airport

JPDO – Joint Planning and Development Office
K
KBOS – Boston Logan International Airport
KCEL – Cleveland Hopkins International Airport
kHz – Kilohertz
KSEA – Seattle Tacoma International Airport
KSTL – Lambert – St Louis International Airport

L
LAACS – Logical Access and Authentication Control Service
LAAS – Local Area Augmentation System
LCGS – Low Cost Ground Surveillance
LIDAR – Advanced Light Detection and Ranging
LNAV – Lateral Navigation
LOA – Letter of Agreement
LPV – Localizer-performance with Vertical Guidance
LAHSAO – Land And Hold Short Operations
LGA – LaGuardia International Airport

M
MASPS – Minimum Aviation System Performance Standards
MCP – Mode Control Panel
MDA – Minimum Descent Altitude
MFD – Multi-Function Display
MHz – Megahertz
MIA – Miami International Airport
MIT – Miles-in-Trail

MOA – Military Operation Area

MPAR – Multifunction Phased Array Radar

MSD – MCP Spacing Display

MSL – Mean Sea Level

MSP – Minneapolis St. Paul International Airport

MVFR – Marginal Visual Flight Rules

N

NAS – National Airspace System

NASA – National Aeronautics and Space Administration

NASEA – NAS Enterprise Architecture

NAVAID – Navigational Aid

NDB – Non Directional Becon

NCRCC - National Capital Region Coordination Center

NDOT – NextGen Decision Oriented Tools

NEI – Network Enabled Infrastructure

NEO – Net Enabled Operation

NextGen – Next Generation Air Transportation System

NNEW(S) – NextGen Network Enabled Weather (Systems)

NOAA – National Oceanic and Atmospheric Administration

NOTAM – Notice to Airmen

NSA – National Security Area or Administration

NVS – National Airspace System Voice Switch

NWxP WP1 – NextGen Weather Processor Work Package 1
O
OAG – Official Airline Guide
OEP – Operational Evolution Plan
OPD – Optimized Profile Descent
OTM4D Pre-Departure – Oceanic Trajectory Management 4-Dimensional Pre-
Departure
OPSNET – Operations Network

P
PARTNER – Partnership for Air Transportation Noise and Emissions Reduction
PARC – Performance-Based Operations Advisory Rulemaking Committee
PATA – Personal Air Transportation Alliance
PF – Pilot Flying
PHL - Philadelphia International Airport
PM – Pilot Monitoring
PNT – Positioning, Navigation, and Timing

R
RADAR – Radio Detection And Ranging
RCP – Required Communications Performance
RIL – Runway Intersection Lights
RIRP – Runway Incursion Reduction Program
RLVs – Reusable Launch Vehicles
RNAV – Area Navigation
RNP – Required Navigational Performance
ROA – Remotely Operated Aircraft

ROD – Record of Decision

RPAT – Parallel Approach Transition

RPR – Rulemaking Project Record

RSP – Required Surveillance Performance

RTA – Required Time of Arrival

RTCA – Radio Technical Commission for Aeronautics

RWSL – Runway Status Lights

S

SAAAR – Special Aircrew and Aircraft Authorization Required

SAMS – Special Use Airspace Management System

SBAS – Satellite-based Augmentation System

SBS – Surveillance Broadcast Services

SDSS – Surface Decision Support System

SE – Safety Enhancement

SI – Spacing Interval

SIGMET – Significant Meteorological Information

SIM – Security Information Management

SITS – Security Integrated Tool Set

SME – Subject Matter Expert

SMS – Safety or Surface Management System

SOIA – Simultaneous Offset Instrument Approach

SSA – Shared Situation Awareness

STA – Scheduled Time of Arrival
STAR – Standard Terminal Arrival Route
STP – Surveillance and Transmit Processing
SUA – Special Use Airspace
SVS – Synthetic Vision Systems
SWIM – System-Wide Information Management
SFO – San Francisco International Airport

T
TA – Tailored Arrival
TAWS – Terrain Awareness Warning Systems
TBO – Trajectory Based Operation
TCAS – Traffic Alert and Collision Avoidance System
TDLS – Tower Data Link System
TDZE – Touchdown Zone Elevation
TFM – Traffic Flow Management
TFM-M – Traffic Flow Management-Modernization
TFMS – Traffic Flow Management System
TIS-B – Traffic Information Service-Broadcast
TMA – Traffic Management Advisor
TMIs – Traffic Management Initiatives
TOAC – Time of Arrival Control
TOD – Top of Descent
TSA – Transportation Security Administration
TSAFE – Tactical Separation Assisted Flight Environment
TSO – Technical Standard Orders
TTF – Traffic-To-Follow

U
UAS – Unmanned Aircraft Systems
UAT – Universal Access Transceiver
URET – User Request Evaluation Tool

V
VDL – Very High Frequency Digital Link
VFR – Visual Flight Rules
VHF – Very High Frequency
VLJ – Very Light Jet
VMC – Visual Meteorological Conditions
VNAV – Vertical Navigation
VOR – Very High Frequency Omni-Directional Radio
VSI – Visual Slope Indicator

W
WAAS – Wide Area Augmentation System
WARP – Weather and Radar Processor
WATRS – Western Atlantic Track System
WWII – World War 2
WT – Wake Turbulence
WTMA – Wake Turbulence Management for Arrivals
WTMD – Wake Turbulence Mitigation for Departures
Appendix B: Financial Section

The FAA is aware of declining federal dollars and altered its request for its budget request for the Fiscal Year (FY) of 2009. The FY 2009 budget request of $14.6 billion for the FAA reflects the Administration's commitment to increase the safety, performance, and capacity of our aviation system (DOT 2009). Below in Table 3 are the changes that the FAA has made in its request for funds because of the NextGen policy.

