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MITRE TECHNICAL REPORT

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Executive Summary

The MITRE Corporation (MITRE) has been researching the Next Generation Air Transportation System (NextGen) avionics equipage incentives for a number of years, and through our privileged industry and government contacts, we are exposed to the frank perspectives of many National Airspace System (NAS) stakeholders. MITRE believes that these perspectives should be documented and shared, in order to better inform NextGen policy-decision making.

MITRE sees challenges that, if addressed, would improve chances of government incentive program successes in motivating NextGen equipage investments. MITRE also believes that activities launched as a result of the recent Federal Aviation Administration (FAA) re-authorization offer an opportunity to advance NextGen equipage.

Accordingly, the purpose and key objectives of this paper are as follows:

1. To help in educating key decision-makers as to options and implications of different incentives strategies by providing an executive-level synopsis of MITRE findings related to potential NextGen equipage incentives.
2. To communicate our incentives research experience in a way that the FAA could use to inform an integrated policy on the various forms of incentives, including operational, financial and regulatory approaches.
3. To illustrate how intended stakeholder behaviors may or may not be influenced by incentives strategies, by providing a hypothetical walk-through of the aircraft operator decision process.

The paper concludes with suggested research questions and proposed next steps.

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1.1 Background: What Do We Mean By "Incentives"?

Incentives are means to induce a party to act in ways that may not be perceived to be in their self-interest, either in terms of commitment to action, or in terms of timing of actions. For example, an incentives strategy may accelerate the timing of investments where the near-term stakeholder business case for the Next Generation Air Transportation System (NextGen) capabilities is unclear in their absence.

The key types of results sought in the context of an avionics equipage incentives program are summarized below:

- To induce stakeholders to commit resources to take desired actions in terms of aircraft equipage.
- To induce stakeholders to accelerate the timing of actions for which they are already committed.
- To enlist stakeholders in taking actions that will accelerate the creation of critical masses of equipped capabilities, on a regional or national basis.

For NextGen, three incentive approaches have been identified:

- **Operational Incentive:** Where an action-based quid pro quo is established, i.e. "if I take an action of value for you, you will take an action of value for me".
- **Financial Incentive:** Where a monetized form of quid pro quo is established, i.e. "if I give you something of monetary value, you will take an action of value for me".
- **Regulatory Incentive:** Where rulemaking establishes the action required of the stakeholder—essentially a quid pro quo with a stick.

It is also worth noting that there may be alternatives to incentivization along the lines described above. For example, improved Federal Aviation Administration (FAA) program design yielding near-term and visible wins along the way to the longer term objectives, as well as clear communication of program and benefits delivery commitments may provide means to mitigate the need for operational or financial incentives.

1.2 Why Incentivize?

As air traffic control systems and concepts have evolved, a greater emphasis has been placed on cooperative air traffic management, where aircraft automation systems work in concert with ground based automation systems. Key components of the FAA's NextGen program are anticipated to depend on high levels of technical and operational collaboration among airborne and ground based automation to achieve desired improvements in National Airspace System

(NAS) capacity, throughput, flight efficiency, FAA cost-effectiveness, environmental impact and safety.

However, whether considering investment in Air Navigation Service Provider (ANSP) ground automation systems or in aircraft operator owned avionics systems, no investment can be made without a clear vision as to the benefit delivered to the investor, either qualitatively, quantitatively, or both.

When these benefits are not clear or where timing of collaborative improvements is not aligned with benefits delivery, stakeholders are likely to decline making the needed investments, and the desired improvements will not be realized.

To motivate equipage, incentives must resonate with those we want to incentivize and a cross-NextGen approach to incentives is essential—operators upgrade aircraft by fleet or sub-fleet, not individual capabilities or avionics boxes.

