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United States Government Accountability Office
Washington, DC 20548

May 20, 2009

The Honorable Jerry Costello
Chairman
The Honorable Thomas E. Petri
Ranking Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

Subject: *Responses to Questions for the Record: March 18, 2009, Hearing on ATC Modernization: Near-Term Achievable Goals*

This letter responds to your request that we address questions submitted for the record related to the March 18, 2009, hearing entitled *ATC Modernization: Near-Term Achievable Goals*. Our attached responses to these questions are based on a review of literature on avionics and equipage incentives, interviews with Federal Aviation Administration officials, interviews with stakeholders and developers of avionics with knowledge of the maturity and costs of avionics equipment, and our knowledge of the areas addressed by the questions.

We conducted this work from April 2009 to May 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We are sending copies of this letter to the Acting Administrator, Federal Aviation Administration. The report will also be available on GAO's Web site at www.gao.gov.

If you have any questions or would like to discuss the responses, please contact me at (202) 512-2834 or dillinghamg@gao.gov.

Gerald L. Dillingham

Gerald L. Dillingham, Ph.D.
Director
Physical Infrastructure Issues

Enclosure

Enclosure

March 18, 2009
Subcommittee on Aviation
Hearing on
ATC Modernization and NextGen: Near-Term Achievable Goals
Questions for the Record
To:
Dr. Gerald L. Dillingham
Director, Physical Infrastructure Issues
U.S. Government Accountability Office

Questions for the Record Submitted by Chairman Costello

1. **Dr. Dillingham, in your written testimony you state that before midterm NextGen implementation can occur, the Federal Aviation Administration (FAA) must validate and certify technologies and issue rules for new procedures. Please detail the specific steps that must be taken for new avionics to be used aboard aircraft operating in the National Airspace System (NAS)?**

RESPONSE: In order for new avionics to be used aboard aircraft operating in the national airspace system (NAS), steps must be taken in three broad areas when the new equipment, such as Automatic Dependent Surveillance - Broadcast (ADS-B), is part of an air traffic control system that has both airborne and ground components:

(1) Certification of airborne equipment.
(2) Ground system approval (that is linked to the airborne equipment).
(3) Procedure development.

Certification of Airborne Equipment

Before airborne equipment can be used in the NAS, several steps must be completed to certify its use including the following:

(1) Establish requirements for the airborne equipment and for its validation.[1]
(2) Certify or approve the airborne equipment's design, production and installation.
(3) Certify the use of it (by pilots and controllers). This step is called "operational approval."

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[1] Validation is the process through which a technology is shown to operate in a real-life environment with a desired level of confidence.

Establishing requirements and standards, which RTCA[2] most often does, typically takes 1 to 5 years, because government, industry, and international stakeholders need to reach consensus and air traffic control systems are increasingly complex. RTCA is currently developing an updated equipment standard for ADS-B Out,[3] the next step in ADS-B's deployment, and expects to complete this phase by December 2009. The requirements and standards typically form the basis for a Technical Standard Order (TSO),[4] which FAA uses to grant design and production approval. TSOs make installation approval, which is the next step in the certification process and is needed before the equipment is placed in service, simpler and less costly.[5] Design and production approval are the responsibility of FAA's Aircraft Certification Service. Installation approval is granted by the Aircraft Certification and Flight Standards Services. Lastly, FAA's Flight Standards Service is responsible for giving operational approval, which requires that an applicant, such as an airline, demonstrate, among other things, that its pilots are trained to use the equipment and that its maintenance personnel are trained to maintain it.

To meet the demands of NextGen, the entire process from the initial request (in most cases to RTCA) to set up a committee and produce a consensus standard, through the issuance of a TSO or aircraft certification and through operational approvals must be streamlined. RTCA is working on streamlining the production of the standards documents. The FAA must do the same for the process of developing and issuing the related TSO or aircraft certification and finally operational approval.