Table 3 The Requested Budget Of The FAA In FY 2009

<table>
<thead>
<tr>
<th>Federal Aviation Administration Budget (Dollars in Millions)</th>
<th>2007 Actual</th>
<th>2008 Enacted</th>
<th>2009 Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>8,374</td>
<td>8,740</td>
<td>0</td>
</tr>
<tr>
<td>Facilities and Equipment</td>
<td>2,518</td>
<td>2,514</td>
<td>0</td>
</tr>
<tr>
<td>Research, Engineering, and Development</td>
<td>130</td>
<td>147</td>
<td>171</td>
</tr>
<tr>
<td>Airport Grants (Obligation Limitation)</td>
<td>3,515</td>
<td>3,515 *</td>
<td>2,750</td>
</tr>
<tr>
<td>Air Traffic Organization</td>
<td>0</td>
<td>0</td>
<td>9,670</td>
</tr>
<tr>
<td>Safety and Operations **</td>
<td>0</td>
<td>0</td>
<td>2,052</td>
</tr>
<tr>
<td>Total</td>
<td>14,537</td>
<td>14,915</td>
<td>14,643</td>
</tr>
</tbody>
</table>

* In 2008, the Airports Grant program has an obligation limitation of $3,515 million, but only $17 million in new contract authority. The program cannot award new grants until sufficient contract authority is provided for 2008.
** The Air Traffic Organization (ATO) and Safety & Operations appropriations will be new accounts in FY 2009. The new account structure aligns with proposed FAA reauthorization legislation that would reform the financing structure of our Nation’s air traffic control system.
The FAA’s current financing structure expired at the end of FY 2007 and, therefore on February 14, 2007, the Administration transmitted a reauthorization proposal that would transform the FAA’s current financing system. The FY 2009 budget reflects this reauthorization proposal. The aim is to create a more direct relationship between revenue collected and services received, thereby providing the FAA with a stable revenue stream and creating incentives to make the National Airspace System more efficient and responsive to user needs (DOT 2009). It is evident in Table 4 that the FAA is concentrating on the NextGen system, in its decision making we can see the areas in which the FAA places zeros flips. In 2007 there is a concentration in operations and facilities to keep things running smoothly, then there is a switch, they no longer ask for an increase in those areas but instead ask for that money to be relocated into the air traffic and safety operations.
Table 4 The Change Of Budget Requests From FY 2008 To FY2009 For Airport Grants

<table>
<thead>
<tr>
<th></th>
<th>Air Traffic Organization</th>
<th>Safety &amp; Operations</th>
<th>Research, Engineering, &amp; Development</th>
<th>Airport Grants</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2008 Base</td>
<td>9,361</td>
<td>1,893</td>
<td>147</td>
<td>3,515</td>
<td>14,915</td>
</tr>
<tr>
<td>Pay Inflation Adjustments</td>
<td>213</td>
<td>46</td>
<td>0</td>
<td>2</td>
<td>262</td>
</tr>
<tr>
<td>Non-Pay Inflation Adjustments</td>
<td>30</td>
<td>16</td>
<td>0</td>
<td>1</td>
<td>47</td>
</tr>
<tr>
<td>Annualization of FY 2008</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Non-recurring Costs or</td>
<td>-171</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-171</td>
</tr>
<tr>
<td>Savings (Preliminary)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Re-engineering,</td>
<td>213</td>
<td>60</td>
<td>-7</td>
<td>-778</td>
<td>-512</td>
</tr>
<tr>
<td>Reductions or Adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FY 2009 Current Services</td>
<td>9,659</td>
<td>2,026</td>
<td>141</td>
<td>2,741</td>
<td>14,567</td>
</tr>
<tr>
<td>Levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program Initiatives</td>
<td>11</td>
<td>26</td>
<td>30</td>
<td>9</td>
<td>76</td>
</tr>
<tr>
<td>FY 2009 Request</td>
<td>9,670</td>
<td>2,052</td>
<td>171</td>
<td>2,750</td>
<td>14,643</td>
</tr>
</tbody>
</table>

Table 5 shows a further breakdown of the new money that the FAA is requesting, what we want to pay attention to is the money requested for the reduction of congestion. One of the ways the congestion is going to be reduced is to increase the amount of
runways. The money that is allocated for grants to airports is money that will be used to build new runways. One fact that I would like to point out is the large reduction in the money that is left for airports compared to the reorganization of air traffic. To help in understanding this chart a positive number represents an increase in change from 2008 to the 2009 level. For example a 0 represents a no change in the budget request, while a negative number represents a decrease in the amount requested. The amount for air traffic a little more than double, while airport grants still increased; it just did so at a slower rate.

