NowGen

Improving Air Traffic Control with Existing Technologies

Airport Management and Planning

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Executive Summary

The Next Generation of Air Traffic Control (NextGen) promises to reduce airline fuel consumption by shortening gate-to-gate travel times. The use of Global Positioning System (GPS) satellites combined with NextGen technology will allow pilots to choose more efficient routes to their destinations by utilizing the concept of Free Flight. The current radar-based Air Traffic Control (ATC) system is antiquated and requires airliners to fly in designated corridors that are not usually the most direct routes.

Although implementation of the complete NextGen package is years away, new technologies have been developed in support of the NextGen initiative, which include: Automatic Dependant Surveillance-Broadcast (ADS-B), the Traffic Collision Avoidance System (TCAS), and the Enhanced Ground Proximity Warning System (EGPWS). These technologies have been successfully tested by the Federal Aviation Administration (FAA) in a pilot program in Alaska and have proven to be ready for system-wide implementation.

Implementation of these selected elements of NextGen sooner than the generally accepted target date of 2025 is the most effective way to minimize fuel consumption and travel times.

Most of the technological hurdles have already been addressed, but implementation will not be expedited unless the following issues are resolved: implementation methodology, distribution of costs, gaining collaboration among stakeholders, improvement of leadership/direction in the FAA, encouragement of innovative thinking, and most importantly, the addition of a significant motivating force to drive the project.

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Problem Statement and Background on the Design Challenge

The team agreed the challenge of reducing fuel consumption is especially relevant in these times, and this particular challenge would provide an opportunity to contribute to a discussion that not only has an unprecedented impact on the aviation community, but has implications that could also impact national energy policy.

Fuel consumption is the single, greatest variable cost to the airlines, and to the traveling public. The overall health of the entire industry depends on bringing in the most passengers possible by ensuring the availability of affordable airfares. In addition, passenger traffic is directly impacted by convenience issues—chief among these is the issue of flight delays which, by definition, means increased gate-to-gate travel times. The NextGen solution addresses both these issues in one package.

Although the problem is being addressed in other ways, such as the development of more efficient jet engines and greater use of light composite materials in aircraft manufacturing, these solutions are costly and implementation is dependent upon the relatively lengthy life-cycle of existing, less efficient aircraft. Furthermore, these solutions do nothing to address the issue of travel times.

System Capacity Issues

The United States is currently using an ATC system that relies on a network of radar stations based on technology developed during World War II. This network causes the aircraft to take circuitous routes to their destinations instead of direct routes; which costs airlines billions of dollars in wasted fuel.

One of the most pressing issues we face today is an aircraft operates on a highway in the sky, much like a vehicle operates on a freeway during rush hour. In a vehicle, the driver can exit the freeway and use the roadways to get to its destination when it encounters delays. However, an aircraft does not have this alternative; it must remain on a predetermined flight plan which is guided through the sky with radar.

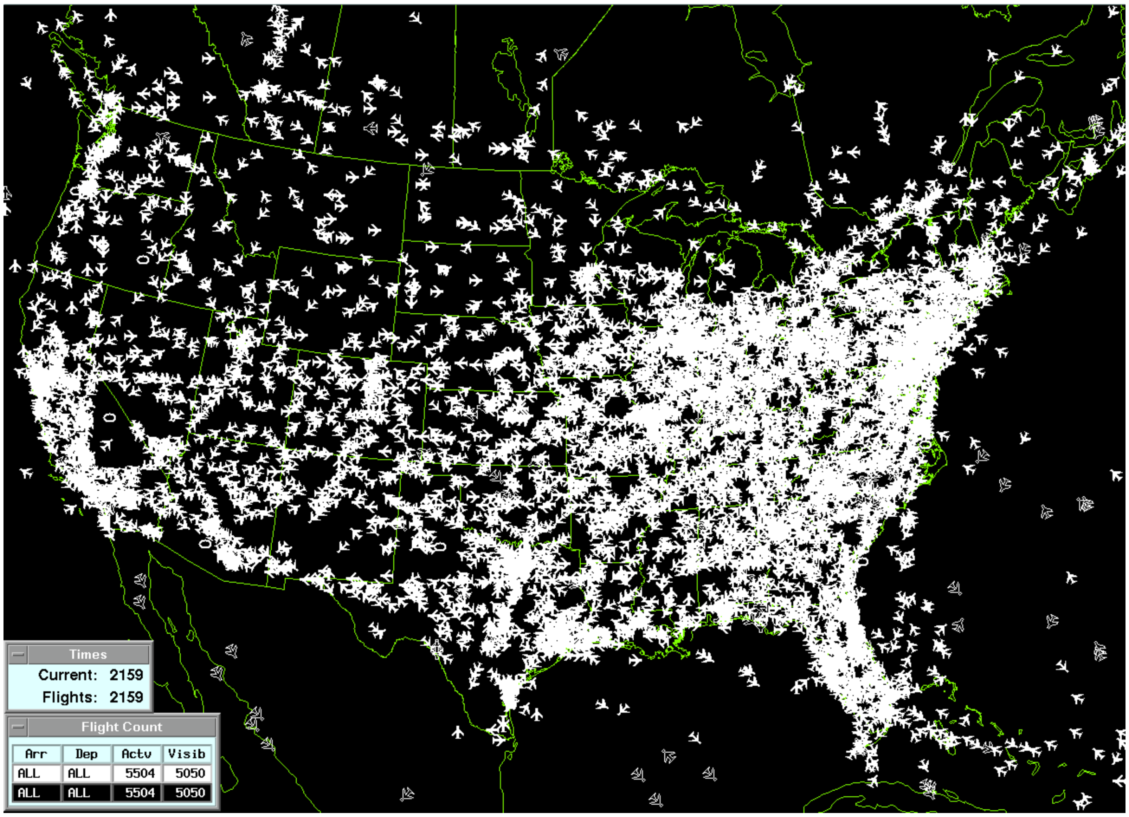
A well-known weakness of the current radar-based technology is the lack of real-time awareness of the location of airplanes in the sky. Air traffic controllers are updated by radar pulses echoes that can take several seconds to echo back to the controller. In addition, radars have limited range, are subjected to dead zones caused by "clutter," and are not relatively accurate in determining location or speed. The net result is that airplanes must be separated by distance and altitude in order to avoid the possibility of collision.

Another factor is the relative number of aircraft compared to the number of air traffic controllers. According to the Bureau of Transportation Statistics, during 2008 air traffic controllers:

- Moved 660 Million Passengers (average of 50K per day)
- Controlled 10.341M Departures
- Launched 11.116M tons of freight/mail.

The FAA manages:

- 124 FAA-staffed Towers
- 239 Contract Towers
- 26 Stand-Alone TRACONS
- 139 Co-located Towers and TRACONS
- 4 Consolidated TRACONS



(Figure 1. U.S. Airspace, 7:50 PM EDT, May 30, 2007. The icons in this NASA image depict the positions of 5307 planes. (Photograph by NASA) Peterson, B. S. (2007, August). End of Flight Delays? FAA's GPS Fix Could Bust Sky Gridlock. Retrieved February 5, 2009, from Hearst Communications, Inc.

The image above is a representation of the amount of air traffic that occurs over the United States at any given moment. NextGen will not decrease air traffic, but it will provide alternative routes which in return reduce fuel consumption and minimizes delays.