Ground System Approval

The ground system that is linked to the airborne equipment must also be approved before the airborne equipment can be used in the NAS. This approval focuses on safety and is done in accordance with FAA contract documents and policies and procedures that are part of the agency's acquisition management system. FAA's Air Traffic Organization has the primary responsibility for the approval of ground systems. Before a ground system can be used in the NAS, several steps must be completed, including the following:

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[2] Organized in 1935 and once called the Radio Technical Commission for Aeronautics, RTCA is today known just by its acronym. RTCA is a private, not-for-profit corporation that develops consensus-based performance standards for air traffic control systems. RTCA's recommendations are the basis for a number of FAA's policy, program, and regulatory decisions.

[3] ADS-B has two components. ADS-B Out continuously transmits an aircraft's position, altitude, and direction to controllers on the ground and to other aircraft. ADS-B In enables another aircraft to receive the transmitted data, giving pilots with ADS-B In a complete picture of their aircraft in relation to other ADS-B equipped traffic. FAA is deploying the nationwide ground infrastructure needed to receive ADS-B information and integrate it with controller displays. FAA expects this ground network to be fully deployed in 2013. FAA is proposing a rule that mandates ADS-B out equipage by 2020. Some stakeholders believe that this mandate is too far out and that incentives should be provided to encourage aircraft operators to equip sooner.

[4] A TSO is a minimum performance standard for specified materials, parts, and appliances for use on civil aircraft.

[5] To receive installation approval, the applicant submits a certification plan and test plan to one of FAA's aircraft certification offices for review and approval. In addition, the applicant conducts ground and flight tests under FAA's supervision to ensure that the new equipment operates properly upon installation.

(1) Establish requirements for the ground system.
(2) Design and develop the system.
(3) Test and evaluate the system.
(4) Train personnel to operate and maintain the system.
(5) Ensure that the ground system works as intended when installed (commissioning).

FAA develops, owns, and operates most ground systems that provide air traffic services and air navigation services. However, FAA has contracted with a private firm to deploy the ground infrastructure needed nationwide to receive ADS-B Out information. FAA expects the ADS-B ground system to be tested in 2010 and the ground network to be fully deployed in 2013.

Procedure Development

Even after the airborne equipment has been certified and the ground system approved, the capabilities of some airborne equipment cannot be fully used until more procedures are developed. Procedure design criteria are developed by the Flight Standards Service; the procedures themselves are developed by FAA's Aviation System Standards within the Air Traffic Organization. For example, these procedures include Area Navigation (RNAV)/Required Navigation Performance (RNP) procedures for arrivals and departures, RNAV procedures for routes, and RNP procedures for approaches, all of which rely on Global Positioning System (GPS) navigation as opposed to traditional ground navigation aids. Since 2004 FAA has published more than 260 RNAV procedures, more than 135 RNAV routes, and 135 RNP approaches, but much remains to be done. FAA estimates that the following numbers of procedures remain to be developed:

Table 1: FAA's Estimate of the Procedures Needed in the NAS for Performance–based Navigation

Procedure type	Development targets
RNAV/RNP procedures (arrivals and departures)	2,000-4,000
RNAV/RNP routes	800-1,200
RNP approaches	1,000-2,000

Source: FAA.

FAA believes that it can annually develop about 50 RNAV/RNP procedures, 50 RNAV routes, and 50 RNP approaches. We and others have previously expressed concerns about the time and human resources required to develop procedures and have identified them as a significant risk to the timely and cost-effective implementation of NextGen. It is important to note that outside of FAA, numerous companies with expertise and experience to develop procedures exist and are doing this work for air navigation service providers around the world. In addition, some stakeholders have noted that procedure development needs to move beyond basic overlays of existing routes to incorporate more optimal flight paths, improved airport arrivals and departures in mountainous areas, and improved and efficient traffic flows. Furthermore, FAA must develop new standards for reduced separation between aircraft that take advantage of the latest

technologies like ADS-B in order for NextGen to fully deliver on its promise of increased capacity and efficiency.

