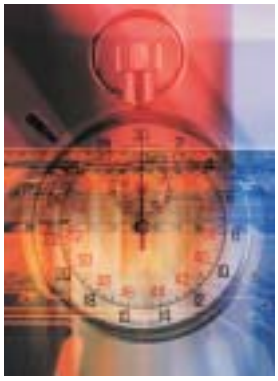
NextGen Now!

How the Digital Age of Aviation Will Unleash Abundance in Our National Airspace System

dayjet

Contents

NextGen is the first major technological transformation of airspace, aircraft and airport management systems in over 50 years, using digital technology to redefine every element of air transport—from communications, surveillance and navigation to air traffic management.



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Welcome to the Digital Age of Aviation

Unleashing Abundance in our National Airspace System

Today's air traffic system has evolved over some 80 years. Given the mix of technology and demands that are made of it by myriad users, its safety and efficiency are remarkable. However, the current system is stressed well beyond its design capacity—as one in three flights persistently encounter delays—costing U.S. passengers an estimated 320 million hours in lost time or $12 billion in 2007.

With passenger demand expected to reach one billion by 2015, we face the inescapable fact of a two- to three-fold increase in air transportation demand by 2025 that simply cannot be accommodated in the existing system. Failure to address the need for expanded capacity in our National Airspace System (NAS) by this time will cost the U.S. economy a minimum of $22 billion annually in lost economic activity.

The solutions to tomorrow's challenges do not merely lie in scaling up the present system by adding controllers, airports and runways. In fact, even doubling the number of controllers, runways at large airports, radars, and control towers will not meet the challenge, much less be affordable.

Some would argue that we have a scarcity of airspace, when in fact, airspace is in abundance. It does not help with our mental models that the morning news depicts airport delays by showing a map of the U.S. with all airborne airplanes covering the country—using aircraft icons that are the size of small states. We need a new mental model for the nation's airspace that is based on the principle of abundance.

The barriers constraining our 20th Century airspace procedures are from *physical* limitations of where we have installed radars, instrument landing systems, radio antennae, and other ground-based communication, navigation, and surveillance infrastructure. As a result, airspace appears scarce, when in fact, if these constraints are lifted, airspace is abundant.

At the very least, we have vast regions of underutilized airspace, airports, and runways, all of which can become accessible in the 21st Century. Embracing the technology advancements of the last two decades allows us to develop new mental models, based on airspace abundance, which guide us toward new solutions. Digital solutions can move us from ground-based constraints to a system-wide abundance of airspace.

To facilitate this transition, several capabilities need to improve: our ability to pinpoint dangerous weather events; our ability to keep aircraft separated with greater precision as traffic increases; our navigation through complex traffic flows and airspace architecture with ever-more accuracy; our navigation and satellite surveillance need to be able to handle additional routes, more traffic, a greater mix of aircraft, and additional destinations; and aviation radios need to carry more data, including weather, sequencing, and traffic information more efficiently.

The good news is that the technology needed is here, and it is broadly scalable and adaptive enough to handle needs for the foreseeable future and likely beyond. We are riding a new wave in technology—ground-based, aircraft-based, and space-based—that will continue to expand in capability at an accelerated pace. These new technologies will bring the digital age to aviation, and with it, a new level of scalability, affordability, robustness, reliability and safety.

"It has been apparent for far too long that to millions of Americans who fly, our domestic air travel system is broken. In 2007 alone, passengers, airlines, and our economy felt a $41 billion punch in the gut from flight delays, and the problem is only going to get worse."

U.S. Senator Charles E. Schumer
Chairman of the Joint Economic Committee (JEC)
"Your Flight Has Been Delayed Again"
May 22, 2008

So, What Is "NextGen?"

The umbrella term for the modernization of the National Airspace System is known as the Next Generation Air Transportation System, or "NextGen." NextGen is the first major technological transformation of airspace, aircraft and airport management systems in over 50 years using digital technology to redefine every element of air transport—from communications, surveillance and navigation to air traffic management.

NextGen will boost the capacity and efficiency of our nation's airspace by shifting from ground-based systems using outdated avionics, navigation and radar systems to digital-based systems located inside the aircraft. Not only will NextGen safely expand the nation's airspace to serve more travelers in more aircraft in more cities over the next decade, it will do so while reducing fuel consumption, carbon emissions, noise footprint and travel time.

By Act of Congress

This term was developed by the U.S. Joint Planning and Development Office (JPDO), chartered in 2003 by Congress to create strategies for the transformation of our nation's airspace to head off the growth of delays in air travel and to increase the effectiveness of air commerce in the interest of our economy and quality of life. The motive driving the JPDO and NextGen is the realization that a two- to three-fold increase in air transportation demand by 2025 simply cannot be accommodated in the existing system.

JPDO has established a vision, concept of operations and work plan for transformation of the U.S. air transportation system through modernization of the NAS. This work is closely coordinated among the departments and agencies responsible for the many moving parts of the U.S. air transportation system including: the National Aeronautics and Space Administration (NASA), Department of Defense (DOD), the Federal Aviation Administration (FAA), Department of Transportation (DOT), Department of Homeland Security (DHS), Department of Commerce (DOC), the National Oceanic and Atmospheric Administration (NOAA), and the White House Office of Science and Technology Policy (OSTP).

Transformational Technologies

NextGen has a number of components, each of which is beneficial alone, but all of which, combined, have synergies much greater than the mere sum of their parts. The NextGen technologies encompass performance-based communication, navigation, surveillance and information management systems. There are other domains affected by NextGen including system safety, security, international harmonization, and environmental footprint. These technologies affect the aircraft, the airspace, the airports and the climate.

The systemic nature of the NextGen challenge is obvious. Less obvious is the fact that all of these changes need to occur in harmony. While NextGen technologies could be implemented in sequence (and some are currently being implemented), the enormous overall benefit of these technologies working as a system will not be realized until the system is working as designed: together, mutually-supportive, and self-reinforcing. The result will be transformational.