In addition, the FAA funds, maintains, and operates a vast system of support facilities. This creates logistical challenges as aircraft are handed-off from facility to facility. This requires time, attention, and coordination among all the players and moving parts.

<u>Fuel Consumption Issues</u>

Although the aviation community is currently experiencing an intermission in jet fuel prices prompted by the current economic downturn, it would be a mistake not to plan for eventual recovery and a return to expensive fuel prices.

The cost of jet fuel will always be a prime consideration for airlines. According to Boeing, the 737-700 has a maximum fuel capacity of 10,707 gallons. Prior to September 11, 2001, the cost for a gallon of jet fuel was less than one dollar. During the peak of the recent oil shortage caused by increased international demand, airlines paid up to five dollars per gallon. The cost to refuel a 737 increased from $10,000 to $50,000.

Since the airlines are not in control of the cost of jet fuel, they had to focus on conservation efforts such as not fueling airplanes to their maximum capacity. This effort has met resistance from commercial pilot organizations who cite safety concerns.

Delay Issues

An increase in passenger air travel, regional jets holding fewer passengers, and fewer air traffic controllers are some of the aggravating factors that contribute to flight delays. The current state of the National Aviation System (NAS), which include airports and the air traffic control centers, is a contributing factor to system-wide delays. The Department of Transportation indicates that 32% of all flight delays are caused by the NAS (Schmidt, 2007). But a significant reason for flight delays is congestion or breakdowns within the NAS, which includes airports and the ATC centers.

The team collected data addressing reasons for gate-to-gate delays. Several of the reasons for the delays can be addressed and corrected by revising procedures, while others need to be resolved with the help of the FAA and the airlines.

America's Most Time-Draining Airports Ranks

Rank	Airport	Security	Late Aircraft	National Aviation System	Cancellation	Carrier	Weather	Final Rank
10	Minneapolis/St. Paul, Minn.: Minneapolis St. Paul International	89	86	91	91	93	94	91
9	Atlanta, Ga.: Hartsfield-Jackson	94	98	98	98	100	100	92
8	Philadelphia, Pa.: Philadelphia International	74	82	93	83	79	88	93
7	Boston, Mass.: Logan International	77	87	90	94	87	93	94
6	San Francisco, Calif.: San Francisco International	90	89	94	85	91	81	95
5	Dallas/Ft. Worth, Texas: Dallas/Ft. Worth International	88	99	95	99	98	99	96
4	New York, N.Y.: La Guardia	52	81	97	97	82	92	97
3	New York, N.Y.: Kennedy International	84	90	96	0	88	91	98
2	2. Newark, N.J.: Newark Liberty International	86	94	99	96	78	90	99
1	Chicago, Ill.: O'Hare	96	100	100	100	99	97	100
	Total Points	830	906	953	843	895	925	

Figure 2. Data retrieved from “America's Most Time-Draining Airports. Ruiz, R. (2008, June 3). Forbes.com.

The data above was collect from an article, “America’s Most Time-Draining Airports” which indicates which ten airports are considered to be the most time-draining. O'Hare International Airport is considered the nation's worst airport for delays, according to the 2007 Bureau of Transportation of the statistics for 100 of the largest airports.” (Ruiz, 2008). Above is the chart which ranked each airport by most delays. The primary reasons for all delays were placed squarely on the NAS. Upon calculating the data, the team focused on the top three issues for delays. The NAS, weather and late aircraft are areas that can only be addressed by the FAA, because these issues are caused by the congestions in the skies. The team also noticed that these issues affect both flight delays and fuel consumption. So, as we find a solution for gate-to-gate delays, we can also resolve the issue for minimizing fuel consumption.

The FAA and the Airline Industry have many tools available that assist the commercial airlines with flight delays. These systems are short term solutions for a long term problem. Switching to NextGen would allow our country to use satellites and GPS, which in return triples air traffic capacity.

Summary of Literature Review

Fuel Consumption

The Airspace Flow Program (AFP) focuses on flights that encounter weather delays. It decreases flight delays and gives airline the choice of accepting delay flights, scheduling aircraft to fly through a storm, or increasing flight routes by flying around storms. (Access Intelligence, LLC, 2007)

Minimize Gate-to-Gate Time

An increase in passengers, regional jets holding fewer passengers, fewer air traffic controllers are a few factors that contribute to flight delays. The primary issues for congestion or breakdowns are due to the NAS, which include airports and the air traffic control centers. According to the Department of Transportation, 32% of all flight delays are caused by NAS (Schmidt, 2007).

During 2006, Alaska Airlines rescued approximately 1000 flights from weather delays by using NextGen. This FAA pilot program minimizes delays, cancellations and diversions. In return, this has added millions of dollars to the airline's financial bottom line. NextGen can completely change the nation's outdated ATC system from ground-based radar to space-based

GPS. The current radar system cannot handle the projected traffic demands the United States expects by 2015 (Peterson, 2007).

The AFP adds real-time flight and weather data from multiple sources and equitable management of air traffic in congested airspace. (Volpe National Transporation Systems Center , 2006).

<u>NextGen</u>

The FAA released a Progress Report Fact Sheet in October 2007 summarizing necessary actions needed to make the transition to NextGen via planning, technology, and cost as the aviation industry is projected to double and possibly triple within the next eighteen years (Fact Sheet, 2007).

Honeywell released a cover story "Unlocking the Potential of Required Navigation Performance (RNP)". This article defines RNP, addresses the benefits of the aircraft equipment, procedures, and operational approvals, as well as the key to the future of RNP (Honeywell, 2007).

The article address the Approximate Economic and Employment Impacts for NextGen. It is estimated that an infusion of $4 billion in funding for NextGen would create 77,000 jobs. The method referenced is a multiplier system developed by the FAA, based on Bureau of Labor Statistics figures, which estimates the number of jobs that would be created for each $1 million invested in NextGen (Air Transport Association of America, Inc, 2008).

NextGen addresses real-time weather hazards. It is unknown at this time specifically which software program will be used. Honeywell has developed IntuVue which provides pilots with 3-D weather technology capable of providing alerts regarding wind shears, turbulence, and hazardous storms (ThomasNet, 2009).

The article addressed the airports with the most delays. The article was converted into a spreadsheet to allow the team to demonstrate the different types of delays an airport may experience (Ruiz, 2008).

The Boeing website provided the team with insight on the technical aspects for the Boeing 737-700 ER. This information provided us with a general understanding of the fuel capacity for an aircraft (Boeing, 2009).

Without NextGen there will be gridlock in the skies. By 2022, it is estimated that this failure would cost the U.S. economy $22 billion annually in lost economic activity. That number grows to over $40 billion by 2033 if action is not taken. The FAA reports that without some of the initial elements of NextGen simulations show that as early as 2015 delays will be far greater than what we are seeing today. (Business to Business Travel Websites Group, 2009)

FAA released an update to its NextGen Implementation Plan on January 30, 2009. With its internal NextGen planning well defined, the agency will now focus on developing parallel commitments with the aviation community, particularly on avionics equipage. (FAA, 2009)

Safety

The Safety Management System (SMS) Manual provides safety policies, risk management, safety assurances, and safety promotion for a more secure and safe NAS. The manual assists in the coordination between ATC and stakeholders' regarding the safety challenges (SMS, 2008).