With multiple FAA offices responsible for each of the steps within the three broad areas described above, including the Aircraft Certification Service, Flight Standards Service, and Air Traffic Organization, coordination and integration is vital since delays in avionics certification, ground system approval, procedure development, or separation standard reduction, for example, could each prevent or delay full realization of NextGen benefits.

2. Dr. Dillingham, the "NextGen Implementation Plan for 2009" lists avionics equipage items that the FAA is targeting for mid-term NextGen operations. Of the avionics listed, which are the most mature, and the most ready for immediate deployment and why? Please address each technology listed and provide an estimated cost.

RESPONSE: The aircraft capabilities listed in FAA's 2009 NextGen Implementation Plan that are most mature and ready for immediate deployment are those associated with performance-based navigation and approach capabilities, while most surveillance and information display capabilities and data communications capabilities listed in the plan are a little further behind. The costs of equipping planes with these capabilities are difficult to estimate precisely because the needs of each aircraft type will differ depending on the equipment that it already has and some of the needed equipment has yet to come to the market. Where estimates are available, we provide ranges of potential costs provided by stakeholders. It is important to note that procedure development (including procedures for the use of closely spaced parallel runways), timely certification, airspace redesign, standards for reduced separation between aircraft, FAA automation, and pilot and controller training are necessary precursors to producing the benefits that could be provided by equipping aircraft with the latest technologies. In addition, construction of new airport infrastructure and timely deployment of technology and procedures to manage ground operations safely and efficiently will be important to take full advantage of an equipped aircraft fleet.

Performance-Based Navigation and Approach Capabilities

Of the avionics capabilities listed in the NextGen Implementation Plan, performance-based navigation and approach capabilities—including Area Navigation (RNAV) and Required Navigation Performance (RNP), curved path capability (also known as RNP-RF), RNP Authorization Required (RNP AR),[6] Vertical Navigation (VNAV), and Localizer Performance with Vertical Guidance (LPV)—are the most mature and in some areas are already in use. These capabilities allow for more efficient arrival and departure

[6] RNP AR is a category of RNP approach procedures that take advantage of specific equipment, aircrew qualifications, and operating procedures to allow for lower approach minimums. A required component of RNP AR approaches is the ability of the navigation system to monitor the navigation performance achieved and to identify to the flight crew whether or not the operational requirements are being met during the operation.

procedures, more repeatable and predictable trajectories, more routes, and enable the use of runways that cannot currently be used under certain conditions. The equipment (navigational systems and sensors) needed for aircraft to achieve these capabilities exists and is certified for installation on aircraft.

The extent to which the existing fleet of aircraft is equipped with these capabilities and the cost to equip varies. FAA and MITRE[7] estimate that nearly all air carriers have the capability to fly en route and terminal RNAV and RNP operations. To equip those aircraft used by air carriers that are not equipped, the cost is estimated at between $100,000 and $200,000 per aircraft. Fewer of the aircraft used by air carriers—MITRE estimates about one-third—are equipped with the navigational systems and sensors needed for more advanced and precise RNP capabilities—such as curved path capability and RNP AR. To equip for curved path capability, costs for air carriers are estimated at between $400,000 and $600,000 per aircraft, while the costs to equip for RNP AR capability are between $1 million and $2 million per aircraft. All major air carriers currently have VNAV capability through a flight management system to fly a specified vertical profile. FAA also estimates that LPV, which provides vertically-guided approach service down to 200 feet using the Wide Area Augmentation System (WAAS), is available on more than 20,000 aircraft (out of over 200,000 aircraft), primarily within the general aviation community.

Action from FAA is required for greater use of these capabilities within the NAS. As discussed earlier, thousands more RNAV and RNP procedures must be developed at individual airports for these capabilities to be used across the NAS. In addition, FAA has not yet begun to develop any navigational procedures for arrivals and departures that would allow aircraft to use curved path capability within the NAS. For RNP AR—for which some procedures have been developed with curved paths—additional training and certification of flight crews is also necessary for aircraft to fly those procedures. Furthermore, according to stakeholders, existing procedures are not used as much as they could be and operational approvals to use the existing procedures are needed. To more fully leverage the potential benefits of these capabilities, FAA must also engage in major airspace redesign around the more congested airports, which would require the creation of new flight paths and thus may also require environmental approvals, which can take several years. The environmental constraints could be a major obstacle to achieving timely benefit from RNAV/RNP and could benefit from deliberate attention by the community to solve.