The critical factor before us now is the early adoption of the system's initial capabilities, so that technological progress can be accelerated and lead sooner to a system that adapts as the future unfolds. This system concept and its major constituents are explained in this paper.

"Without NextGen, the historic delays that plague us now will soon be known as the good old days."

Marion C. Blakey
Former FAA Administrator
Testimony Before House Committee on Ways and Means
August 1, 2007

An Abbreviated History of Air Traffic Control

ATC (Air Traffic Control) and its tools: communication, navigation and surveillance began as controlling traffic by knowing where any given airplane should be, based on the flight plan, the speed of the airplane and observed winds, and the clock. Later, radar indicated the airplane's position and control was based on knowing where the airplane *is*. The next generation of ATC will be based on knowing where the airplane *will be*. The rest of this story is about Trajectory-based operations, achieved through performance-based ATC, which will smoothly transition from the control tower into the cockpit.

From Ground-Based to Space-Based Navigation

In the earliest days of air travel, pilots followed roads, bonfires, and signal lights while they sought their destinations. As command of time and operating expenses took precedence over the sheer exhilaration of actually accomplishing a flight, more-direct routes were demanded, sometimes above or in the clouds, sometimes at night. Low frequency radio was employed: a radio signal was transmitted from the ground, the navigator tuned to it, and the pilot "flew the beacon" to its origin, switching frequencies to pick up the next radio signal and continuing flight. Thus, early airways were created.

In the 1950s and 60s, Very High Frequency Omni-Directional Radio navigation systems (VORs) were implemented along with gyroscopes for attitude control, allowing pilots to "follow the needle" in the "steam gauge" cockpits of the latter 20th Century. This system and its refinements persisted as the primary means of navigation until quite recently, when GPS (Global Positioning Satellite) technology became the preferred means of pinpointing locations.

Yet we still fly the old airways: eight miles wide and constrained to the geography locked in place by those ancient bonfires. These airways continue to be the conduits of choice for commercial and much, if not most, instrument flight rules (IFR) traffic. We use equipment with better reliability, but our traditional problems remain because we are using outdated operations.

Tale of the Long Tails in Aviation

Many airways will remain popular because they represent the most-traveled routes for the large cities; but non-hub and many community airports get left out of the equation. These suburban, rural and remote airports' capacity for convenience, congestion relief, and added safety is lost in the public debate about fixing the "big" airport system. Think of smaller airports (about 250 surrounding the nation's major metroplex areas, with a potential for about 3,000 more serving the rest of America) as the small towns that were forgotten when the Interstate system bypassed them.

"We're left trying to hold the system together like MacGyver—with duct tape and scissors and string."

"Air Traffic Controller Sounds Alarm"
Time Magazine
April 26, 2008

Life Cycles in Transportation

The patterns in the nation's popular transportation evolution are surprisingly similar, as new technologies (rail, auto, propeller planes and jets) each had gestation periods of early adopters, followed by rapid growth. As the growth phase led to general acceptance, the matured and preferred mode of transport became dominant.

During the mature phases of these patterns, economic considerations and aging technologies led to consolidation for efficiencies that left consumers with fewer choices. These conditions became ripe for development and acceptance of newer, eventually more-popular technology, which more-efficiently transported more people.

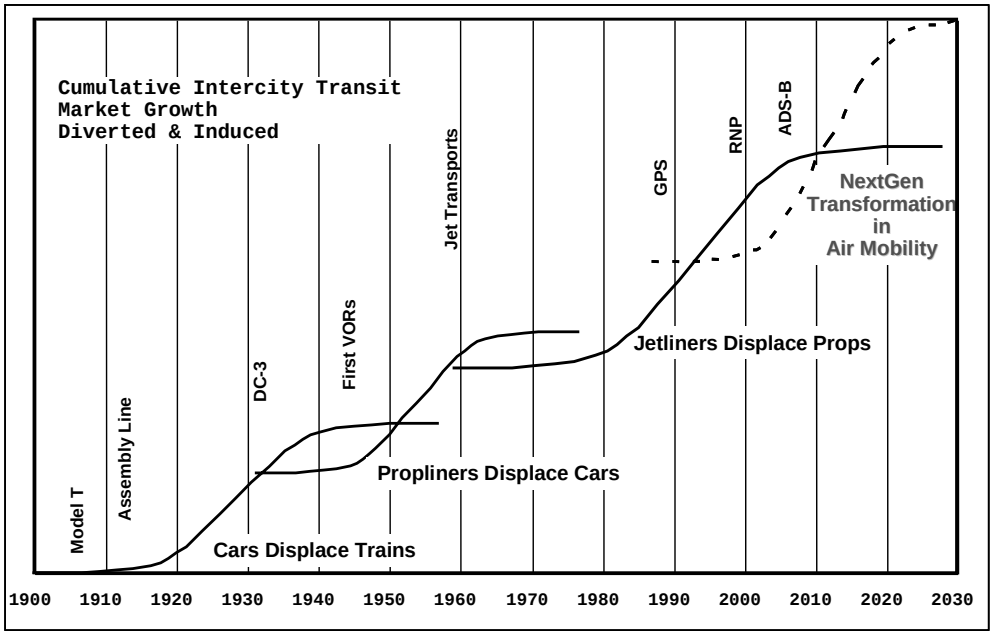
Today's airspace architecture, air traffic control systems, hub-and-spoke business models, and regulatory infrastructure are currently approaching the top of the "S" curve of technological innovation.

For several years, a quiet coalescence of innovation has emerged, affecting new navigation systems, satellite technologies, digital communications abilities, processors and displays, along with the understanding of how to integrate these into a Next Generation Air Transportation System.