In February 2007, the U.S. Department of Transportation released a memo in the form of a report regarding the Joint Planning and Development Office (JPDO) taking needed actions to reduce risks associated with NextGen by identifying areas of concern, the findings, as well as specifying the recommendations (Dobbs, 2007).

The Advisory Circular 150/5200-37 was initiated on February 28, 2007 as an Introduction to SMS for Airport Operators. This circular promotes the balance of safety and production to assist airport staff to identify, detect, and correct incidents or accidents (Advisory Circular 150/5200-37, 2007).

This article addresses the current NAS, the need for change, and the solution for aviation to continue with the safest form of transportation while briefly stating how we get to NextGen now (NASA, 2009).

Approach to the Design Challenge

Upon the selection of the challenge, team members began a multi-step process which included research of the problem of how to reduce fuel consumption and delays, identification of possible solutions, and the development of a consensus on a possible solution. We found that each of the steps significantly overlapped each other during the development of the paper. Not surprisingly, the research often caused the team to revisit assumptions and solutions not anticipated when we first selected the challenge. For example, while we were attracted to NextGen as a solution relatively early during the process; we were surprised to find that the implementation of a solution with such far-reaching benefits could be delayed for other reasons than technology.

Design Process

The team took a thorough look at systems currently being used by the United States airline industry. The AFP, NextGen and Aerobahn Service are a few of the systems will address as a team. These systems aid in conserving fuel and minimizing delays and are currently being used by the FAA.

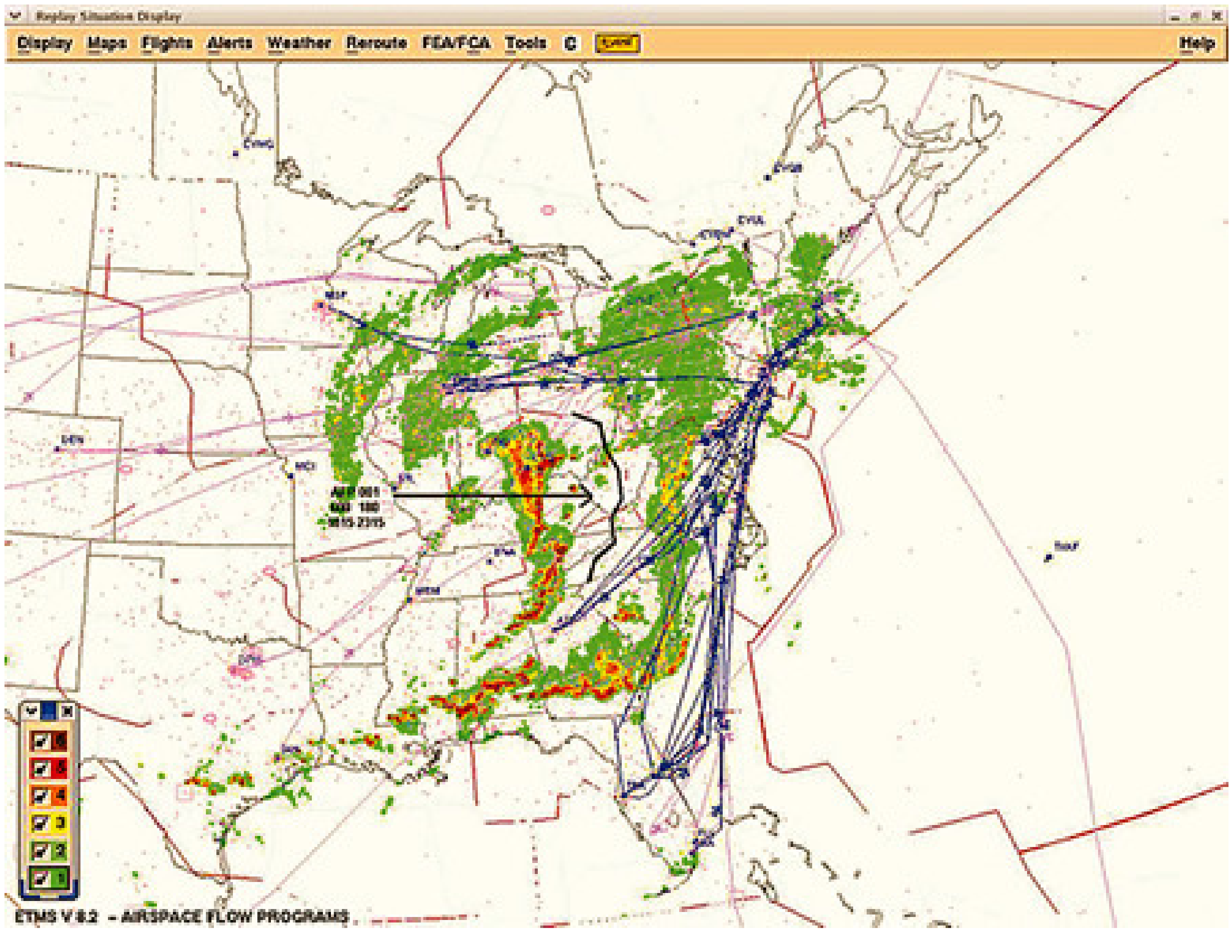


Figure 3. A screenshot of the Airspace Flow Program in use. Volpe National Transporation Systems Center . (2006, September/October). Volpe Journal. Retrieved February 5, 2009, from Research and InnovativeTechnology Administration (RITA).

The above picture is a screenshot of the AFP in use. This program focuses on flights which are affected by bad weather and decreases flight delays for aircraft. It provides airline companies with options of accepting delay flights, scheduling aircraft to fly through a storm, or increasing flight routes by flying around storms. AFP was tested in 2006 at seven locations in the Northeast and flight delays decreased by 9% compared to 2005. The program generated approximately $100 million in annual savings. (Access Intelligence, LLC., 2007)

The Enhanced Traffic Management System (ETMS) is a mission-essential system used by FAA to support its Traffic Flow Management mission and increase air system capacity. The AFP integrates real-time flight and weather data from multiple sources, presenting information graphically in a highly adaptable format, enabling more efficient, predictable, and equitable management of air traffic in congested airspace (Volpe National Transporation Systems Center , 2006).

Figure 4. This 68-minute US Airways Flight 2046 (yellow) uses about 275 gal. of fuel to fly 585 miles from Washington, D.C., to Boston, Mass. The same flight under NextGen (blue) would save 23 minutes, 91 gal. and 185 miles. (Illustration by Golden Section Graphics) Peterson, B. S. (2007, August). End of Flight Delays? FAA's GPS Fix Could Bust Sky Gridlock. Retrieved February 5, 2009, from Hearst Communications, Inc.

The next system the team reviewed was the NextGen, which is an umbrella term for the current, wide-ranging transformation of the United States' NAS. It represents progress from a ground-based system of air traffic control to an innovative satellite-based system of air traffic management. NextGen will not replace the United States radar system, it will provide an alternative. The system allows aircraft to use a different flight path, which would free up some of the congestion currently caused by our radar system. Aircraft using NextGen will fly at a lower elevation which would be monitored by a GPS based solution.