Another approach capability listed in the NextGen Implementation Plan is the GNSS Landing System (GLS), but this capability is a little further behind the capabilities listed above in terms of its maturity. GLS is a positioning and landing system that integrates satellite and ground-based navigation information to provide the position information required for precision approach and landing guidance. According to one stakeholder involved in the development of this technology, the ground-based systems for GLS will

[7] The MITRE Corporation is a not-for-profit organization chartered to work in the public interest. MITRE manages four Federally Funded Research and Development Centers including one for FAA. MITRE has its own independent research and development program that explores new technologies and new uses of technologies to solve problems in the near-term and in the future.

be certified to basic precision approach standards this year.[8] The cost of these ground-based systems, including the equipment and installation is estimated to average about $2.5 million. Several aircraft are equipped with the avionics needed to meet these standards.

Surveillance and Information Display Capabilities

Among the surveillance and information display capabilities listed in the NextGen Implementation Plan are ADS-B Out, ADS-B In, and Electronic Flight Bag (EFB) integrated with ADS-B. These capabilities are not fully mature because standards are still under development, standards have just been finalized for them and the equipment is not yet widely available, or the capability is still under development and demonstration. In addition, the applications that will be supported by the ADS-B technology have not been fully defined.

ADS-B Out enables an aircraft to transmit its position, velocity, and other information to air traffic control systems for surveillance purposes. With ADS-B Out, controllers will see radarlike displays with highly accurate traffic data derived from GPS satellites. RTCA plans to publish a revised standard (DO-260B) with specifications for ADS-B Out and FAA plans to publish a revised TSO that references this standard in December 2009. Manufacturers will then be able to produce the ADS-B transceiver and any associated onboard equipment based on the new standard. In addition, FAA issued a Notice of Proposed Rulemaking in October 2007 and plans to issue the Final Rule in April 2010. This rule would mandate that all aircraft be equipped with ADS-B Out by 2020. The revised standard will be consistent with the FAA's requirements in this rule. Equipment does not yet exist relative to the revised standard and therefore costs for equipping aircraft to that standard are unknown. However, cost estimates to equip aircraft based on ADS-B Out equipment that meets the current standard range from $32,000 to $78,000 to upgrade current production aircraft, and up to $175,000 to retrofit aircraft that are out of production. Additionally, to fully implement ADS-B Out, FAA must continue to deploy ADS-B ground stations, which are scheduled for full deployment by 2013.

ADS-B In enables aircraft to receive information transmitted by ADS-B Out from nearby aircraft, Traffic Information Services – Broadcast from the ground, and Flight Information Services – Broadcast. This information can then be viewed on a cockpit display. Aircraft equipped with ADS-B In and an associated cockpit display will be able to “see” each other, which, among a number of capabilities, will allow for greater situational awareness in the cockpit and enable the self-spacing of aircraft, and also eventually allow for self-separation, which will increase capacity and decrease delays. RTCA has published standards for application related to situational awareness and spacing, but not for self-separation, which requires more stringent performance requirements. Several applications have been developed for ADS-B In, but only a few are certified.

[8] A basic or “Category I” precision approach has a 200-foot ceiling/decision height and visibility of one-half mile. A Category II precision approach has a 100-foot ceiling/decision height and visibility of one-quarter mile. A Category III precision approach has even lower requirements.