1.3 Diverse Equipage Incentivization Objectives and Strategies

Sections 221 and 222 of the FAA reauthorization seem to assume that offering operational improvements or cash/loan subsidies or guarantees should unlock the equipage decision for NAS aircraft operators and stakeholders. However, in many cases, these operators and stakeholders remain unclear as to what the overall NextGen strategy is, and thus are reluctant to move forward with commitments and/or investments. They see various financial, operational and regulatory approaches in progress, applied to different FAA programs in different ways, and often on different timescales. Some are program-specific, some are Agency-wide, and it's not clear to the NAS stakeholders how they fit together, or even if they do fit together at all. It's also unclear that equipage will actually be incentivized; since there are many factors involved in an equipage decision, going well beyond the purchase of the desired avionics systems.

It also seems to NAS stakeholders that there are diverse and potentially divergent FAA objectives for equipage incentives. One perceived objective is that the FAA seeks to enhance equipage rates as proxy for NextGen approval from industry/operator stakeholders, in essence providing a public metric by which to measure the FAA's mission success in implementing NextGen. Another perceived objective is that the FAA seeks to use incentives to accelerate attainment of high levels of equipage, or critical equipage masses, in order to enroll and/or encourage Air Traffic Operations staff in the operational use of NextGen capabilities. A third perceived objective, particularly where the incentives are program-specific rather than Agency-wide, is that the FAA seeks to support (internal) program prioritization decisions using high levels of equipage as justification for the programs that this equipage supports.

And of course, there are diverse operator objectives as well. The most fundamental questions the operators tend to ask are:

1. "Will the targeted capabilities improve my own operations if I equip?" "If so, how can this be qualified and quantified?"
2. "Will the targeted capabilities disadvantage my competitors if I equip?" "If so, how can this be qualified and quantified?"

1.4 The Investment Context

Another complication presented in the design of incentives programs is that the investment horizon of NAS stakeholders tends to be diverse from one another and quite different than that of the FAA, operating as a taxpayer-funded government agency.

From a commercial operator's point of view, aircraft and fleet upgrade programs are budgeted/approved from launch through completion—usually spanning a few years at the most, with very short paybacks, on the order of 2.5 years, and with high decision discount rates, often 17.5% or greater, as the NextGen Advisory Committee's Business Case and Performance Metrics Working Group has reported. Decisions also tend to be based on overall fleet considerations, and upgrades often need to be fleet-wide or sub-fleet-wide, rather than regional or airport specific, leading to rather significant financial hurdles. At the same time, opportunity costs and costs of capital will often be the key drivers in capability upgrade investment decision making.

On the other hand, the FAA faces the very difficult situation of operating under annually-at-risk budget authorizations while seeking to fund extremely long-term acquisitions (spanning 10 to 20+ years). The executive branch of the Federal government operates on year-to-year appropriations, with authorizations set a maximum level of spending across a time frame (e.g. five years), laying out the range of actions that can or must be taken by an organization in the executive branch. In order to commit these acquisitions, appropriations are required to actually provide funding—until these appropriations are secured from Congress, no program has more than a very near term committed life. Further, spending priorities tend to be (re)negotiated on a program and budgetary basis rather than on cross-NextGen needs assessment.

From the legal view, most United States (U.S.) government agencies have multi-year budget frameworks that are approved by a governing body and which serve as a strategic plan for allocation of resources. However, actions taken by the FAA or other organization within the Executive branch are constrained to those which are funded by Congressional appropriations, through legislation, or via executive order. The FAA cannot make commitments beyond the legislative or executive authority assigned to it. For example, the FAA can only adjust spending allocations within pre-defined margins from the allocations designated in legislation, and while the FAA may be authorized to take an action they may not have appropriations sufficient to execute the action.

Finally, FAA is precluded by statute (e.g., the Anti-Deficiency Act) from accepting financial liabilities beyond their Congressional appropriations. As such, FAA is precluded from indemnifying aircraft operators against losses incurred in the situation where FAA benefits commitments are not realized, thereby forcing aircraft operators to self-indemnify against losses in investments in NextGen avionics.

2 Making the Case for Investment in Aircraft Equipage

Aircraft operators considering forward fit and retrofit equipage will weigh a number of factors in any investment analysis addressing the benefits and costs associated with equipage. The relative weights of these factors are usually consistent among operators with similar mission profiles, but there is no standard business case that covers all operators or all operators within a single group. Each operator has a different set of criteria for constructing an equipage business case reflecting the individual operator's business model, fleet characteristics, and areas of service.