Table 5 The Money Requested For Building New NextGen Technologies

<table>
<thead>
<tr>
<th>NextGen Programs</th>
<th>FY 2008 Budgeted</th>
<th>FY 2009 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATO Capital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NextGen Network Enabled Weather (NNEW)</td>
<td>7,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Data Communications for Trajectory Based Operations</td>
<td>7,400</td>
<td>28,800</td>
</tr>
<tr>
<td>Demonstrations and Infrastructure Development</td>
<td>50,000</td>
<td>28,000</td>
</tr>
<tr>
<td>NextGen – System Development</td>
<td>-</td>
<td>41,400</td>
</tr>
<tr>
<td>NextGen – Trajectory Based Operations</td>
<td>-</td>
<td>39,500</td>
</tr>
<tr>
<td>NextGen – Reduced Weather Impact</td>
<td>-</td>
<td>14,400</td>
</tr>
<tr>
<td>NextGen – High Density Arrivals/Departures</td>
<td>-</td>
<td>18,200</td>
</tr>
<tr>
<td>NextGen – Collaborative ATM</td>
<td>-</td>
<td>27,700</td>
</tr>
<tr>
<td>NextGen – Flexible Terminals and Airports</td>
<td>-</td>
<td>37,100</td>
</tr>
<tr>
<td>NextGen – Safety, Security and Environment</td>
<td>-</td>
<td>8,000</td>
</tr>
<tr>
<td>NextGen – Networked Facilities</td>
<td>-</td>
<td>17,000</td>
</tr>
<tr>
<td>NextGen – Integrated Airport</td>
<td>1,760</td>
<td>-</td>
</tr>
<tr>
<td>System-Wide Information Management</td>
<td>35,350</td>
<td>41,000</td>
</tr>
<tr>
<td>ADS-B NAS Wide Implementation – Segment 1b</td>
<td>85,650</td>
<td>300,000</td>
</tr>
<tr>
<td>ADS-B Air to Air</td>
<td>9,350</td>
<td>-</td>
</tr>
<tr>
<td>NAS Voice Switch</td>
<td>3,000</td>
<td>10,000</td>
</tr>
<tr>
<td>SubTotal ATO Capital</td>
<td>187,718</td>
<td>631,100</td>
</tr>
</tbody>
</table>

Research, Engineering and Development (RE&D)

<table>
<thead>
<tr>
<th></th>
<th>FY 2008 Budgeted</th>
<th>FY 2009 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Deck/Maintenance/System Integration Human Factors</td>
<td>1,000</td>
<td>-</td>
</tr>
<tr>
<td>Air Traffic Control/Technical Operations Human Factors</td>
<td>1,000</td>
<td>-</td>
</tr>
<tr>
<td>Wake Turbulence</td>
<td>8,000</td>
<td>7,370</td>
</tr>
<tr>
<td>NextGen – Air Ground Integration</td>
<td>-</td>
<td>2,554</td>
</tr>
<tr>
<td>NextGen – Self Separation</td>
<td>-</td>
<td>8,023</td>
</tr>
<tr>
<td>NextGen – Weather in the Cockpit</td>
<td>-</td>
<td>8,049</td>
</tr>
<tr>
<td>NextGen Environmental Research – Aircraft Technologies, Fuels and Metrics</td>
<td>-</td>
<td>16,050</td>
</tr>
<tr>
<td>NextGen – JPDO</td>
<td>14,321</td>
<td>14,494</td>
</tr>
<tr>
<td>SubTotal RE&amp;D</td>
<td>24,221</td>
<td>56,542</td>
</tr>
</tbody>
</table>

Safety & Operations

<table>
<thead>
<tr>
<th></th>
<th>FY 2008 Budgeted</th>
<th>FY 2009 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>NextGen – Environmental Performance</td>
<td>-</td>
<td>704</td>
</tr>
<tr>
<td>SubTotal Safety &amp; Operations</td>
<td>0</td>
<td>704</td>
</tr>
</tbody>
</table>

Total NextGen Programs

<table>
<thead>
<tr>
<th></th>
<th>FY 2008 Budgeted</th>
<th>FY 2009 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>212,039</td>
<td>688,246</td>
</tr>
</tbody>
</table>
The money for airport grants is further broken down into its component NextGen technologies and improvements. A large amount of money from the total budget is being poured into the implementation of the NextGen system. Currently the FAA is going full steam ahead with this policy and it is the first time in decades that the FAA has not allocated most of its spending on safety as it is slowly switching to other areas. As we can see from Table 5 many of the NextGen Technologies will be implemented soon since they received funding in 2009 whereas they didn’t have funding in 2008. Disappointingly, there is a cut in the money allotted for air traffic control and wake turbulence mitigation research, which are some of the largest reasons for airport congestion.