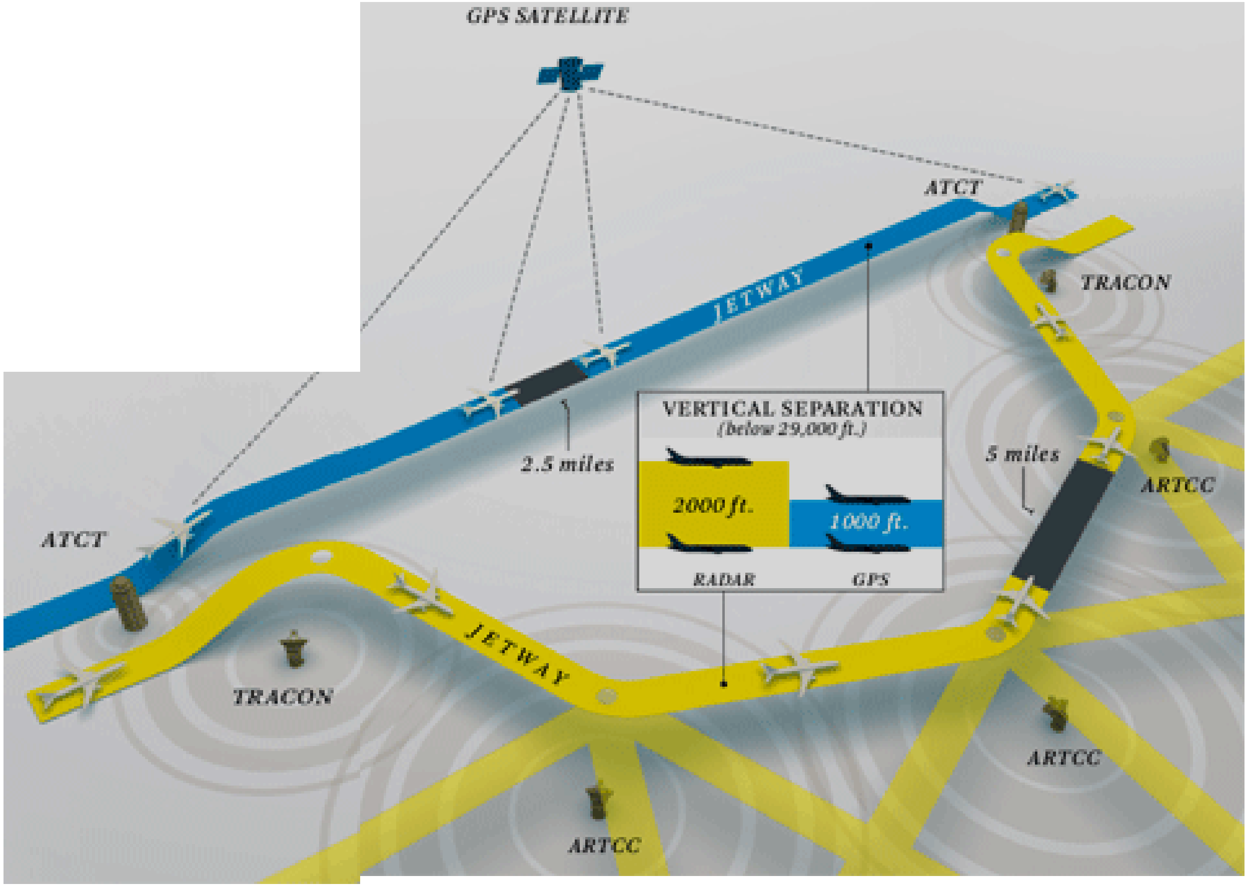


Figure 5. The picture shows how NextGen will provide pilots and ground control crews with identical real-time displays of aircraft positions, enabling pilots to reduce congestion by choosing more efficient routes and separation distances. Peterson, B. S. (2007, August). End of Flight Delays? FAA's GPS Fix Could Bust Sky Gridlock. Retrieved February 5, 2009, from Hearst Communications, Inc.

The third system reviewed by our team was the Aerobahn Service which was developed by the Sensis Corporation. The Defense and Security Systems, which is primarly used by the military, increases strategic capablities. This is accomplished by using the advanced radar detection and surveillance intergration.This system currently provides Continental Airlines (Continental) with real-time situational awareness into their hub operation at George Bush Intercontinental. Continental is also subscribing to use this system at Newark Liberty International Airport" (Access Intelligence, LLC., 2008). This technology provides the precise location of the aircraft while it is on the tarmac. The aircraft can be seen from three miles out, while landing, exiting the runway, as well as the path to the gate. This system helps eliminate burning excess fuel, long delays, and waiting for available gates.

Technical Aspects

Components of the NextGen system include:

- ADS-B
- Area Navigation (RNAV)
- RNP
- EGPWS
- TCAS

ADS-B is the single most critical component for the advancement of the next generation transportation system. All other components of NextGen integrate with ADS-B to enhance awareness and safety. Using satellite and additional technologies, ADS-B enables an aircraft to constantly broadcast its current position simultaneously to air traffic controllers and other aircraft.

RNAV was originally developed in the 1960s as a navigational aid that used ground-based beacons to guide an aircraft. Today, the system has been supplemented with the use of GPS satellites. The system allows more access and flexibility for point-to-point operations.

RNP, as defined by the International Civil Aviation Organization (ICAO) is a “statement of the navigation performance necessary for operation within a defined airspace.” RNP was developed from RNAV technology to enable closer en route spacing without intervention by air traffic control and permits consistent departures and arrivals.

The enhanced EGPWS uses GPS technology to give the pilot an accurate picture of his altitude in time to avoid a collision with the ground. This is a vast improvement of the former radar-based system which was less reliable. To date there is no record of an airplane equipped with EGPWS ever having suffered what the FAA calls a controlled flight into terrain accident (CFIT).

TCAS integrates with ADS-B to communicate information with other aircraft such as identity, location, and velocity. The system warns the pilot if an avoidance maneuver is required to avoid a collision.

Safety Risk Assessment

In less than 100 years, aviation has evolved from pilots flying by the seat of their pants to becoming a complex integrated system, which unfortunately does not allow for an exchange of seamless information [between airplanes and air traffic controllers] at this time (NASA, 2009). Between 2007 and 2025, the number of passengers traveling through the air is expected to increase two billion passengers (Fact Sheet, 2007) while potentially causing a loss of productivity, more expensive fares, and higher operational costs resulting in an annual cost of billions of dollars to the United States (NASA, 2009). The current radar system along with human limitations will not support these growing numbers (Fact Sheet, 2007) and cause serious limitations to capacity and flexibility in operations. The flight environment also provides a risk to the industry due to uncertain conditions at any given time from weather, performance of the aircraft, any policy changes (NASA, 2009).

Due to the expected growth in airline transportation, the FAA has introduced a new document for airport operators. Advisory Circular AC 150/5200-37 refers to another publication, Safety Risk Management (SRM) that is a component of the Advisory Circular. The Safety Management System (SMS) provides international airports within member States a safety program offering a proactive and well-defined policy that has formal procedures for risk analysis and assessment. Before a safety risk occurs, SMS will allow airport operators to detect and correct any possible incidents (Advisory Circular 150/5200-37, 2007).