2.1 Operator Business Case Considerations

Both commercial and government (i.e. the Department of Defense (DOD) as well as other governmental entities) aircraft operators need to construct a business case that can be used to justify equipage. Some of the components of the business case include the return on investment, the investment horizon, and the operator's view on the time value of money, affordability, and lifecycle costs.

- **Return on Investment (ROI):** The proportion of net benefits to the overall costs, when viewed over a given investment horizon. Many organizations have a minimum ROI (e.g. 18%) that must be demonstrated by a business case. Costs that will be incurred are weighed against potential benefits; see section 2.4 for a summary of benefits that may be considered.
- **Investment Horizon:** The (risk-adjusted) period of time to achieve a return on investment. The U.S. government, which has a long-term interest in societal benefit, tends to use longer return horizon; typically 20 years. Airlines, which operate in a low-margin, highly competitive market, tend to have short return horizons, typically 12–30 months.
- **Time Value of Money:** Money available in the future has inherently less value than money available "now"; because the recipient does not have the ability to use money until it's available. (Note that this is different from inflation rates, which also devalue future cash flows). Cash flows that occur over multiple years are assigned a present value by "discounting" future expenses or benefits by a defined rate. Standard guidance from the Office of Management and Budget (OMB) for government analysis is to use a 7% discount rate; airlines tend to use discount rates ranging from 15–20%. Note that future revenue may be further discounted with a risk index.
- **Affordability:** The ability of an aircraft operator to afford the absolute cost of the required investment. Affordability is the precondition for an aircraft operator to consider the potential return on investment. Affordability challenges may be addressed by making new sources of financing available (e.g., financial incentives, such as loans).

- **Competitive Advantage:** A competitive advantage is a discriminator between an entity and other entities offering similar services or products that result in improved profits. Competitive advantage can be achieved by reducing the relative cost or by increasing the likelihood that either more products/services are sold in the same market or that a product/service can be sold at higher prices in comparison to competitors. Competitive advantage is often temporary, as other aircraft operators seek to achieve equity in a service or cost structure. Thus investments that are anticipated to create a competitive advantage must be seen as having a sufficiently long period of uniqueness to justify the investment. Operators may also see an avionics investment as necessary to maintain competitive standing with other operators who have already made investments and are getting benefits.
- **Lifecycle Costs:** Aircraft operators, when considering either forward fit options for new airframes or retrofit have to address a wide range of costs in addition to the purchase price for avionics. Even if an aircraft operator receives avionics at no cost, installation plus the other factors listed above are equal to, if not higher, than the cost of the unit. Costs that may be included include: Cost of acquiring and storing spares, aircraft out-of-service costs while the aircraft is being modified, training for all flight crew members and upgrades of any simulator equipment, cost of additional weight, in terms of fuel requirements and/or lost cargo capability, and costs to update and maintain documentation associated with the upgrade. Further, significant costs may be incurred if the capability requires associated upgrades in other equipment, such as primary field of view displays, Flight Management System (FMS) interfaces, etc.

2.2 Potential Obstacles to Justifying an Equipage Investment

Even when a capability is well understood and results in broad system-wide benefits, the business case that an operator conducts may not close, or the operator may not be able to obtain authorization for investment. Potential obstacles may include any or all of the following:

- **Benefits Clarity:** The specific benefit mechanism must be articulated unambiguously and must be perceived as feasible. For example, if the overall benefit achieved is delay reduction, how is it achieved? Is the benefit delivered specifically to aircraft with the capability? Benefits must be defined in terms of their business value; not just in terms of their operational effects.
- **Applicability of the Investment to the Operator's Mission:** The geographic scope of the NextGen capability must match the flight operator's typical mission. Lack of clear deployment locations undermines the operator's view of the applicability of the capability.
- **Confidence in the Ability to Achieve Benefits by a Given Date:** Flight operators will not invest in avionics until there is confidence in the date that the capability will be available. Confidence decreases with the number of factors that

are outside of the operator's control. Premature investments tie up money, result in failure to achieve payback periods or ROI, add weight on the aircraft, result in unnecessary expenses in training and maintenance, and force additional inventories of avionics spares.