On the aircraft-hardware side, engineers and designers, aware of these "futuristic" capabilities, have been building them into the most-modern very light jet (VLJ) packages; and support companies have examined ways to integrate newer technologies into existing aircraft. These technologies and these aircraft exist today. They are faster, safer, and quieter than previous aircraft; and their fuel-efficiency exceeds the passenger-miles-per-gallon rates of automobiles. Many of the smallest aircraft, in fact, deliver 25-30 m.p.g. at well over 100 m.p.h. Clearly, modern aircraft efficiencies point to the sky as an essential arena for efficient transportation in the 21st Century.

"Introducing an innovation such as this—one that would build to demand—must come from a CEO who has used emergent strategy processes to create a new-market disruption in another service business. It will require an outside perspective to enact this type of disruptive innovation in the aviation industry."

Clayton Christensen
Professor, Harvard Business School
"Seeing What's Next," 2004



Today's airspace architecture, air traffic control systems, hub-and-spoke business models, and regulatory infrastructure are currently approaching the top of the "S" curve of technological innovation.

Thinking in 3-D

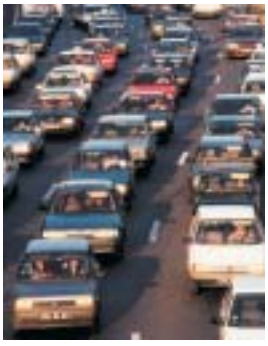
Studies by the nation's transportation research community demonstrate the futility of attempting to build our way out of road congestion. Even so, as urban communities expand geographically, the main focus of public administrators has been on two-dimensional ground transportation.

Unfortunately, in 30 states, over a third of the population faces serious road-congestion problems. In three states, over half the population is threatened by daily gridlock.

Rail has not made progress either; virtually all the nation's High Speed Rail initiatives are at a standstill. As the 21st Century unfolds, we need to be adept at thinking in the third-dimension, 3-D. What about the sky above as an asset of value to meeting our nation's mobility needs?

The Tipping Point

Already-accepted plans for 20th Century airports and airlines, operating under the hub-and-spoke system, concede that six airports and four metroplex areas will need serious additional capacity within the next ten years. "Six airports" doesn't sound like a big problem—until one realizes that 80 percent of today's air traffic uses just 35 airports. "Four cities" doesn't sound alarming, until one realizes that two of these four airports serve New York and Los Angeles, the largest cities in the U.S.



Can't We Just Build Our Way Out?

Equipping an existing airport to accommodate additional traffic, particularly instrument-dependent air traffic, is challenging. Myriad regulations combine with equipage and budgetary factors to preclude immediate inclusion of many otherwise-qualified airports. The geographical demand consideration of "Who needs an airport where no one wants to go?" also plays an obvious part. This is the classic case of 'chicken and egg,' but consider as an example the growth in prominence of Atlanta after the massive expansion of Hartsfield-Jackson.

Further, building an airport is a logistical nightmare. If an airport is to serve a metroplex area, important questions of eminent domain are at the top of the list in addition to acquisition costs and access; new airports are near-impossible to build. [The last major airport constructed in the US was Denver International, over a decade ago.]

Even airport expansion is increasingly difficult, as dwellings and industrial areas are built right up to the fence. Displacing these buildings involves direct costs as well as political costs that few are willing to address; and fewer still are capable of paying the bills. Even with immediate action to build future airports, decades typically pass between concept/agreement and delivery. Solutions are needed now.

"Our nation's air transportation system has become a victim of its own success. We created the most effective, efficient and safest system in the world. But we now face a serious and impending problem... The warning signs are everywhere. Flight delays and cancellations have reached unacceptable levels... If we fail to address issues such as increased capacity in a deliberate and focused way, we will suffocate the great engine of economic growth that civil aviation has become."

Marion C. Blakey
Former FAA Administrator
Testimony Before the Committee on Commerce, Science and Transportation, Subcommittee on Aviation
July 25, 2006

How Crowded is Our Airspace?

In striving to build a realistic model of the National Airspace System (NAS), we measured the corner-to-corner distance from Maine to southern California. Scaling those (everything here is "roughly") 3,300 miles down to the 340-foot corner-to-corner dimension of the in-bounds area of a football field, we can see that a typical airliner would scale out about the same as a poppy seed. A really big airport (like Denver or O'Hare), in this scale, would be about the size of a bagel, and a runway would be just a fat pencil line, accommodating just one landing per minute.

On any normal day during heavy traffic hours, the airspace above the continental U.S. may have as many as 2,000 commercial and 4,000 or so smaller aircraft on IFR flight plans. As "poppy seeds over a football field," their traffic is practically insignificant; but each hour, most of these aircraft will land at just a few airports. [Just 67 airports account for 90 percent of domestic passenger traffic, while almost 80 percent of all U.S. passengers are routed through 35 major hub airports.]

It's easy to see that there is plenty of airspace; the delays we encounter come from the tiny number of airports we use in our hub-and-spoke system. The airspace between those airport-pairs is overused and congested.

We Have Lots of Airports. Why Don't We Use Them?

Though many airports are available, and they are located at the places people want to travel, direct air connectivity is not possible in a hub-and-spoke system. Consequently, over-utilization of hub-and-spoke airports has forced many people to ride airliners to places that are inconvenient for their own travel.

Fortunately, not every airplane needs a big airport. Better yet, efficient new-technology aircraft are starting to carry increasing numbers of travelers efficiently, point-to-point, to small airports that are also better-positioned for the travelers' needs. Compared to shipping two or three hundred travelers to a hub that is not convenient as a final destination, smaller numbers of people can travel to larger numbers of smaller airports, efficiently, in smaller aircraft.

Scalability of economics and performance is vital to any future airspace model. The current hub-and-spoke system is difficult to expand; doubling the capacity of the NAS using the old architecture is both physically and financially impossible, even if the also-impossible scheduling problems could be accommodated. We simply don't have the time, space, or money to continue using the old model.