The FAA will reduce risk with the transition to NextGen, as well as improve coordination between the participants of JPDO has identified a number of issues. Actions to reduce the safety risks are first, developing a roadmap for the industry. The roadmap would indicate aircraft maintenance scheduling and required equipage in specific time increments. Second, there is not an alignment of planning even though the participating agencies are coordinating amongst each other. Third, the FAA and JPDO need to consider potential conflicts between the new technology and the past modernization efforts as well as what special skills will be needed. Lastly, although NextGen operates on technology, people will still be needed to ensure responsibilities are safely accommodated by pilots and controllers. The pilot will assume more responsibility from this new automation. Studies and analyses are recommended to ensure the safety of the changes (Dobbs, 2007).

Addressing the known issues that exist are currently being reviewed, documented, and in some cases are already being enforced such as the SMS manual provides the roadmap for the Air Traffic Organization (ATO) staff with the necessary safety information needed for daily activities. This manual continues to evolve due to advances made in the industry; the overall goal is for the document to provide a proactive approach to system safety under a formalized process (SMS, 2008).

In a report to the FAA dated February 12, 2007 from the U.S. Department of Transportation, some key areas of research were mentioned, one of which is automation improvements to allow flawless performance with routine separation and managed traffic flow. Another area of research needed is weather integration into automation, which provides up-to-date weather information to identify hazardous conditions (Dobbs, 2007). Honeywell has developed the RNP, which is a satellite based system that allows aircraft to fly in smaller corridors along predetermined custom flight paths and can avoid hazardous terrain areas, restricted areas, and heavily populated areas (Honeywell, 2007).

The ADS-B is the backbone of NextGen while providing satellite-based technology that broadcasts an aircraft's identification as well as speed and position updates each second (Fact Sheet, 2007). Honeywell as also developed 3-D Weather software called IntuVue that is designed to assist pilots to avoid weather delays and turbulence. It is currently unknown if this particular software will be a part of the NextGen project (ThomasNet, 2009). To address coordinating concerns, Congress in Vision 100 – Century of Aviation Reauthorization Act mandated the JPDO, a private/public partnership. The JPDO has been tasked with planning and implementing NextGen by using three documents as guides. They are ConOps, Enterprise Architecture, and Integrated Work Plan (Fact Sheet, 2007). The JPDO will develop a system that will handle three times the current air traffic while decreasing the FAA operating costs (Dobbs, 2007).

On January 27, 2004, Norman Y. Mineta, then-Department of Transportation Secretary, stated, "the changes that are coming are too big, too fundamental for incremental adaptations of the infrastructure…we need to modernize and transform our air transportation system – starting right now" (NASA, 2009). The Department of Transportation also expressed their view that NextGen needs to begin implementation and not just research (Dobbs, 2007).

The Advisory Circular, dated February 28, 2007 indicated the FAA is instituting a new SMS that will provide international airports within member States with a safety program offering a proactive and well-defined policy that has formal procedures for analysis and assessment.

Before a safety risk occurs, SMS will allow airport operators to detect and correct any possible incidents (Advisory Circular 150/5200-37, 2007).

Currently, there are steps being taken to provide pilots with data indicating a warning within seconds while on the runway through using Airport Surface-Movement Detection Equipment Model X (ASDE-X) (Honeywell, March 2007.)

The NextGen system will allow pilots to navigate throughout the sky. Pilots will be able to use one of two flight sources. Pilots using the NextGen system will fly at a higher elevation and will not need to remain on a set route. The pilots choosing to remain on the radar system will fly on a predetermined route, which sometimes causes delays and often keeps the aircraft in the skies longer. This would be similar to the freeway during rush hour. There are times when it is easier to take alternate routes to eliminate drive time and distances.

The stepping up of global distribution and delivery systems has strengthened issues, problems and risk that are, under the current system, either unmanaged or unmanageable. Our current response cannot deal effectively with problems originating beyond our own country's borders or with a scale and complexity that no country can manage on its own.

We are all now living in a world of accelerating but unmanaged global risk. This GPS system provides a fresh and creative look at risk within the Airline Industry and its impact on some of the most critical challenges of our time. NextGen presents a practical solution that can truly make this a better world for the next generation.

"The United States is currently enjoying the safest period in the history of aviation. NextGen will play a critical role in ensuring that statement remains true well into the next century. As the number of aircraft flying in the NAS continues to grow, and new types of aircraft are introduced, it will be critically important for operators and controllers not only to know precisely where an aircraft is at any given moment, but also where it's going, how fast it's moving, and how long it's going to take to reach its destination. NextGen satellite technologies will dynamically make this information available to both pilots and controllers, with levels of accuracy and precision unattainable by radar. Even though planes will be flying more closely together, the precise information provided by NextGen will significantly increase safety by allowing pilots to know exactly where their aircraft is located in relation to other aircraft throughout all phases of flight" (FAA, 2007).

Interactions with Airport Operations and Industry Experts

A priority for our team was to converse with an industry expert who had direct experience utilizing NextGen technology. To that end we sought-out, and were able to speak with an air traffic controller who has hands-on experience with NextGen.

Before the interview, our team developed a list of open-ended questions that were designed to allow the interviewee to draw from his experiences. Follow-up questions would be asked as appropriate to clarify the interviewee's response.

On February 25, 2009 team leader Robert Hawes conducted an interview with William Gamble, an Air Traffic Controller at Ted Stevens Anchorage International Airport in Anchorage, Alaska to gather an Air Traffic Controller's perspective on the matter.

Mr. Gamble is uniquely qualified to talk about the NextGen system as Alaska is the most comprehensive test-bed for the new technology in action. In addition, his 29 years on the job provided a well-seasoned perspective on NextGen and issues related to its use and implementation.

To begin the interview, Mr. Gamble was asked to respond to the team's general question of how to reduce fuel consumption. Mr. Gamble's first response was to tout the reduced travel times experienced by commercial aircraft participating in the NextGen pilot program.

Mr. Gamble expressed his approval for two of the NextGen technologies—ADS-B, and TCAS. He cited numerous instances when ADS-B prevented flight delays and rerouting due to weather conditions that could not have been safely avoided with the old radar-based technology. He appreciated the additional confidence he and the other controllers had when controlling planes equipped with TCAS.

When asked if a partial implementation using parts of the NextGen package was feasible, he said “absolutely!”

However, Mr. Gamble’s praise of the new technology was tempered by what he perceived to be issues that are delaying the timely implementation of the most effective product possible.

The main issue is that the FAA has not sufficiently integrating air traffic controllers into the design process. While emphasizing that safety is the most important concern for both sides, he described a contentious relationship between the National Air Traffic Controllers Association (NATCA) and FAA management that is dysfunctional neither to the point where input is not asked nor, in some cases, volunteered.

After reviewing articles published on-line from NATCA officials, the team concluded that Mr. Gamble’s assessment of the relationship between the FAA, the air traffic controllers, and NextGen is generally consistent.

Projected Impacts of the Design and Findings

<u>Practicality and Feasiblity</u>

After reviewing the different types of systems currently being used by the airline industry, the team felt that NextGen would be part of the solution for our challenge. This system would address both areas of the design challenge, which is to minimize gate-to-gate times and fuel consumption. NextGen is currently being used as a pilot program throughout the state of Alaska. The team would like to offer a to the entire airline industry in the United States.