Some say that we are at a critical point because over the next ten years the use of our air system will double and then soon triple over time. If we are to keep this economy moving in the right direction, we must start taking action now. NextGen is the answer that we are looking for that will save the air travel industry and as well as American aviation. Currently, the reality is that if the transformation does not occur, the aviation sector and all of its related services which contribute to about nine percent of the overall gross domestic product will become less productive. NextGen will flexibly and efficiently meet that growing demand with ease. Every end of the aviation industry will benefit from this, law enforcement, commercial, defense, and recreation. Someday, it will also be able to handle the use of low earth orbit vehicles. Currently the UPS hub at Louisville Kentucky is using the ADS-B system and it is saving time and money just by taking off, landing, and moving aircraft on the ground more efficiently. The new demonstrations, technologies, and procedures will become the backbone that is going to bring our air system into the 21st century. Just like the railways and highways did in
allowing Americans the freedom to travel and to provide goods and services all across the nation.
Appendix C: NextGen Opinion Survey 1

NextGen Opinion Survey

Introduction: First, I would like to thank you for taking the time out of your day to complete this questionnaire. I am a graduate student at the Rochester Institute of Technology doing research on pilots’ opinion of the FAA’s new policy, the Next Generation Air Transportation System. I am also a private pilot and I am a pilot select for the United States Air Force, so I know just as much as you about the joy of flying. The results will be helpful in understanding what us pilots really feel about this policy and its effectiveness. Thank you for your participation!!

What is your age bracket:  O 20-30  O 31-40  O 41-50  O 51-60  O 60+
Are you a civil or military pilot:  O Civil  O Military
If you are Civil were you ever Military:  O yes  O no
What is your pilot rating (check all that apply):  O Private  O Instrument  O Multi-engine
O Commercial  O ATP  O CFI  O CFII  O Other:  ______
   Military:  O pilot  O senior  O command
What is your current number of hours flown:  ______ hrs
   Current airframe:  ______
   Employer/Carrier:  ______
Do you know what NextGen technology is (ADS-B, RNAV, CDA,...)?:  O yes  O no
Have you used it?:  O yes  O no
If yes what are your likes and dislikes?
As a pilot, would it be beneficial to you to have the following technologies in the cockpit?
Real time weather picture:  O yes  O no
   Because: _______________________________________
Final approach and runway occupancy awareness:  O yes  O no
   Because: _______________________________________
The ability to view other vehicles operating on the airport surface:  O yes  O no
   Because: _______________________________________

Would you, as a pilot, say that the following policy changes would lower expenses, increase efficiency, and/or increase safety:
Increased VFR flight following coverage outside of controlled airspace:  O yes  O no
   Because: _______________________________________
Increased enroute capacity:  O yes  O no
   Because: _______________________________________
Reduction in separation standards:  O yes  O no
   Because: _______________________________________
Enhanced acquisition allowing you to identify other aircraft in VFR and IRF conditions:  O yes  O no
Because: ______________________________________________________

Lighted movement areas, like traffic lights, instead of calling in for movement:  □ yes  □ no
Because: ______________________________________________________

Anything you would like to add?
______________________________________________________________
Appendix D: Opinion Survey After Correction From Beta Test

NextGen Opinion Survey

Introduction: Thank you for taking the time to complete this questionnaire. I am a graduate student at Rochester Institute of Technology doing research on pilots’ opinions of the FAA’s new policy, the Next Generation Air Transportation System. I am a private pilot and I am a pilot select for the United States Air Force. I hope to gain a better understanding of how the flying community feels about this policy and its effectiveness. Thank you for your participation!!

What is your age bracket: ______20-30 ______31-40 ______41-50 ______51-60 _____60+

Are you a Civil or Military pilot: _______Civil _______Military

If you are Civil were you ever Military: _______yes _______no

What is your pilot rating (check all that apply): _______Private _______Instrument _______Multi-Engine _______Commercial _______ATP _______CFI _______CFII _______ Other:_______

Military: _______ pilot _______ senior _______ command

What is your current number of hours flown: ______hours

Current airframe:________________________________________

Employer/Carrier:________________________________________

Are you familiar with NextGen technology is (ADS-B, RNAV, CDA ...)? : ____ yes ____no

Have you used it? : _______ yes _______no

If so, what are your likes and dislikes?

As a pilot, would it be beneficial to you to have the following technologies in the cockpit?