EFBs provide electronic charts, manuals, and other applications to aid flight crews. Higher-capability EFBs can incorporate information from ADS-B transceivers to show the location of other aircraft in the air or on the airport surface, and moving map displays, enabling some ADS-B In applications. Although EFBs are ready for deployment on aircraft, stakeholders indicated that there is currently no clear business case for equipping with higher capability models, given the high cost to equip. Depending on whether the EFB is portable or fully installed and subject to airworthiness requirements and the type of aircraft (i.e., whether it is a retrofit of an out-of-production or in-production aircraft), costs can range from about $166,000 to $388,000 per aircraft.

Data Communications Capabilities

Initial data communications capabilities are mature and ready for deployment while more-advanced data communications capabilities are maturing, but are not ready for immediate, widespread deployment.[9] Data communications enables flight crews to receive and reply to air traffic control clearances via electronic messages instead of voice messages as is done today, enabling controllers to safely handle more traffic. This improves air traffic controller productivity, and enhances efficiency, capacity and safety. Standards for VHF Digital Link Mode-2 (VDL-2) radios—which support data communication—and for data communications applications are mature. Certification of data communications equipment supporting initial Aeronautical Telecommunications Network applications (known as ATN Baseline 1) required for the European data link mandate is expected in 2010. While VDL-2 radios and Future Air Navigation System version 1/A+ (FANS-1/A+) application software are widely available now for aircraft in the current Boeing and Airbus fleets, most of today's aircraft must upgrade their radios to VDL-2, and install data communications application software. To retro-fit aircraft, the cost is estimated to range between $55,000 to $190,000 per aircraft. For forward-fit on new aircraft, the range is $13,000 to $23,000 per aircraft. Additionally, FAA's ground communications network and ground automation systems are not yet capable of data communications operations outside of a couple of airports. Data communications for the en route environment will require updates to the En Route Automation Modernization system, the timing of which depends on how FAA sets priorities for the program.

A later data communications model, ATN Baseline 2, is also listed in the NextGen Implementation Plan and is intended to build on the initial data communications system's capabilities, providing widespread Flight Management System integration and advanced applications. These advanced applications are not yet defined well enough to be able to define standards and standards have not yet been developed. This should not cause the FAA to postpone delivering interim capabilities over the midterm.

[9] Data communications (FANS-1/A+, ATN Baseline 1) is the basic data communications capability that will initially provide globally harmonized data link capabilities. Data communications (ATN Baseline 2) builds on initial capabilities and provides advanced applications.

3. Dr. Dillingham, if the FAA were to provide targeted incentives or subsidies for NextGen avionics equipage, which technologies hold the most immediate potential for accelerating NextGen benefits?

RESPONSE:

Technologies with the Greatest Benefits (Capacity and Efficiency) over the Next 2 Years

Stakeholders told us that the technologies with the greatest immediate potential (over the next 2 years) to accelerate the NextGen benefits of increased capacity and system efficiency are RNAV/RNP and limited ADS-B Out.

RNAV/RNP
As previously discussed, many aircraft are already equipped to use RNAV/RNP but accompanying arrival and departure procedures have not been fully developed at most airports. To illustrate that this technology is here and being used to generate fuel and time savings, one stakeholder reports that during a 12-month period, more than 8,000 RNP approaches at Brisbane, Australia, saved 34 Qantas 737-800 aircraft a total of 4,200 minutes of flying, 65,000 gallons of fuel, and 621 metric tons of carbon dioxide emissions. Average delays at the airport were reduced by 30 seconds for each arriving aircraft, which benefit from the fact that the RNP approaches for the 737-800 aircraft are taking between 10 and 23 nautical miles off their approach path to the runway, compared with an existing visual approach. Since 2005, Alaska Airlines, an early RNP pioneer, has documented 5,300 flights that avoided diversions using RNP procedures. In 2008, avoiding these diversions saved $8 million. The United Parcel Service, relying on Continuous Descent Arrivals which uses RNP, uses these procedures at Louisville, KY with reported savings of between 250 and 465 pounds of fuel (37-69 gallons) per arrival.