To avoid this trap, any new system must be (and NextGen is, by its design) easily expanded without linear (or geometric) growth in cost and further encroachment on metropolitan land. The result is the ability to reach virtually every small community in the nation with air mobility through affordable infrastructure and business models.

"Aviation is essential to virtually every industry and it is clearly at a crisis point. Millions of business transactions are made possible every day by aviation—a business trip to a meeting, a door-to-door air express shipment, a cargo shipment for international trade, or a general aviation trip to a manufacturing plant."

Thomas Donohue
President and CEO
United States Chamber of Commerce
February 2005

The Alternative That Makes Sense: Use More

The solution lies in the promise of technology to unsnarl the airspace around the "Big 35" airports and use their runways more efficiently: utilize more airspace; spread air traffic vertically, use more altitude; allow greater use of altitude-separation. The solution also lies in spreading the air traffic to more airports, lowering the load on the "Big 35" airports while allowing many people to actually get closer to their desired destinations, and cut wasted time on the ground.

Another obvious path to additional efficiency and safety is to allow aircraft to have more options when choosing altitudes. Currently, aircraft are spaced no less than 500 feet apart (vertically). It is easy to see that, if it were safe to do so, spacing flights at 250-foot vertical intervals would theoretically double the available "enroute" airspace.

Today's technology can do this; tomorrow's demand requires it. The idea is ready and achievable in an accelerated timeframe. All we need to do is adopt it, fund it, and implement it.

Tapping into Our Nation's Underutilized Resources

Air travel, unlike rail or road travel, actually has untapped capacity in the form of underutilized airports, altitudes, and routes. Some 250 airports can be considered "spoke city" airports to the nation's 35 major hub airports.

The good news is that 98-percent of the U.S. population lives within a 30-minute drive of these spoke airports and the more than 3,000 underutilized public use airports in the nation.

Not only are these airports potential solutions to the congestion problem, they can promote additional benefits: much air travel between hubs requires additional travel, either to another city (at the end of a "spoke") or to another hub that connects to the desired spoke city. These routings can add more than 15 percent waste in distance traveled, fuel burned, carbon emitted, and time lost resulting from the dog-leg routes required. Additionally, much of the air travel that concludes at a hub airport needs to be further augmented by ground transport to bring the traveler to his or her ultimate destination, a destination often served by a smaller airport.

Benefits of using underutilized airports accrue from three effects: personal travel times are reduced; additional congestion on the ground is obviated; and some incremental measure of environmental costs is avoided. A fourth major benefit, economic opportunity diffused throughout more of the nation's population, is also engendered.

NextGen will not only safely expand the nation's airspace to serve more travelers in more aircraft in more cities over the next decade, it will do so while reducing fuel consumption, carbon emissions, noise footprint and travel time.

From Scarcity to Abundance

Imagine an airway eight miles wide and five hundred feet deep; picture these airways linking ground navigation stations designed in the past century on the basis of old airmail routes; envision these airways as only connecting between a fraction of the airports across the land; comprehend the limitations of using aviation radios on a party line with analog voice communications for direction-giving. These are the realities of the existing airspace system.

As an example, out of over 5,000 public-use airports in America, fewer than 1,000 have precision instrument landing systems. It is like building an interstate highway system and only having 20 off-ramps per state for 50 states.

The NextGen Mental Model

Now imagine the capacity possible on airways that are a few hundred feet wide and deep; imagine passing lanes, aerial equivalents to HOV lanes, convoys of aircraft moving efficiently along routes between any and all of the nation's thousands of airports.

Imagine that the airports do not require expensive instrument landing systems to be purchased and maintained. Picture the possibility of some airports without control towers, able to handle traffic as though they had one, and runways without approach lighting, able to safely handle airplane arrivals in bad weather as though they had such lighting.

And envision aircraft able to separate themselves without radar assistance, by virtue of the satellite navigation and digital communications systems they carry on board, with digital radios capable of conducting business using common Internet protocols for two-way information sharing. Contemplate an airspace with no vectors to the final approach, virtually no missed approaches, no holding patterns, no vectors for traffic, no one-in-one-out procedural separation in non-radar airspace, virtually no radio frequencies to adjust. These are merely hints of the real possibilities of NextGen.

Public-Private Collaboration Yields High-Performance System

The technical term for this future airspace system is *"Performance Based Air Traffic Management."* The concept of performance-based navigation draws on a fundamental shift in the role of the central government from designing, owning, and operating all of the airspace system infrastructure to establishing and managing the performance requirements of the system that will be provided from others including users (airborne equipment) and contractors (using performance based contracts).

This shift allows these systems and their technologies to advance at the pace of technology and business instead of the pace of governmental organizations.

Technology will change the way America flies. NextGen will accommodate two to three times the current traffic levels by shifting from 40-year old ground-based, human-centric communications, navigation and surveillance systems to satellite-based, cockpit-enabled air traffic management.

Using Technology to its Potential

The technological underpinnings behind NextGen shifts us from an analog world to a digital world, and from terrestrial navigation systems to space-based GPS systems—putting more operational capability directly into the cockpit. This means that many of the radar surveillance systems of the last century can be replaced with airborne systems to safely expand the nation's airspace capacity.

The technology already available, and foreseeable in the near term, is both more efficient and ultimately more economical than what prevails in today's system. Its reliability makes it inherently safer, and its expansion will not require concomitant expansion of headcount or even scalewise expansion of hardware. It is expandable because it is very adaptive by design.