Real time weather picture: ____ yes ____no

Because:____________________________________________________
Final approach and runway occupancy awareness: _____ yes _____ no
Because:___________________________________________________________

The ability to view other vehicles operating on the airport surface: _____ yes _____ no
Because:___________________________________________________________

Would you say that the following policy changes would lower expenses, increase efficiency, and/or increase safety (check all that apply):

Increased VFR flight following coverage outside of controlled airspace:
_____ lower expenses   _____ increase efficiency   _____ increase safety
Because:___________________________________________________________

Increased enroute capacity:
_____ lower expenses   _____ increase efficiency   _____ increase safety
Because:___________________________________________________________

Reduction in separation standards:
_____ lower expenses   _____ increase efficiency   _____ increase safety
Because:___________________________________________________________

Enhanced acquisition allowing you to identify other aircraft in VFR and IRF conditions:
_____ lower expenses   _____ increase efficiency   _____ increase safety
Because:___________________________________________________________

Lighted taxi ways, like traffic lights, instead of calling in for movement:
_____ lower expenses   _____ increase efficiency   _____ increase safety
Because:___________________________________________________________
Anything you would like to add?
Appendix E: Results From NextGen Survey

This section will display the results of my research. I interviewed twelve pilots and did my best to pool from military and civilian pilots, getting an even amount (n= 6 and 6). Below are the results of the survey in context. I have posted the question and then all of the answers that were received by that question.

NextGen Opinion Survey Results

Table 6 What Is Your Age Bracket:

<table>
<thead>
<tr>
<th>Age bracket</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>3</td>
</tr>
<tr>
<td>31-40</td>
<td>4</td>
</tr>
<tr>
<td>41-50</td>
<td>2</td>
</tr>
<tr>
<td>51-60</td>
<td>2</td>
</tr>
<tr>
<td>60+</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 7 Are You A Civil Or Military Pilot:

Table 8 What is your pilot rating(check all that apply):
Table 9 Military:

<table>
<thead>
<tr>
<th>Military Rating</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 10 What Are Your Current Number Of Hours Flown:

<table>
<thead>
<tr>
<th>Hours flown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Mode</td>
</tr>
<tr>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Sample Variance</td>
</tr>
<tr>
<td>Skewness</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
<tr>
<td>Sum</td>
</tr>
<tr>
<td>Count</td>
</tr>
</tbody>
</table>
Current Airframe:

- A-4
- F-86
- C-130E
- C-141
- F-111
- Piper PA-20
- GA-8
- 737
- Cessna 152
- Lear
- Cessna 172

Employer/Carrier:

- American Eagle
- US Air Force
- American Airlines
- Self Employed
- N/A
Table 11 Are You Familiar With NextGen Technology Is (ADS-B,RNAV,CDA,...)? :

Heard of NextGen

<table>
<thead>
<tr>
<th>Frequency</th>
<th>yes</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
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<td></td>
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<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answer: heard of NextGen
Table 12 Have You Used NextGen?

![Bar Chart showing frequency of use of NextGen]

If so what are your likes and dislikes?

- Its ease of use and usefulness
- It enhances safety in the skies
- It saves fuel
- It will expand industry capacity
- It does not account for airport arrival/departure rates
- The greatest benefit was that airplanes in the pattern could see each other and figure out their own arrival priorities
- It does not display call signs so you can communicate with them
- Traffic avoidance, runway information, CTAF’s, navigation information
- Excessive amounts of keystrokes
- Gives good sense of traffic over a very wide area so a pilot can plan sequencing from/to an airport
- Improved situational awareness during inclement weather
- Increases head down time
- Ability to combine traffic and terrain avoidance on the same page. Also direct function of runway alignment
- Hard to set up for GPS approaches
As a pilot, would it be beneficial to you to have the following technologies in the cockpit?

Table 13 Real Time Weather Picture:

Because:

- Weather can kill you, data to avoid it is a plus
- Current weather system rarely works
- More accurate, the better
- Self explained benefits
- Right information keeps coming
- During VFR flight you could avoid bad weather
- Don’t like calling
- Collision avoidance
- Promote safety and reduce distractions
- Any future changes in plan due to inclement weather
- Too often planes circle in minimum weather conditions
- If it was intergraded in another screen so it wasn’t always on the weather channel
Table 14 Final Approach And Runway Occupancy Awareness:

Because:

- Could be a simple light setup because you can’t find the runway at all on final
- Incursions happen often
- See chances of a derivation in flight plan
- Air traffic controllers cannot see everything
- Hard to see by yourself
- Improved situational awareness helps with discretion and actors
- Make sure we are all in the right place
- Self explained benefits
- Good for others, from air to ground and ground to air
- Would be good
- Avoid other’s mistakes
Table 15 The Ability To View Other Vehicles Operating On The Airport Surface?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
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</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

Because:

- Avoid other’s mistakes
- Cannot see all of the time
- Have to watch for others
- Better knowledge of aircraft on surface locations when taxiing
- Only when on the surface though
- Reduce dependency on ground control and speed up things
- It does get busy at times
- Only when I am on the ground
- SAFETY
- Big boom for safety
- It would be too much activity
Would you say that the following policy changes would lower expenses, increase efficiency, and/or increase safety (check all that apply):

Table 16 Increased VFR Flight Following Coverage Outside Of Controlled Airspace:

Because:

- Would help let pilots be less aware of threats
- I have heard people, mostly older pilots, worry about being watched. But, most feel the benefit outweigh the problem
- See other planes
- Promote safety and reduce distractions
- Collision avoidance
- Don’t like calling
- Someone will be waiting over a year, lowering it may reduce pilot initiative
- Good, if system can do it
- Easier in-flight diversions
- Make it a moving map
- Saves time for direct flights
- But could add extra complexity to VFR flight
Table 17 Increased Enroute Capacity:

Because:

- Increase go/no go decisions
- Fewer mid air collisions
- “Follow the yellow brick road”
- Easier in flight diversions
- Better spacing
- Greater throughput, more flights
- Hard to see by yourself
- Only if the airport can handle it
- Better operating efficiency and fuel savings
- Granted their good pilots
- Only if all planes have them
- Helps to lower gas network
Table 18 Reduction In Separation Standards:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>lower expenses</th>
<th>increase efficiency</th>
<th>increase safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>9</td>
<td>0</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Because

- Help ease of flying
- Definite increase in situational awareness
- Again, more aircraft in airspace = more efficiency
- With reduced air traffic controller communication
- Especially over the water!!
- It does get busy at times
- More planes in the air at one time, the more people flying
- Only if the system could do it safely
- Over the water especially
- Collision avoidance needs tempering though
- Fewer canceled flights
- Lower diversions
Table 19 Enhanced Acquisition Allowing You To Identify Other Aircraft In VFR And IFR Conditions:

Because

- We already have IFF
- Safer operations
- Better communications
- Just like the IFF system
- More eyes are better
- It will be easier
- Drastic improvement for VFR efficiency, makes it a whole new ball game
- Increase in situational awareness
- Would be great
- Increased communications is never a bad thing
- Increased situational awareness helps avoid aircraft and makes night and IFR flights much safer
Table 20 Lighted Taxi Ways, Like Traffic Lights, Instead Of Calling In For Movement:

Because

- Less time spent waiting
- Hate when air traffic controllers are busy
- ? not sure
- Would help out IFR and night flying
- Less engine running time
- Quicker
- No waiting
- Some people lose brain function when sitting on their butt waiting for clearance
- Improved procedures
- Have to keep it maintained, already have at some airports and is used daily
- Better situational awareness, saves time, less confusion, fewer ground accidents
Anything you would like to add?

(No additional comments were made)
Appendix F Previous Research:
As previously stated, this thesis is a continuation of my Senior Project. Below are the main points from that project which provide further background for this research. The way that pilots feel or have felt about the NextGen system, so far, has not been documented. Qualitative data is best captured by direct questioning of the participants. The most common method of data collection will have to be the use of a survey. With a survey the pilots are treated as the experts of the field of aviation. A survey is highly personal, especially with the use of open ended questions, because naturalistic inquiries takes the researcher, into the real world where people live and work, and because interviewing opens up what’s inside people. Qualitative inquiries, in most cases, are more intrusive and involve greater reactivity from its participants than other quantitative approaches. To obtain the pilots opinion the best option is to use a survey rather than other methods of qualitative research, like: case studies, grounded theories, phenomenology, ethnography, or historical, because they just don’t apply to the contest of this problem.

One idea that we get from the studies of qualitative analysis is that surveys, or good ones for that matter, are hard to comprise. Good questions are hard to come up with. There are a million questions that you could ask someone, but they have to stay relevant to your thesis question to show real results and not something you were not intending. There may be a hundred questions that need answering but there is only so much free time that subjects have to answer questions. There are certain things that certain questions give you. There are close ended questions that have answers provided to them, such as multiple choice questions and true and false type questions. These do not let the participant shed their own voice on the question. However, it is faster to get a consensus
on a question and helps with coding. The open ended question is similar to an essay question. It has a question mark at the end and allows full participation. This makes for a fuller and more detailed response, but there are a million different answers that can come from the same question which can make the displaying of the results difficult. I have chosen to use a mix of closed and open ended questions with a mix of a few other questions in order to make the data collected quantifiable, which makes it better to analyze and make predictions of the information.

For example: (may not be used but meant to give an idea)

<table>
<thead>
<tr>
<th>Open ended</th>
<th>Close ended</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In your opinion what is the best thing about NextGen? What is the worst? What do you think can be improved upon? Is the system helpful/harmful? Is it easy to use?</td>
<td>- On a scale of 1 to 10… do you prefer the current system or NextGen? Do you prefer calling for weather or getting it on your ADS-B? Do you prefer getting the curb to curb service or just worry about flying runway to runway?</td>
</tr>
</tbody>
</table>

There is a chance that we might stumble upon something that NextGen is missing or something that a pilot would really like to see happen. I am a pilot myself and I have connections to other pilots who live in the area and work at the Rochester airport. There is a chance that the Airport Director, David Damelio, might allow me to sit in the pilots’ lounge and I can just hand the questions to the pilots. I would also bring a pen and notepad with me for any additional questions, comments, or thoughts that the survey pilots may have.
Another way that I plan on collecting data is with the use of a descriptive method of research. Descriptive research is used to obtain information concerning the current status of the phenomena to describe "what exists" with respect to variables or conditions in a situation. The methods involved range from the survey which describes the status quo; the correlation study which investigates the relationship between variables; and ends with the developmental studies which seek to determine changes over time. The survey will illustrate a point about the sample, and then we can use these results to make a generalization about the population.