ADS-B Out
Immediate benefits to operators from ADS-B Out are limited, but ADS-B Out is a key enabler of future benefits to be derived from ADS-B In and other NextGen technologies. Immediate benefits include increased capacity over limited nonradar areas such as the Gulf of Mexico, large portions of Alaska, or in airports beneath radar coverage. For areas with no radar coverage, there is a business case for aircraft operators to equip with ADS-B Out because separation between aircraft can be reduced. However, few areas in the United States, other than the areas mentioned above, are without radar coverage. In addition, FAA cites some safety improvements, and benefits associated with more efficient, fuel saving continuous descent approaches in its notice of proposed rulemaking on ADS-B Out. However, FAA has not committed to reducing aircraft separation. Deploying ADS-B infrastructure without tying it to reduced separation, merging, spacing, and other applications delivers little benefit, and thus there is very little incentive for aircraft operators to equip their fleets now. From a systemwide perspective and over the midterm and long-term, equipping with ADS-B Out also provides benefits to FAA in the form of reduced costs from decommissioning a large number of the secondary surveillance radars, and from more efficiency and precision in air traffic control surveillance information.

Technologies with the Greatest Benefits over the Next 3 to 6 Years or More

Over the next 3 to 6 years or more, according to MITRE and others, additional technologies that hold significant potential for accelerating NextGen benefits include data communications and RNP-RF.

Data Communications
According to MITRE and others, data communications will do the most to accelerate capacity benefits nationwide in the 4 to 6 year time frame. Data communications will help relieve congested or constrained en route airspace by increasing the effectiveness of air traffic control automation systems and increasing air traffic controller productivity. Coupled with the controller capability to reroute multiple aircraft around weather and datalink clearances to multiple aircraft, it has the benefit of increasing schedule reliability and reduce miles flown and fuel used, which are most important metrics for scheduled carriers. To realize these benefits, updates to automation systems, controller training, and new procedures will be required.

RNP-RF
According to MITRE, RNP-RF will provide benefits over the next 3 to 5 years in congested, multi-airport metropolitan areas. Increasing the number of aircraft with this capability would allow airspace to be redesigned to expand and remove conflicts between arrival and departure flows for multiple airports in dense metropolitan areas. To realize these benefits, updates to airspace design, controller training, and procedures will be required.

Besides increasing capacity over the near term, equipping aircraft with the avionics mentioned above will increase efficiency and fuel savings and build a foundation for later NextGen capabilities.

4. Dr. Dillingham, some have suggested that if the government were to subsidize aircraft equipage it might share costs with airspace operators to distribute risk between the government and users. What are GAO's thoughts on this suggestion, and what would be the best way to structure such a cost sharing arrangement?

RESPONSE: Traditionally, FAA mandates the equipage of aircraft and provides several years for operators to comply. For example, FAA has recently proposed a rule that mandates equipage with ADS-B Out by 2020. However, for a variety of reasons, operators do not equip until the mandate is near because they face a number of disincentives to invest early in new technologies. For example, a technology may not work as needed, may not provide any operational benefits until a certain percentage of all aircraft are equipped, or may become obsolete because a better technology is available. In addition, several stakeholders have indicated that potential early investors are concerned that FAA may not follow through with the requisite ground infrastructure, procedures, or separation standard reductions. Given all of these disincentives, several options exist to encourage operators to equip aircraft earlier than the mandate with the latest

technologies. The federal government can (1) develop standards, procedures, processes, and infrastructure fully enough to create a strong business case to purchase the aircraft equipment, (2) provide operational benefits to those that equip, a notion that FAA has endorsed, called "best-equipped, best served", and (3) provide financial incentives such as sharing the cost of the equipment through subsidies or tax credits. Generally, a combination of these options may be needed to promote early equipage of a new technology.