- **Competing Investments:** An avionics acquisition may provide benefits, but not as much as another investment. Additionally, investments may compete on a subjective basis. The operator will choose the most valuable investments on an overall basis, not just investments that have positive ROI or payback. Affordability becomes the limit on which investments will be pursued. Military operators, for example, may have other mission-critical needs that override investment of limited funds on avionics.
- **Opportunity Cost:** All funds spent on one purchase result in reduced opportunities to spend on other purchases. Because aircraft operators usually have fixed funds available for investments, opportunity cost is a consideration before committing to a purchase. Commitment of funds to purchase avionics also may limit the operators' ability to respond to new investment opportunities. For example, commercial operators may choose to make investments that result in higher revenue, versus making an avionics purchase that may reduce operating costs.
- **Market Effects:** Flight operators will consider the relationship between their own investment and benefits with those of others in the marketplace. A marketplace failure may occur, for example, if there are "critical mass" threshholds that delay initial benefits. That is, if an operator will not receive benefits before others equip, it significantly increases the overall risk of the investment. Operators may also be reluctant to invest in a capability if there are "free-rider" benefits. That is, if significant benefits accrue to aircraft not equipped for a capability due to "spill-over effects", then operators have the perverse incentive to wait for others to invest instead. Both critical mass thresh-holds and free-rider issues can result in no operator willing to be an early adopter.
- **Airframe Cost/Affordability:** If the avionics investment is high relative to the airframe value or the airframe remaining useful life is low, the flight operator may not equip. Further, a business case may result in a positive ROI but the required investment may be more than the operator can afford.
- **Fleet Homogeneity:** Operators may find that the business case will close for one portion of their fleet, but cannot justify equipage for a significant portion of the remaining fleet. In this case, mixed equipage adds additional complexity to training, crew assignment, and maintenance, and operators may forgo an investment due to the increased complications of multiple fleet capabilities.

2.3 Justifying Equipage Decisions

In addition to establishing a business case for equipage, aircraft operators also have to ensure that they are able to follow up and implement an equipage decision in a timely manner. In some cases, aircraft operators may not be able to equip at a desired pace even when a business case closes. Some of the considerations on the acquisition of NextGen avionics include the following:

- **Operator Funding:** Aircraft Operators may not have sufficient funding or credit to finance an investment. For commercial operators, this is generally not the case if a business case can be constructed that shows high confidence in achieving investment criteria. On the other hand, government aircraft operators have little flexibility to finance avionics outside of appropriations and program budgets.
- **Credit Availability:** In some cases, operators may seek to use credit financing for equipage and related costs. Commercial credit sources may deem joint investments with FAA to be a high risk since realization of benefits are beyond the control of the borrower. Incentive financing—such as that envisaged in Section 221 of the FAA Re-Authorization Act—is meant to address this consideration.
- **Operator Control of the Aircraft:** A large percentage of operators do not own the aircraft that they use. Data shows that more than 50% of the U.S. registered Federal Aviation Regulations (FAR) Part 121 fleet is leased; many air taxi and GA operations also make use of leased aircraft. Aircraft owners (lessors) may dis-allow the installation of additional avionics, especially for short-term leases. In the case of fractional ownership or lease of aircraft, gaining agreement is further complicated. This situation is exacerbated when solutions are not globally harmonized, due to the inability to use the new capabilities in another airspace region where the aircraft may need to be moved at lease-end.
- **Timing and Budget Planning Cycles:** Flight operators having a justified investment need to work within their organization's decision processes and ensure that the proposed investment is aligned with the operator's overall strategic plan. Timing and budgets are often inflexible for much of the fiscal year. For government aircraft operators, budget cycles require several years in advance planning before authorizations can even be requested.
- **Availability of Offerings:** A certified avionics capability providing benefit and matching an operator's mission may not be available for purchase for a portion of an operator's fleet. Avionics manufacturers may not have sufficient market demand to justify the research, development, testing, and regulatory approval of avionics for a given airframe, based on the size of the market.
- **Fleet Upgrade Cycles:** Aircraft operators with large fleets typically schedule upgrades over a multi-year cycle to minimize disruption to overall operations. Typical fleet major upgrade cycles range from five to seven years. Except for urgent repairs or for mandated safety upgrades, new avionics will be installed