Of the many moving parts of the larger NextGen vision, there are four foundational components that shift us toward an aircraft-centric NAS, enabling the safe expansion of the nation's airspace to serve more travelers in the next decade:

- **Performance Based Navigation** through RNAV-Area Navigation and Required Navigation Performance (RNP) departures, arrivals, and approaches for both intercity routes and airport terminal airspace. This cornerstone technology provides new means of accurate navigation and control, trimming air lanes from several miles wide to a few hundred feet. As a result, aircraft will fly more precise flight paths, reducing fuel burn, carbon emissions and noise.
- **Performance Based Surveillance** through Automatic Dependent Surveillance-Broadcast (ADS-B), or GPS for planes, which delivers new technology for tracking aircraft based on equipment in the airplane instead of radar on the ground. As a result, the positions of aircraft are known everywhere, anywhere, improving safety while increasing airspace capacity.
- **Performance Based Communication** through networked digital radios that bring the speed and knowledge-gathering qualities of the Internet into the cockpit. As a result, the exchange of routine controller-pilot messages and clearance can be made via data, enabling controllers to safely handle more traffic while reducing "routine" workload.
- **System Wide Information Management** (SWIM) for integrated real-time data on weather, traffic, and airport conditions that will facilitate better and faster decision making as information is more easily accessed. As a result, flight planning will take minutes instead of an hour or more.

FAA depiction of aircraft communicating at different altitudes via ADS-B.

"In the future, an aircraft-centric National Airspace System will be able to use technology in a more robust way with better navigation and landing capabilities and thorough, accurate and real-time knowledge of weather and traffic conditions. The system will be built on a far more comprehensive information network than anything we have ever seen, ensuring the right information gets to the right person at the right time, while keeping traffic running smoothly."

Nicholas A. Sabatini
FAA Associate Administrator for Aviation Safety
"Flying into the Future,"
FAA New Technologies Workshop
January 9, 2007

Why Should We Embrace NextGen?

We should do it because we have to and because the changes will produce scalable expansion of the nation's airspace with long-lasting benefits in footprint, cost, mobility and economic opportunity. NextGen promises to lower long-term costs, add three-fold capacity and efficiency to the NAS, and improve safety while boosting the economy (via enhanced air mobility) at the local, state and national level.

We should do it from an operational viewpoint because the current system is incapable of meeting the increasing demands of commercial, GA and emergency response air transportation. We expect no slowing in the expansion of air travel; estimates call for 1.1 billion commercial US travelers by 2015. Our current air transportation system has simply overrun its usefulness, is not scalable, and additional short-term fixes will cost disproportionately more to implement.

As an FAA official put it, "We can't just keep subdividing airspace. When there's too much [traffic] density in a sector, we divide the sector when possible. We need to include automation that works out the separation, trajectories, etc. Controllers then become a 'communications link' in this scenario." With NextGen technology providing separation and routing, controllers will be able to do more and will have more freedom to assess and deal with non-routine events, or management by exception.

NextGen implementation paves the way to both tangible and intangible benefits for a multitude of constituents:

- For the traveling public, NextGen means fewer delays through an expanded airspace able to accommodate up to three-times the current volume of air traffic. The rollout of NextGen technology will not only improve the passenger experience, but will also attract travelers who today either drive for hours, or simply forego travel all together because of the inconvenience.
- Airline industry benefits, in the form of improved safety and reduced operating costs arising from enhanced pilot situational awareness, greater precision in flight path guidance, ability to increase segments flown per day, and shorter segment lengths with reduced fuel burn.
- Corporate aircraft travelers, who today fly in professionally-crewed, high-performance aircraft, will have more and safer landing options open up, ultimately promoting more commerce in smaller communities.
- General aviation pilots who will not immediately receive the large incremental benefits that will characterize airline travelers will most-importantly not be negatively affected. As NextGen expands to benefit the lower-flying, smaller aircraft, they will inherit additional benefits; and as their own aircraft capabilities and their own training progress, they will get increasing rewards from their added participation in NextGen's benefits.
- For the nation's air traffic controllers (ATC), NextGen reduces workload and cost while increasing productivity, capacity and safety. By shifting from two-way, voice-only communications for every aircraft traffic movement to a data communications-enabled system, controllers are freed-up to "manage by exception." This enables ATC to work more efficiently while giving maximum attention to priority areas.

"Whether you consider commercial travel, air cargo, military aviation, business and private travel or general aviation, the aviation industry is an essential component of our domestic economy and everyday lives. There are challenges and changes that lie on aviation's horizon which must be understood and resolved to ensure this vital industry continues to grow and succeed."

Carol Hallet
Former Head of the Aerospace Industries Association
"Chamber of Commerce Aviation Summit"
AIN, May 1, 2008

- For many communities, NextGen means greater economic development as thousands of the nation's underutilized airports become accessible for commercial use through ubiquitous, all-weather access we have come to take for granted at the nation's largest airports.
- Even the non-flying public benefits from NextGen's favorable footprint in terms of energy, carbon, noise and cost of added airspace capacity.

It's Not Just Time, Money and Convenience: It's the Planet!

Air travel, while extremely efficient on a per-passenger/mile/time basis, still consumes tremendous amounts of fuel and produces significant emissions. Though the price of fuel is spurring rapid efficiency improvements in propulsion and flight-planning, and though aircraft designs are increasingly carbon-responsible, efficiencies in the "engine-on" system—ground support, taxiing, startup, takeoff, climb, cruise, descent, ground handling and parking—will each make positive contributions to aviation's overall carbon footprint. Each of these activities can benefit from a comprehensive overhaul of the NAS.

Time and fuel are wasted on the ground, as airplanes stand in line to take off and as they wait for taxiways and gates to open after landing. In fact, according to a recent study on flight delays by the U.S. Joint Economic Committee, approximately 740 million gallons of jet fuel were expended in 2007 due to flight delays. Further, 78 percent of delays occurred before take-off—with 58 percent at the gate and 20 percent during the taxi to the runway.

While larger airports, more gates, and additional apron (airplane parking) areas clearly help, these solutions are expensive; and additional gates will not solve the problem of an overcrowded taxiway.