Given the range of potential options to address the equipage problem and the disincentives facing operators, Congress could consider a number of issues if it decides to establish a structure through which the government and airspace operators can share the cost and risk of equipping aircraft.[10] First, a subsidy, whether it be a grant, investment tax credit, fuel tax reduction, or other mechanism, should be targeted and specific to airborne equipment that (1) is mature, but does not have a strong aircraft operator business case for immediate implementation, and (2) achieves capabilities that lead to real benefits in terms of increasing the capacity and efficiency of the NAS. It is in these cases that the federal government's sharing of costs is most justifiable because there are adequate aggregate net benefits to be realized through equipage, but those who need to make the investments in the equipment do not accrue enough benefits themselves to justify their individual investments.

The second issue that must be considered is how to provide benefits to those that equip with the targeted avionics early—either with or without a subsidy. FAA has furthered the notion of "best equipped, best served" to encourage operators to equip. What this means in practical terms is that FAA must ensure that those that do equip receive some form of operational benefit, such as preferred airspace, routings, or runway access, which can save time or fuel. If early equippers get a clear competitive advantage, other operators may be encouraged to follow their example, further incentivizing all operators to fully equip their fleets. For some capabilities, a critical mass of users is needed before benefits can be realized. For example, enough aircraft must be equipped with ADS-B Out for FAA to effectively separate traffic and provide preferential airspace to those that are equipped, because in a mixed equipage environment, FAA must retain more conservative separation standards for less well-equipped aircraft. According to RTCA, data communications capabilities can lend themselves well to the "best equipped, best served" concept. For example, currently when controllers are faced with unpredicted weather facing many aircraft, they effectively slow them all down in order to give the controller time to devise reroutes and communicate new clearances by voice for each one. With data communications, the controller can uplink reroutes to all equipped aircraft without slowing them down, but slow down those aircraft that are not equipped

[10] Congress has sometimes authorized cost-sharing arrangements to provide incentives to industry to pursue advanced technology where there are perceived to be broad public benefits but there may not be an established business case for such investment. Examples include tax incentives for the installation of alternative energy sources and the Department of Energy's Advanced Technology Vehicles Manufacturing Loan Program, which authorized up to $25 billion in grants and direct loans to automobile manufacturers for developing more fuel-efficient vehicles.

in order to provide them with clearances one at a time by voice. Thus, those equipped would get a clear benefit in terms of reduced delay and better routes.

Another issue to consider is that stakeholders may not have an incentive to equip early because FAA has not always followed through in the past to allow operators to take full advantage of investments in equipage. As a result, industry questions whether FAA will now follow through with the tasks required to provide these benefits. According to many stakeholders, operators are wary of investing in equipage when they cannot achieve the full benefit of this investment and recoup their investment until FAA has completed tasks such as developing RNAV/RNP procedures at major airports around the country, redesigning airspace, reducing separation standards, and deploying the necessary ground systems in a timely manner. To allay industry's concerns, FAA could complete some of these activities so that operators can take better advantage capabilities they already have, such as RNAV/RNP. The majority of air carriers have aircraft that are equipped to take advantage of RNAV/RNP capabilities now, but until FAA completes its work, they cannot do so. In addition, FAA could implement its "best-equipped, best served" notion to simultaneously provide incentives for users to equip and build trust in FAA to follow through on promises to provide benefits to early equippers.

Finally, because prudent use of taxpayer dollars is always important, it is preferable that a minimum of government resources be used to reach the threshold number of equipped aircraft required to produce real, tangible benefits for those that equip. Any cost-sharing arrangement should be structured so as to avoid unnecessarily equipping aircraft (e.g., those that are about to be retired) or paying more of a subsidy to equip than would otherwise be necessary. One option that Congress could consider to achieve a minimum level of subsidy is to employ market incentives through a reverse auction. Under a reverse auction, aircraft operators would presumably be willing to bid down the level of subsidy to the point that the value still resulted in a positive business case for the installation of specified airborne equipment. Under the simplest form of such an auction, the subsidy starting value would be the full cost of aircraft equipment including purchase, installation, and training. The auction would proceed with the subsidy dropping by a specified amount over a given time period until a targeted critical number of equippers remained. To reiterate, tangible benefits that "complete" the business case and provide a competitive advantage for aircraft operators who equip must accompany the subsidies so that those operators that do not equip have an incentive over time to equip their aircraft in order to take advantage of the same benefits. The advantage of holding an auction for such support is that the government can have more assurance that it is paying the lowest price for achieving the desired benefits, because the auction is employing market forces and allowing individual airlines to make decisions in their own best interest.