For this research question there needs to be a very good background section since there are very few people in the world who know anything about the protocols on how airplanes fly and navigate from one place to another. If someone taking the survey is not familiar with the actual aspect of flying and all that it involves, they will not understand the proposed changes or what they mean for the aviation industry. The emphasis is on describing rather than judging or interpreting anything (I'll leave that up to the pilots). This will eliminate any bias I might have. This approach of describing is quick and has a nice, flexible approach. This approach is good for me because NextGen is evolving every day. It started with its implementation in 2003. If new questions and issues should arise, then I will have the opportunity to investigate them further.

In any case, the best approach is to look at the opinions of pilots on the NextGen system. I believe that holistic and inductive venues are the best methods to use. There are many things that cannot be obtained from statistical analysis. You can state that nine out of every ten pilots like the system, but no one ever knows why that 10th pilot does not
like it. There is a more realistic feeling that you get from understanding why that 10th pilot does not like it rather than just stating, no.

Participants:

There are a varying number of pilots that come in and out of the airport on any given day. Commercial pilots are on a tight and stringent schedule that makes it hard for them to stay put for very long. On the other hand there are several general aviation pilots that I do know firsthand that live in the area. They are not on so tight of a schedule and I believe I can get them to participate just by asking them. If I had to guess, there are about fifteen pilots I know personally I can ask. However, I have to make sure that I get both military and commercial pilots, the mix of their flying experience, their abilities, and their training will give a better scope to the research.

In actuality I am going to collect the opinions from twelve pilots. Six of which will be military and six of them will be civil pilots. This way I am dipping into the two major employers of pilots. The reason that I am only selecting twelve participants rather than the normal thirty is because this is only a preliminary study to a much grander research. This is my senior project for a bachelor’s degree in Public Policy, this project will lay the groundwork for me to begin my masters work in the same field of study and same topic.

Other than their sector of employment, there are many other factors that are being tested with the participants. There are only two major factors that I am looking for. The first one is the opinion of the pilots on the NextGen system. The second factor is if the
pilots have not heard of the system, would they like it if they did. This way if they say
they like all of the changes that NextGen would make then we can say that they would
like the NextGen system. Just like saying if you like the sun and you like being outdoors,
then you would like having sunny days outdoors, even if you have never been outdoors
while it was sunny. There is a fallacy of making this kind of inference, like saying if you
like pickles and you like ice cream, and then you would like pickle flavored ice cream,
which is not the case. But, in this case, with making changes in job habits that pilots
would face, I think this would be a safe assumption.

**Instruments:**

The survey questionnaire will be the main tool for gathering information since
it is the information of the respondents that make this report. There will be a Likert scale
that will be applied to questions that are close ended. This will help me graph the results
of the questions in order to display the results. Choices will pose the degree of
satisfaction with a part of the current system as compared with the proposed changes
from the NextGen system. It will be on a weighted mean system such as, having a choice
between A or B, 1 being liking A best, 10 being liking B best, and 5 being indifferent
between the two. Also, there will be questions with just one variable; and the Likert scale,
will be 1 strongly don't like and 10 being strongly in favor. Questions will evolve as
pilots are interviewed, because as the insight that pilots have is closed in on, the questions
need to be more pertinent.
All of the responses from the surveys will be collected and compiled. The Likert questions will be analyzed by graphing. The open ended questions will be compiled into a lump sum of an overall response. Everything will be summed up into one generalizing overall statement. It will be this statement that will be presented. All of the specifics that the pilots will state in their open ended questions will be used as a gauge to tailor the questions to better suit what the pilots are trying to say.

**β Test:**

This section is the practice test for my survey. I am calling it a beta test because I do not want any confusion when it comes time to access sections of this project. Normally it is called a pilot study, but in this case, who we are surveying, will be pilots. Therefore, this beta test is a precursor to a full-scale study used to make sure all operational parameters are in check. A beta test can refer to many types of experiments. Generally the goal of a study is to replicate the full scale experiment, only on a smaller scale. The results of one can then be adjusted and then redone to make sure everything is refined for the actual test. The first survey is located in this paper as Appendix C: NextGen Opinion Survey 1.

I received many of the ideas from the first survey from other students who have done this type of work in the past. There were many things that I was asked to change after performing the beta test. These are some of the changes that I was asked to make. The beta test was given to two random subjects. One was not a pilot, and he had no idea of what was going on with NextGen technology. The reason for picking this subject is that I would have someone to critique the wording of this survey. The second subject I
picked had some flight experience. This subject would be familiar with the terminology even if he was not familiar with the NextGen technology. This subject could test the legitimacy of the questions. I also gave the survey to a professor who could go over the grammar, flow, and professionalism of the survey. Below are some of the items that needed to be corrected:

- Too difficult to read:
  - Some people had problems looking to find the questions and the answers to them.
  - Some also said it was too wordy and that some words should be taken out of the introduction.