NextGen seeks to improve aviation industry efficiency from the engine to the cockpit to overall air traffic management (FBO 2008). Both the business community and leisure travelers are dependent on a transportation system that is safe and efficient. NextGen promises to deliver that in the following ways:

- Use of trajectory based operations which allow pilots to pick the most efficient route, rather than relying on direction from the current ATC system that often requires pilots to take circuitous routes to their destination.
- Collaborative air traffic management by increasing the pilot's control
- Reducing, and reduced travel delays resulting from weather by expanding the pilot's options to avoid bad weather.
- NextGen will reduce the consumption of fuel and the wireless network component will allow for the transmission of real-time information by accessing the air traffic control system. The system also addresses both of the issues for this challenge.

The collateral benefits of NextGen include:

- Reduced delays and system gridlock
- Integration of weather information into decision support tools to reduce weather-related delays
- Reduced adverse impacts to environment
- Reduced fuel consumption

- Precise trajectory-based operations
- Network-enabled real-time information access by ATC and system users

Research conducted by the FAA estimates that without NextGen there will be gridlock in the skies. By 2022, and it is estimated that this failure would cost the U.S. economy $22 billion annually in lost economic activity. By 2033, that number is expected to grow to over $40 billion, if action isn't taken. It is reported that without some of the initial elements of NextGen transformation, by as early as 2015, delays will be far greater than what we are seeing today (FAA 2009). "The implementation of NextGen is vital to the future of the airline industry and the business travel community" says, The National Business Travel Association (NBTA) Executive Director & COO, Bill Connors (Business to Business Travel Websites Group, 2009).

The good news is that commercial air passengers can enjoy these benefits, sooner than the full implementation projected to occur in 2025. Perhaps the biggest surprise discovered by the team while studying the problem is that, in large, technological aspects of the system has already been resolved.

The most expensive component is the 26 GPS satellites already in orbit. Competition among manufacturers and technical advancement is driving the cost of equipping individual airliners to the point where the costs of retrofitting aircrafts and equipping new aircraft is no longer prohibitive.

Now is the Time

The benefits of the NextGen system align almost perfectly with the stated goals of the new administration. Among these are: the concept of reviving the economy through federal stimulus dollars, support of green technologies/conservation, and reducing independence on foreign oil.

Finally, the timing may never be better. The Alaska experiment has shown that a viable system can be accomplished with minimal expense and effort and that the system does not require an "all-on" approach; the GPS based NextGen system operates relatively seamlessly with the older ground-based radar system.

Since design of the physical system is already well under way, the question of "when" has already been answered. However, the team now had to focus attention toward the design of a much more complex system—an implementation process. The team agreed that five main issues have to be resolved before a system-wide, expedited implementation can be achieved:

1. How to implement
2. How to pay for it
3. Reversing the contentious relationship among stakeholders
4. Obtaining leadership from the FAA
5. Encouraging innovative thinking to overcome roadblocks

How to Implement

For this answer we again turn to the Alaska pilot program where selected technologies have already been successfully applied. The same selective approach can be applied, locally or regionally. Since radar and NextGen technologies are not mutually exclusive, planes that are equipped with NextGen technology packages can be flown in parts of the country that are not yet participating in the new technology. The approach of letting both technologies coexist could lead to consumer-driven demand as passengers begin to realize benefits from flights equipped with the newer technology. As more of the technologies come online, they can be installed without taking entire fleets out of service. Furthermore, costs will be distributed over time.

How to Pay

It has been estimated that the total implementation cost of NextGen is $40 billion. $20 billion for FAA program development, research and development, deployment and technology acquisition, the other $20 billion for operators for avionics equipment, training and related costs (Air Transport Association of America, Inc, 2008).

In order for NextGen to be successful in delivering the desired the NAS performance improvements, it will require investment by both the government and the private sector (FAA, 2009). The NBTA and 10 other organizations from the commercial and general aviation communities submitted a letter to Congress requesting $4 billion of the $20 billion in total required equipment costs to accelerate the program and its benefits (Approximately 20,000 aircraft can be equipped with this investment).

"The purpose of this stimulus package should be to stimulate our economy and get business moving. Adding funding for NextGen projects does just that!" Bill Connor stated in the letter. This request was made on behalf of the commercial and general aviation communities. Organizations that joined the NBTA in this request include Aerospace Industries Association, Air Carrier Association of America, Air Line Pilots Association, International Air Transport Association, Aircraft Owners and Pilots Association, Cargo Airline Association, General Aviation Manufacturers Association, National Air Carrier Association, National Air Transport Association, National Business Aviation Association, and Regional Airline Association. This $4 billion investment is largely in the area of avionics technology, operational procedures, and flight planning processes.

Components of Request

Total Request - $4.048 billion

1. ADS-B ($2.2 billion)
2. RNP Equipage ($500 million)
3. FAA RNAV/RNP Procedure Development ($20 million)
4. FAA LPV Procedures Development ($500 million)
5. Electronic Display Upgrades (including EFBs), ($458 million)
6. GBAS (370 million)

An infusion of stimulus funding would significantly jumpstart the NextGen process, advancing the schedule and resulting in an array of positive economic and employment impacts. It is estimated that NextGen will generate 77,000 jobs. The Bureau of Labor statistics created a figure reflecting the number of jobs created for each $1 million invested in NextGen (Airlines 2009).

Recently, NextGen proponents were disappointed to learn that, of the hundreds of billions allocated in the stimulus package, only $150 million was allocated for NextGen research.

Incentives or funding to support avionics implementation would accelerate many of the economic and environmental benefits. Next Generation air taxi operators plan to provide their pilots with high pay and good quality of life benefits because they view finding and retaining qualified pilots as one of their greatest challenges (VLJ Magazine).

- Aircraft Equipment: 24 jobs per million invested
- Construction: 21 jobs per million invested
- Research & Development: ranges from 32-36 jobs per million invested.

While the government and the FAA continue to fund NextGen in a piecemeal fashion, an expedited solution can still be achieved if airlines and the passengers agree to share the cost.

One possible scenario is demonstrated below. While the airline pays the up-front costs of purchasing the equipment for their planes, the costs are spread among the passengers. Ultimately, the passengers still win by reaping the advantages of faster travel, more consistent flights, and less fuel computed into their ticket price. Attached below is a copy of a Southwest Itinerary. The cost associated with the airline ticket is provided on the attached ticket.

Southwest Airlines Air Itinerary and Pricing

Pricing									
Passenger Type	**Trip**	**Routing**	**Type of Fare**	**Base Fare**	**U.S. Taxes**	**PFC**	**Security Fee1**	**Passenger(s)**	**Total**
Adult	**Depart**	ALB-BWI-ABQ	Anytime	$361.86	$34.34	$7.50	$5.00	1	$408.70
	Return	ABQ-BWI-ALB	Anytime	$361.86	$34.34	$7.50	$5.00	1	$408.70
			Total	**$723.72**	**$68.68**	**$15.00**	**$10.00**		**$817.40**

1 Security Fee is the government-imposed September 11th Security Fee.

Figure 6. Illustration of the cost associated with a Southwest Ticket. Southwest Airlines Air Itinerary and Pricing Airline.