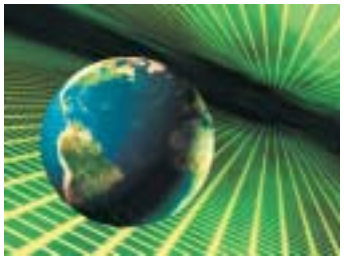
More-efficient ground control and coordination will allow greater throughput using existing infrastructure. As new facilities are built and older ones remodeled to accommodate advances in positioning technology, these gains will grow at an expanding pace.

Even passenger-routing and handling at airports of various sizes; security procedures; baggage-handling systems and procedures—all these offer additional venues for increased efficiency and an enhanced passenger experience.

As individual components of fuel use are improved, the overall effect will be significant steps toward making aviation sustainable. NextGen can reduce carbon emissions in aviation by 12 to 20 percent while lowering fuel consumption and cost for industry, and delays for passengers.

"The entire concept of the airline schedule will be redefined as the boundaries between traditional carriers and on-demand service providers begin to merge. This proliferation of options will effectively enable customers to choose air transportation services tailored to their needs."

"Next Generation Air Transportation System Integrated Plan"
Department of Transportation
December 2004



Now, Consider the Roll-out

NextGen is already well-planned; the technology is both proven and widely available; and implementation is already scheduled. If this sounds like our problems are nearly over, consider that implementation, as currently planned, *will take 20 years*.

Our problem is now. Waiting any longer won't make it any easier to tackle. NextGen can be implemented regionally, and in stages, through public/private partnerships that favor the greatest benefits in the shortest time.

NextGen technology covers both aircraft (aircraft-based equipment and crew training) and non-aircraft (ATC, GPS, satellite and communications) elements. As the non-aircraft parts of NextGen are added to a region's capability, qualified aircraft will be able to realize the benefits immediately, giving early adopters a competitive advantage in scheduling, dispatch, routing, fuel savings, and safety. These incentives present a strong case to competitors and encourage users, promoting the "pull" strategy that will encourage further implementation and utilization.

Early Adopter Success

In fact, many of the components of NextGen have already been used in certain areas of the airspace, with convincing improvements in safety and efficiency. The Capstone Project, first implemented in aviation-intensive Alaska in 2000, is credited with reducing the accident rate by 49 percent via ADS-B equipped aircraft.

In 2005, Alaska Airlines in collaboration with the FAA, implemented RNP approaches at Palm Springs International Airport to significantly reduce landing minima. As a result, Alaska Airlines was able to save over 1,000 approaches between 2005 and 2006 that would have been diverted to another airport 70 miles away.

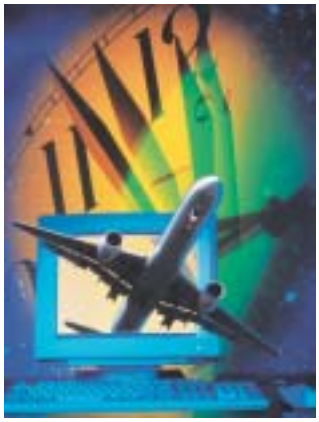
Implementation Timeline

The timeframe for a roll-out of various subprograms and technologies will depend on the political, logistical, and economic priorities of each phase. Early phases can be chosen on the basis of efficacy or ease of implementation, or elements of both. After some "critical mass" of implementation has been reached, further implementation will meet less political resistance as the public appreciates the inevitability of it, and as the benefits of full implementation become increasingly relevant to everyday life.

Further, as the economic benefits begin to outweigh the direct costs, the program's own efficiency will gain supporters and in some ways finance further implementation. Thus, NextGen becomes a self-fulfilling prophecy.

"We're not waiting around for the Big Bang, or a flip of the switch. NextGen is a transformation and it's happening now, and we're moving ahead."

Robert A. Sturgell
FAA Acting Administrator
FAA Forecast Conference
March 10, 2008



How Can NextGen be Implemented Sooner?

Earlier this year, Department of Transportation Secretary Mary Peters announced that Florida will be the national test bed for accelerating NextGen. On June 2, 2008 the FAA signed a Memorandum of Agreement (MOA) with DayJet Corporation to begin a five-year, phased implementation of proven NextGen technologies throughout Florida in collaboration with Florida Department of Transportation Aviation Office and the Daytona Beach campus of Embry-Riddle Aeronautical University.

The agreement establishes a government-industry partnership responsible for developing replicable procedures that can be used for the accelerated deployment of NextGen technologies nationally. Setting the stage for the first integrated implementation of NextGen capabilities for passenger services in the continental U.S., the Florida NextGen project is also the first to focus on the safe expansion of airspace outside metropolitan areas via underutilized airports and routings using modern very light jet (VLJ) aircraft operated by a Part 135 on-demand air carrier.

Florida NextGen Participants

DayJet will be the first air carrier to use NextGen technologies to optimize fleet network performance. DayJet is NextGen-ready by virtue of its real-time fleet management system, its business model and use of smaller community airports, its headquarters location in Florida (the NextGen national test bed), and its fleet of Eclipse 500 VLJ aircraft (with near-term plans for performance-based navigation capabilities).

Sharing its flight data and operational implementation expertise, DayJet will work closely with state and federal agencies to develop priorities for airspace procedures and airport capabilities.

Under the agreement, DayJet, over the next five years, will operate its Eclipse 500 fleet with equipment that will enable it to provide the government with data that comprise some of the key components of NextGen, which are necessary to achieve Performance-Based Air Traffic Management System including:

- New means of accurate navigation and control that will trim air lanes from several miles wide to a few hundred feet.
- New technology for tracking aircraft that will make the position of aircraft known everywhere and anywhere based on equipment in the airplane instead of radar on the ground.
- Networked digital radios that will bring the speed and knowledge-gathering qualities of the Internet into the cockpit.
- System-wide Information Management Systems for weather, traffic and airport conditions that will reduce flight planning costs, while increasing flexibility and accuracy.