Questions for the Record Submitted by Ranking Member Petri

1. **Investment tax credits have been mentioned as an incentive for early equipage. Would this tax incentive, and its promise of competitive advantage, significantly encourage operators to invest in NextGen equipment? Are there any potential negatives to this plan?**

RESPONSE: Tax credits could encourage some operators to invest early in NextGen equipage, and some stakeholders suggest they be considered as the government examines different ways to provide incentives to equip. However, tax credits have several disadvantages when compared with alternative ways for the government to provide financial incentives for equipage. First, in light of the decline in passenger and cargo revenue, many commercial carriers may not have any tax liability that tax credits could be used immediately to offset. While tax credits can be carried forward over several years and used when a carrier returns to profitability and has tax liability, the ability to reduce future tax burdens may not provide a significant incentive to equip now unless the credit is particularly generous. Second, unless the credit can be transferred to firms that do have a current tax liability, a tax credit would provide a more valuable subsidy for carriers that are currently profitable than for those that are not. Other forms of subsidy—grants for example—would provide an investment incentive regardless of the current profitability of the carrier and therefore would not create larger incentives for some carriers than for others. Finally, using the tax system to provide a financial incentive can have administrative consequences for the Internal Revenue Service.

2. **Equipage is an important component of NextGen. Right now the economic conditions and financial pressures on Canadian air carriers are similar to those on U.S. carriers. Yet, in Canada, carriers have said they would be responsible for equipage if NAV CANADA deployed the system. The financial pay back for those who do equip will be fuel and time savings due to more direct routing and optimum altitudes. Would this model work in the United States? If not, why not?**

RESPONSE: No, the Canadian model is not applicable to the U.S. situation for the following key reasons:

(1) Canada is pursuing a voluntary equipage strategy to enable more efficient flight in areas without radar coverage—especially areas over Hudson Bay. Planes equipped with ADS-B Out will be able to fly with reduced separation, as is now required in areas without radar coverage. Therefore, there is a clear and substantial benefit to airlines that equip to fly in that particular airspace. Airlines are not equipping their entire fleets, just those aircraft that fly certain routes across Hudson Bay. United Airlines reviewed its international routes over Hudson Bay and decided to voluntarily equip its airplanes with ADS-B Out because of the potential cost savings. In the United States, while the Gulf of Mexico is similar to Hudson Bay, there is not much other significant non-radar space.

(2) ADS-B Out is not being deployed in Canada where there is already radar coverage, as is being planned in the United States. Therefore, Canada is not requiring operators to voluntarily equip their aircraft, and ADS-B is not envisioned as replacing radar to the same degree as in the United States. Consequently, carriers that operate solely in areas covered by radar may not have an incentive to install ADS-B equipment.

(3) The ADS-B Out technology that Canada is requiring for routes over Hudson Bay corresponds to the minimum standards and equipment for ADS-B today and limits potential future ADS-B In capabilities. In the United States, FAA is establishing internationally recognized ADS-B Out avionics equipage standards. These revised standards, which RTCA is developing, will enable higher-performance applications and services that will enhance the capacity, flexibility, and safety of the evolving airspace. Therefore, there are different concepts of future benefits resulting from equipping a critical mass of aircraft with technology that meets the higher standard. Canada intends to require the internationally recognized standards once they are adopted by the United States and Europe.

(4) Canada is not currently focused on a strategy of voluntary equipage for ADS-B In applications. According to NavCanada, the Canadian air traffic management authority, ADS-B In requirements, capabilities, and strategies for equipage have yet to be determined. In the United States, FAA has conceptualized a number of capabilities arising out of ADS-B In technologies and equipment that it eventually plans to incorporate in the NAS.

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