As illustrated above, the team would like to point out how the price of the ticket increases approximately $90, due to taxes, Passenger Facility Charges (PFCs) and security fee. The customer pays 11.46% in additional fees with the purchase of their airline tickets. Since complete implementation of NextGen would be done in stages, the costs could be spread out over years, thus limiting the impact to both air carriers and passengers.

The other alternative would be for the FAA would apply a small fee to airline tickets that would cover the expenses involved with NextGen. The $40 million price tag for NextGen could be spread among the 2.75 billion passengers that are projected to be flying by 2011 according to the International Air Transport Association (IATA). A three dollar fee added to each airline ticket would collect approximately $8.25 million annually.

In either scenario, of course, the passenger ends up paying.

Turning Contention into Collaboration and FAA Leadership

The many stakeholders impacted by the NextGen project all have different views, goals, and concerns. The FAA, airports, air traffic controllers, airlines, and technology providers must agree that a successful application of the new technology is necessary for the entire industry to survive in a recognizable form.

However, the kinds of realizations that result in the bold action needed rarely come from within. The problem is that no one wants to be the first to commit. The result is the stalemate we have seen to date.

Over time, a solution could be reached amongst the players that could result in a viable solution. However, the possibility exists that a negotiated solution could take too long which could lead to an arbitrary decision by an outside force that would, most likely, be less than optimal. In addition, evidence has shown that in this case, the price of waiting for things to work out is just too high.

NextGen needs a champion. Unfortunately, the FAA has not had a permanent director in years. The acting directors have acted in more of a "caretaker" role and less of an "innovator" role. The ideal candidate will have the vision to see the benefits of implementing the NextGen solution sooner, rather than later. He will have the clout to raise the necessary research and development capitol to perfect a system-wide implementation solution. He/she will also have the strength to make the remaining tough decisions about who shares the expense burden, who will manufacture the components, and what role the air traffic controllers will perform.

Innovative Thinking

Historically, technological progress has been accomplished by first identifying a problem, then developing the technology to solve the problem. For example, when man wanted to go to the moon he developed powerful rockets, life support systems, and rudimentary computers to get him there and back. These new technologies sparked competition for lucrative contract awards and esteem. Collaboration happened when teams lacked certain resources or knowledge that could be gained by strategically partnering with a team of complementary skills or resources. Breakthroughs led to patents that could sustain a company for years.

Here we have a case where the technology existed before there was a perceived problem in air space capacity and fuel usage. In effect, the two sides of the equation are reversed. Since any foreseeable solution requires building upon technology that already exists, none of the above incentives would seem to apply. The relative lack of reward leads to a situation where stakeholders have overwhelming disincentives to solve the problem.

For example, a manufacturer for a key component of the NextGen system is competing for a contract to retrofit airliners where cost is the ultimate decider. Does the manufacturer put the top minds on shaving incremental expenses from the system? Or are the resources more wisely allocated towards developing new technologies that could result in more patents for the company? What we are talking about is an evolution in thinking. The real innovation will happen when we learn to adjust our thinking to apply the resources we already have.

The Driving Force

The recent appointments of NextGen supporters Ray LaHood as Secretary of Transportation and J. Randolph Babbitt as FAA Administrator are steps in the right direction. Babbitt, a former president of the Air Line Pilots Association is seen as someone who can reduce the animosity between the ATC and FAA which would be a first step into securing a partnership for the development of the ultimate implementation of NextGen. The mere presence of a permanent director should provide Congress with the confidence that funding for NextGen is a prudent use of taxpayer dollars. But, the appointments will not provide the kind of driving force needed to expedite implementation of system components that are ready, such as ADS-B.

The remaining question is: Where will the motivation come that will put NextGen on the fast-track?

Since history has shown we can expect only lukewarm support for the project from the government and the airline industry, the only remaining solution is to bring the case for NextGen to the people.

For centuries businesses have been driving demand by advertising the benefits of their products. While the significant benefits that can be achieved with a "NextGen Now" approach can sell themselves, a concerted effort must be made to introduce the product to the market. Once demand is sparked among their constituents, lawmakers will have no choice but to allocate enough spending to support early implementation of "ready for market" components and for speedier development of other planned system enhancements.

There are many substantive selling points that will motivate the public to support the project. Certainly, businesses have reaped tremendous profits from selling products that have only a marginal positive impact on the life of the buyer. An effective marketing plan for NextGen should include the elements:

Step 1: Form partnerships. To obtain maximum impact, the advertising campaign must have support from all stakeholders, including: air traffic controllers, airlines, the FAA, airports, and system developers. Universal buy-in will ensure advertising dollars will be focused on a single, clear message: “NextGen Now.” Furthermore, the “everyone onboard” approach will preclude the proliferation of rival messages from disenfranchised groups and other distractions like NASA is experiencing in their development of a new rocket to replace the space shuttle.

In practice, this means the FAA must make peace with the air traffic controllers and bring them on board with the NextGen design process. Our research has shown that air traffic controllers are in support of the NextGen project, but the NATCA will not make a stand in favor of the project unless they are included in the design process. This proactive approach would not only mitigate possible dissention among one the major stakeholders, it increases the options for effective advertising by allowing the possibility of testimonial support from the government employees most directly charged with the safety of the flying public.

Additionally, the airlines must be included. To date, the airlines have been willing partners in the development process, but their commitment must be utilized in the advertising campaign for several reasons:

First, they will share most of the burden of paying for the advertising in order to simplify the process. The FAA must be careful to sell the system without showing support for an individual airline or group of airlines. An equitable distribution process for government advertising dollars could be produced, but cause delays, which is the very issue we are attempting to overcome. The best way to avoid this pitfall is to have the airlines pay for the advertising.

Secondly, the NextGen message should be focused on the flying public. The airlines interface with passengers on a daily basis and are a captive audience throughout the duration of their flights. While no one is suggesting brutalizing passengers with five hours of NextGen ads, the venue of an aircraft in transit is a wholly appropriate setting for the NextGen safety message.

Thirdly, no one has more experience marketing to flyers than the airlines. In addition to in flight advertising, the NextGen message can be included in a small part of their ongoing advertising efforts.

The Air Transport Association (ATA) which includes all the major U.S. carriers as members has already gone on record in support of the ATC modernization process. Support of the advertising campaign is consistent with their stated commitment to the project. Any dissension on the part of an individual airline could leave it open to charges of not supporting safety.

Step 2: Form a marketable entity. The advantage provided by this step is that, correctly done, it would provide a memorable point of reference for the traveler to remember the message.

Step 3: Sell Safety, Safety, Safety. Safety is the number one priority for the flying public. A unified message of safety from all the stakeholders will increase perceptions of safety among air travelers and could lead to more air travel in itself.

However, an additional value of the safety message is that it will serve as a platform to base secondary messages that include: convenience in the form of reduced travel times and care for the environment in the form of reduced fuels.

Care should be taken that the NextGen message is not delivered at the expense of traveler's opinions of the current system. The system must be marketed in the context of a safety enhancement, not as a fix to a broken system.

Step 4: Invite participation. All forms of advertising in the campaign, which can be presented in any of the traditional methods, (television, print, billboards, internet, etc.), should include a way that allows the listener a convenient way to voice their support. In order to extract the most participation from the traveler possible, the call for action should be as simple and direct as possible. Our team recommends use of the internet using a name that is short and to the point such as: NextGenNow.com.