The project will include major participation by the Daytona Beach campus of Embry-Riddle Aeronautical University who will be responsible for project management, airspace modeling and simulation, implementing RNP procedures and ADS-B applications along with developing curricula for NextGen education. In addition, the Florida Institute of Technology will perform studies of the energy, carbon footprint and noise benefits associated with the implementation of NextGen Technologies.

"We have selected Florida as the test-bed for this transformational technology. The Southeast has a good mix of traffic and a good mix of weather—just the kind of place to put NextGen through the paces."

Secretary Mary Peters
Department of Transportation
FAA Forecast Conference
March 10, 2008

The Florida Department of Transportation will participate in planning the routes and airports for NextGen implementation. In addition, the State Aviation office will be involved in the evaluation of the economic benefits of NextGen at the State and local levels.

Florida Implementation Timeline

Florida's NextGen capabilities will be implemented in three phases over the next five years as follows:

- **Phase 1**—To begin in late 2008 through 2010, the first phase of the project will focus on deploying Performance-Based Navigation to allow DayJet's fleet to fly more precise flight paths, reducing fuel burn, carbon emissions, and noise.

  In addition, this phase will deploy Automatic Dependent Surveillance-Broadcast (ADS-B) technology for performance-based surveillance based on GPS for airplanes that enables pilots to see other aircraft in their vicinity, improving safety while increasing airspace capacity.

- **Phase 2**—To begin in 2009 through 2011, this phase will implement System Wide Information Management for enhanced weather awareness and management.

- **Phase 3**—To begin in 2011 through 2013, this phase will deploy Performance-Based Communications for flight planning and flight plan management.

Expanding Service Beyond the Metroplex

This Florida project expands NextGen's focus beyond the confines of the 35 major hub airports and scheduled air carrier route and airspace architecture. A core concept of the "mini-NextGen" early implementation project in Florida is that with additional airports being utilized, concentrations of aircraft will drop, other things being equal. NextGen's purpose is to optimize existing airport usage and thus decongest the airways, allowing more-efficient, more-convenient, safer and "greener" air transport.

This project will define how the community airports must evolve and adopt an airport classification system that will ensure the air transportation industry and their customers are aware of an airport's capabilities and services and airport managers have guidelines for requirement enhancements. The result will be reduced cost of expanded airspace and access to airports for the new generation of on-demand air transport operators with benefits to underserved communities throughout the nation.

"Florida has a long history of aeronautical innovation and firsts. Our state has the leadership, expertise and innovation to take on this important project that will help the nation make informed, successful improvement to the national aviation infrastructure."

Florida Representative John L. Mica
Republican Leader of the House
Transportation and Infrastructure
Committee

What's in the Way?

The systemic nature of the change wrought by NextGen requires a degree of deliberation we've not seen in aviation. The costs of new equipage and training are not insignificant, and go beyond mere dollars. Aviators, from the low-time private pilot who uses his airplane to visit Grandma every month to the 747 Captain who has been flying for thirty years, have a decades-long culture that maintains a certain skepticism about change. The public has hard-earned expectations regarding the safety and cost and ownership of the national air transportation system. Asking these stakeholders to accept the value of the changes wrought by NextGen on face value is not enough. They need proof.

Legislators reflect their constituencies; they are generally not experts in aviation. Any change will affect some definable group to a differing degree, while the widespread benefits of that change may take a long time to recognize, so politicians (elected and career) are reluctant to change unless their constituents clamor for change, or unless they can make a compelling case for the benefits.

Fortunately, NextGen (with its improvements for safety, efficient travel, convenience, economic growth, and fuel savings among others) offers direct benefits to many constituencies. Thoughtful presentation and positioning of its compelling arguments will make these benefits clear, and concerned leadership will make them happen.

What Does it Cost and Who Will Pay or be Inconvenienced?

First, do no harm. Transition is as important as the end product. All these changes, while sweeping, will not wipe classic old aircraft out of the sky.

Current-tech machinery, VFR-rated pilots—these will continue largely unaffected, even as their numbers and proportion will drop through attrition. [The gas-guzzling muscle cars of the 1960s are today a very small portion of the pollution problem, even though they, individually, guzzle just as much gas as ever. Their numbers will not increase; new standards prohibit their resurgence; the world can afford to ignore them.]

Aircraft and operators that will not immediately qualify for NextGen will not see all the system's benefits, but they will not be penalized, either. At the very least, they should enjoy somewhat lower congestion and better on-time reliability, to the extent that others are able to take advantage of NextGen.

"Current radar-based air traffic control is a relic of the 1950s. GPS systems in cars or cell phones are more sophisticated than the hardware used in passenger and cargo planes."

Senator Jay Rockefeller
"Senate debates how to make skies safer, less congested"
AP, April 29, 2008

How to Get Ready for NextGen— Now

The objectives are obvious, efficient, and necessary: we need to move more people, sooner, improving safety while using fewer resources and doing less damage to the planet.

The technologies are available and proven; the strategy is well-formed; the elements of implementation are in place.

Just as NextGen itself could be implemented piecemeal and still provide benefits along the way, *any* of the implementation partners (FAA, DayJet, Florida and other states, Academia, and Industry) could do its part, and *some* benefits would be realized by *some* sectors of society and industry. And just as with NextGen itself, when every partner pulls together, the net result will far exceed the efforts of any one, or any combination short of full participation.

Therefore, it must be stressed that NextGen's costs and timeline will be minimized exponentially, and its benefits— safety, environmental, capacity, efficiency, and a working gateway to future expansion—fully enjoyed when we all work together, *starting right now.* All the major team members are aligned and in agreement about the goal. Now is the time to start!

Next Steps for NextGen

Here's what you can do immediately:

Airport Owners and Operators

- Incorporate NextGen infrastructure into your Airport Master Plan.
- Communicate to elected officials and the business community the economic benefits that are possible from adopting NextGen and improving the operational capabilities of your airport.
- Communicate the operational benefits to based and transient aircraft owners and operators of being NextGen capable.
- Appreciate the opportunities to give an airport and community a competitive advantage by being ready to accommodate NextGen equipped aircraft.