- The last set of questions should have more choices:
  - I did ask several questions and people wanted to be able to separate the options instead of just saying yes or no to all three.

- The very last question was not a good way to end the survey:
  - This, I think is a good idea. There are additional items that people have on their mind; and, if there is something that they want to say that I did not capture in the survey, then they should have the ability to say it.
The bubbles were a bad idea:

- Some people did not like the fill in the bubble. They would rather have a blank space to put a check mark in.

After considering the responses of this test group the current survey needed several changes. The survey that was used is located in Appendix D: Opinion Survey After Correction From Beta Test.

There is additional information that needs to be given about the population from which the real survey will be given. There is a large population of pilots in the United States, and there are only a select number of pilots that I have access to. For civil pilots I can only talk to ones that are here in the Rochester area. However, for the military pilots, I have a larger range of contacts. Due to the Air Force networking, I can contact pilots from all over the country.

This variable of geographic location is something that I considered when I was completing my survey. If you review the survey, you will notice that there are no questions regarding location in the survey. Flying is a standard, and the rules and regulations are the same all over the country. This is similar to driving. A red light in New York means the same thing that it does in Texas, pilots likewise have the same rules and regulations to follow. Due to the fact that the regulations are the same no matter where you fly in the United States, I did not include location when I completed my survey.
There are many questions on my survey, but the real answers that I am looking for is their opinion on the NextGen system. I am most interested in the answers that they place in the open-ended questions of “Because.” Just an answer of yes or no, if you like something, is not good enough to get a real idea of what people think.

In addition, there are two sets of questions. The first one asks if you have used the NextGen technologies, and if so, what is your opinion of it. The second set of questions deal with what NextGen technologies do. With the questions being stated in this fashion, I can look to see if a pilot has or has not used the NextGen technologies. If a pilot has not used this technology, they are asked about the changes that would take place when the technology is enacted. If a pilot has used NextGen, this survey also asks their likes and dislikes of the new technology. For example, if someone never had a car alarm, but you told them everything about a car alarm, such as how it works and the benefits it offers; you can still find out their opinion on the idea of a car alarm. If they like the idea about something, then they will be more receptive to the actual technology.

The other questions that I ask on the survey, such as the personal questions, are second hand. This is the secondary set of questions. There might be something that I am not accounting for, and those questions are extra variables that I can use to see if they make a difference. The results of my surveys could show that military pilots may like the new technology less than civil pilots. Maybe older pilots have a stronger opinion one way or the other than younger pilots. Even air frames may have an impact on opinions, such as carrying passengers, cargo, or utilities.
**Expectation of results:**

When completing a project of this nature, there are items that you would expect to find. There is no researcher that goes into research blind. To even ask a good question on a survey to the researcher needs to have some background information on the topic. That being said, there are expiations that I think would happen even before I sent out the survey. Each question that I asked was asked for a reason. Except for the last question, “Anything you would like to add?” This question is optional.

I am a pilot and have been for about a year now. I am only a general aviation pilot. That is a term used for someone who pilots small aircraft for recreation, holds some of the basic licenses, and uses them for a non-commercial use. We fly small aircraft, normally only one engine, and have the shortest runways because of the versatility and ease of use of the small planes. When I started this project I had no knowledge of the NextGen system or of any of the technologies. I am only a GA pilot. We are on the edge of what it means to be a pilot. That is not to say that all GA pilots do not know about NextGen, because some do. I am saying that, here in Rochester, the bulk of the GA pilots do not know about it because if they did, I am sure that during my training, they would have told me about it.

I went head first into this project with a basic knowledge of the NextGen system from articles I read. The more and more people that I talked to, the more I learned. I developed the questions to the survey only after talking to people. The questions in the survey were not created from the knowledge that I acquired from reading college level articles. When I ask the survey questions, I am expecting to get the same answers that I received from other pilots in doing research for the project.
The main response that I expected was that not everyone would know about the NextGen changes. There are not many NextGen technologies that are out in the real world for people to see and the FAA journal does not normally have it on the front cover. On the other hand, for the people who do know about it, I expect them to know just about everything about it. This policy is like a tidal wave that is rocking the boat of the pilot community. It is a big deal about some of the changes that they are trying to make will affect the day to day life of a pilot drastically. When you see something in the news that is going to affect you directly then you are more engaged with it.

The second response that I expected to find is that, even if a pilot has not heard of the NextGen technologies, they will like what NextGen is. This is the same thing that I did once I heard about what NextGen was and what it was going to offer, I was floored and I am only a beginner pilot. The NextGen system is made to make life for a pilot that much easier. The more I found out about what it was capable of, such as night and infrared vision for runway approaches at night operations and runway incursion warnings in the cockpit, I ecstatic with all of them. I would expect every other pilot to have the same reaction.

All in all, I expect my results to show a strong correlation between pilot’s knowledge of NextGen and their opinion of liking the system. I am not trying to say that if a pilot knows about NextGen then they like it. I am saying that even if they have not heard of it, they will still like it. I believe that the interviews that I conduct will show, without a doubt, that pilots do like what NextGen is.
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