Finally, implementation of this process will be a testimonial to the American public that effective collaboration does happen in the government. The importance of this message cannot be understated in this age of bipartisanship which has contributed to an 18% Congressional approval rating in a May 2008 survey.

Appendix A - List of Contracts

Faculty Advisor

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Appendix B - Description of the University

Embry-Riddle Aeronautical University

Embry-Riddle Aeronautical University is the world's oldest, largest, and most prestigious university specializing in aviation and aerospace. It is the only accredited, aviation-oriented university in the world. Embry-Riddle was founded December 17, 1925, by barnstormer John Paul Riddle and entrepreneur T. Higbee Embry, exactly 22 years after the Wright brothers' historic flight.

Embry-Riddle is an independent, nonsectarian, not-for-profit coeducational university serving culturally diverse students seeking careers in aviation, aerospace, business, engineering, and related fields. Embry-Riddle Aeronautical University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award degrees at the associate, bachelor, and master levels. Combined annual enrollment for all campuses is more than 34,000.

Embry-Riddle has residential campuses in Daytona Beach, Florida, and Prescott, Arizona, as well as a Worldwide Campus dedicated to providing educational opportunities to working adults worldwide. The Worldwide Campus provides educational opportunities to off-campus students at more than 130 centers throughout the United States and Europe. In addition, degree programs can be pursued anywhere in the world through Web-based online learning.

The University offers more than 30 degree programs. These include undergraduate programs in aeronautical science; aerospace engineering; aviation business administration; aviation environmental science; aviation maintenance science; computer science; and more. Graduate programs are offered in aeronautics, aerospace engineering, business administration, human factors and systems, safety science, software engineering, and space science.

Appendix D - Sign-off Form for Faculty Advisor and Department Chair
FAA University Design Competition
Design Proposal Submission Form (Appendix D)

Note: This form should be included as Appendix D in the submitted PDF of the design package. The original with signatures must be sent along with the required print copy of the proposal.

University ____Embry-Riddle Aeronautical University____________________

List other partnering universities if appropriate____________________

Proposal Developed by: ☐ Individual Student ☒ Student Team

If Individual Student

Name ____________________

Permanent Mailing Address ____________________

Permanent Phone Number __________ Email ____________________

If Student Team:

Student Team Lead ___Robert Hawes____________________

Permanent Mailing Address ___City of Phoenix Aviation Dept, Business & Properties Division_____

__3400 East Sky Harbor Boulevard Suite 3300, Phoenix, AZ 85034__________

Permanent Phone Number (602) 683-3732_____ Email _robert.hawes@phoenix.gov__________

Competition Design Challenge Addressed:

__Airport Management & Planning____________________

I certify that I served as the Faculty Advisor for the work presented in this Design Proposal and that the work was done by the student participant(s).

Signed ____________________ *Date*__________

Name _Frank Grabowski____________________
University/College _Embry-Riddle Aeronautical University__________
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Appendix E - Evaluation of the education experience

<u>The Student Team</u>

Did the FAA Airport Design Competition provide a meaningful learning experience for you? Why or why not?

Each team member gained valuable experience while working on this challenge. The competition allowed each members of the team to gain an understanding of the advantages of using their individual skills and strengths to achieve a common goal. We learned the benefit of looking at the proposal from alternative viewpoints. Finally, the team gained a new understanding on the various methods of conserving time and fuel.

What challenges did you and/or your team encounter in undertaking the Competition? How did you overcome them?

The greatest challenges for the team were the time constraints and the lack of knowledge regarding our topic. Due to the timing of the course, we had less than two months to work on developing and finalizing a proposal for this competition. The team overcame the timing obstacle by keeping the lines of communication open and stayed on track by meeting on a weekly basis. These steps assisted the team to remain on task. We divided the competition into sections, and addressed new section of the challenge each week. We minimized the areas of the proposal to fit within the scope as well as the schedule of the competition. The team decided on the competition category on which to work and determine which solution would assist in our proposal.

Yet another challenge faced by the team was the lack of knowledge regarding the technical aspects of the option we chose.

Describe the process you or your team used for developing your hypothesis.

The team reached a consensus on the competition category to pursue, and then decided to focus on the implementation of NextGen as being the solution. Each team member was then assigned a section of the challenge, and would retrieve useful information for the group. The team as a whole reviewed the research results and selected the option least costly to the FAA.

Was participation by industry appropriate, meaningful and useful? Why or why not?

As employees of a municipal commercial airport, the team members had access to many industry experts including other team members from previous classes and coworkers. The team also was able to consult representatives from other airports and get feedback on their thoughts regarding NextGen.

What did you learn? Did this project help you with skills and knowledge you need to be successful for entry in the workforce or to pursue further study? Why or why not?

The team learned a great deal about minimizing gate-to-gate times and reducing fuel consumption. If the FAA continues to use NextGen, we will have a solid basis of understanding of their costs and benefits. We will all be able to contribute what we have learned to future airport projects. In addition, the diversity of the team members taught us much about the dynamics involved in working as a team.

The Faculty

Describe the value of the educational experience for your students participating in this Competition submission.

The competition provided the team a great opportunity to conduct individual as well as collaborative research to solve a challenging issue of importance to the aviation industry. The learning, teamwork and spirit displayed by this student team were outstanding.

Was the learning experience appropriate to the course level or context in which the competition was undertaken?

Yes, the learning experience was beneficial and was appropriate to the course level. The student team was forced to go outside their areas of expertise to research and develop solutions for implementation of an as yet unproven concept.

Was the learning experience appropriate to the course level or context in which the competition was undertaken?

Yes, the learning experience was beneficial and was appropriate to the course level.

What challenges did the students face and overcome?

A number of challenges are discussed by the student team in their submission. I have reviewed them and concur.

Would you use this competition as an educational vehicle in the future? Why?

Yes. Students are required to interact with others from differing backgrounds, career fields, industry experts and complete in-depth research and meet timelines. The competition requires the students to develop a plan of attack, coordinate their efforts and deal with a myriad of variables to offer logical solutions to the problem. The team received the benefits of getting feedback from competitors that had been involved in previous competitions. The insight they provided, helped us to stay on track. We look forward to providing this same benefit to the 2010 FAA Competition competitors.

Are there changes to the Competition that you would suggest for future years?

The team does not have any suggestions for changes.

Appendix F – Reference

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Appendix G – Definitions

ADS-B	Automatic Dependant Surveillance-Broadcast
AFP	Airspace Flow Program (AFP)
ASDE-X	Airport Surface-Movement Detection Equipment Model X
ATA	Air Transport Association
ATC	Air Traffic Control
ATO	Air Traffic Organization
CFIT	Controlled Flight into Terrain Accident
Continental	Continental Airlines
FAA	Federal Aviation Administration
EGPWS	Enhanced Ground Proximity Warning System
ETMS	Enhanced Traffic Management System
GPS	Global Positioning System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
JPDO	Joint Planning and Development Office
NAS	National Aviation System
NATCA	National Air Traffic Controllers Association
NBTA	National Business Travel Association
NextGen	Next Generation of Air Traffic Control
PFCs	Passenger Facility Charges
RNP	Required Navigation Performance
RNAV	Area Navigation
SMS	Safety Management System
TCAS	Traffic Collision Avoidance System