State Aviation Planners

- Incorporate NextGen preparedness into state aviation system plans.
- Encourage airport owners and operators to understand how NextGen technology and airspace procedures design can benefit their airport including: mitigating noise issues; addressing obstacle concerns; overcoming weather-affected operations; enhancing airport safety.
- Consider grants supporting NextGen education programs for airport owners and operators.
- Consider state support for equipage including:
  - √ Remote tower services (staffed or unstaffed)
  - √ Altimeter setting/RVR/Surface condition
  - √ Enhanced VFR approaches
  - √ Spacing and merging in IMC
  - √ Precision minima for all runways
  - √ RNP departures, arrivals for all runways
  - √ Alternatives to approach lighting
  - √ RVR for all appropriate runways

Just as with NextGen itself, when every partner pulls together, the net result will far exceed the efforts of any one, or any combination short of full participation.

A Closer Look at NextGen Technologies

PBN (Performance-Based Navigation**)**

The NextGen system, as already mentioned, consists of components in space (satellites), in the air (aircraft), and on the ground (Air Traffic Control and others). Here are the major components of NextGen, drawing heavily on official FAA documentation:

RNP (Required Navigation Performance)

RNP is RNAV with the addition of an onboard performance monitoring and alerting capability. An RNP navigation system monitors its own aircraft and alerts the crew whenever flight parameters (altitude, position, heading, speed) are not being met. RNP can enable reduced obstacle clearance or closer route spacing without intervention by air traffic control. Certain RNP operations require advanced features of the onboard navigation function and approved training and crew procedures.

4-D Wx (Four-Dimensional Weather)

This system will change the way weather is collected, analyzed, predicted, tailored, and integrated into aviation decision-making. In the NextGen era,"the primary role of weather information is to enable the identification of optimal trajectories that meet the safety, comfort, schedule, efficiency, and environmental impact requirements of the user and the system."The 4-D Wx Single Authoritative Source (4-D Wx SAS) will provide seamless, consistent weather information for ATM (Air Traffic Management) decisions.

ADS-B (Automatic Dependent Surveillance-Broadcast)

ADS-B works by having aircraft transponders receive satellite signals and using transponder transmissions to determine the precise locations of aircraft in the sky. Instead of using radar data to keep aircraft at safe distances from one another, signals from GPS satellites will provide air traffic controllers and pilots with more-accurate positional information in the sky and on runways. Compared to radar ADS-B is analogous to the difference between black-and-white television and rabbit ear antennae vs HDTV on cable: the clarity and amount of information available are astoundingly improved.

Eventually with ADS-B, some of the responsibility for keeping safe distances between aircraft will shift from air traffic controllers on the ground to pilots who will have displays in the cockpits to pinpoint all the air traffic around them, along with local weather displays. At night and in poor visual conditions, pilots will also be able to see where they are in relation to the ground using on-board avionics and terrain maps.

Furthermore, because the system continuously monitors the aircraft position, even on the ground, ADS-B will help reduce the risk of runway incursions. ADS-B holds the possibility for many additional enhancements in tracking, weather display, terrain visualization and other areas. The FAA committed to implementation of ADS-B in 2005, and early installations will commence in 2010, with full implementation scheduled for 2013.

(SWIM) System Wide Information Management

SWIM provides the infrastructure and services to deliver network-enabled information access across the NextGen air transportation operations. SWIM will provide high-quality, timely data to many users and applications— extending beyond the previous focus on unique, point-to-point interfaces for application-to-application data exchange.
By reducing the number and types of interfaces and systems, SWIM will reduce redundancy of information and better facilitate multi-agency information sharing. SWIM will also enable new modes of decision-making, as information is more easily accessed by all stakeholders affected by operational decisions.

NextGen Data Communications

NextGen transformation cannot be realized through today's voice-only communications. This is particularly true in the areas of aircraft trajectory based on operations, net-centric and net-enabled information access. Initially, data communication provides an additional means for two-way exchange between controllers and flight crews for air traffic control clearances, instructions, advisories, flight crew requests and reports. With 70 percent of aircraft data-link equipped, allowing for the exchange of routine controller-pilot messages and clearances via data can enable controllers to safely handle more traffic.

About DayJet

DayJet is the largest fleet operator of next-generation very light jet (VLJ) aircraft and the pioneer of a new type of regional business travel. DayJet has developed the world's first "Per-Seat, On-Demand" jet service that makes the convenience of corporate jet travel broadly available and affordable for more people and organizations, turning wasted travel time into valuable business and personal time.

"Per-Seat" means customers only pay for the seat(s) they need, not the entire aircraft. "On-Demand" means customers fly according to their individually negotiated time requirements. Business travelers can now book just the seat that they need aboard DayJet's fleet of Eclipse 500™ very light jets (VLJs); customize travel according to their time and budget requirements; fly point-to-point between regional destinations; and return home in a single day. Prices start at a modest premium to full-fare economy coach airfares.

Headquartered in Boca Raton, Florida, DayJet is the first 100% all-digital air carrier. Combined with the speed and efficiency of Eclipse 500 VLJ aircraft, DayJet "Per-Seat, On-Demand" jet service has created the next major advance in corporate productivity and regional economic development.

For more information, visit www.dayjet.com/NextGen.

"DayJet's ambitious, technology-driven business plan could well force a rethink of the way nearly all businesses serve their customers."

"Custom-Made for All"
Inc.
November 2005

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DayJet's "Per–Seat, On–Demand" business jet service is operated by DayJet Corporation's wholly owned subsidiary, DayJet Services, LLC, an air carrier registered with the Department of Transportation and the holder of an on–demand air carrier certificate from the Federal Aviation Administration (FAA) authorizing operations under Part 135 of the FAA's regulations under Title 49, Subtitle VII, of the United States Code.