with major upgrades; software upgrades can often be tied in with scheduled maintenance. Alternatively, dedicated modification lines can be used to install equipment. This approach speeds up the installation process and the ROI timeline, but significantly increases the costs, especially if the aircraft has to be taken out of service.

- **Installation Facility Capacity:** Aircraft Maintenance, Repair, and Overhaul (MRO) facilities have limits in the number of aircraft they can service at a time. This constraint applies to those facilities serving general aviation as well as commercial aircraft. Becoming an approved facility requires a multi-step certification process and requires hiring certificated staff; thus there is little elasticity in the number of facilities that can respond to a high level of demand for installation services in the short and medium term. Installation facilities often have competing activities — requests for new avionics must also be serviced along with retrofit and upgrades of other avionics, as well as repairs/replacements.

2.4 Operator Equipage Benefits

Aircraft operators considering avionics investments will weigh costs and risks against four key benefit categories: cost reduction, revenue enhancement, access (i.e., mission success), and safety.

- **Cost Reduction:** Investment can be tied directly to reduce the cost of fuel, personnel, or maintenance (e.g., equipping with a Global Positioning System (GPS) capability may allow removal of less reliable Very High Frequency (VHF) Omnidirectional Range (VOR) navigation capabilities). Block time reduction is a major cost reduction objective. Other cost objectives may include improved utilization of airframes, reduced training expenses, etc. While many analyses translate delay savings to an average Airline Direct Operational Costs (ADOC), additional granularity is needed by most operators to construct a business case supporting an investment decision. Note that cost reduction is relevant to most aircraft operator classes.
- **Revenue Enhancement:** Improved operations enabled by NextGen avionics may contribute to the operator's ability to increase revenue. Examples of revenue enhancement include the ability to add additional flights to a schedule, improved service delivery quality (enabling the operator to charge higher fares), or competitive advantage (leading to increased market share). This is primarily a factor for Part 121 and Part 135 aircraft operators.
- **Access, or Mission Success:** Operators may invest in avionics to gain, or to retain, the ability to operate in some airspace or an airport. For example, there are specific avionics requirements to operate in en route airspace under Domestic Reduced Vertical Separation Management (DRVSM) rules. Access also includes the ability to reliably operate in an airspace or airport. For example, an operator

may use an Required Navigation Performance (RNP) approaches to enable routine access an airport with terrain and weather obstructions.

- **Safety:** Typical safety benefits from an avionics investment include increasing situational awareness or reducing error and accident rates. For example, utilization of enhanced vision systems can allow the flight crew to see objects during periods of low visibility; electronic flight bags with moving map displays may reduce runway incursions. Claiming safety benefits as a primary driver of the business significantly increases the need for substantiating data.

2.5 Policy Approaches

Because the government has a mission of supporting long term societal goals, a range of policy approaches may be used to influence the behavior of individuals and groups. These policy approaches create incentives for entities to do something that might not otherwise be perceived as being in their self-interest. Reasons for policy-driven equipage incentives can include:

- To achieve an urgent, priority goal for society (e.g. to achieve a safety objective).
- To overcome a market failure.
- To increase operator confidence in FAA commitment to a capability through pioneer, or early adopter efforts, and thus encourage voluntary equipage.
- To accelerate the availability of a benefit that requires high levels of equipage.
- To achieve economic efficiencies, including government efficiencies.

Incentives don't generally change types of behaviors; instead, they are more likely to affect the *timing* of behaviors. For example, an incentive that provides an additional benefit may accelerate the timing for investment in avionics. Conversely, an incentive will not always overcome the barriers to equipage, especially if the barriers are not economic. There are four major policy approaches can be used to address equipage:

1. **Equipage by Natural Evolution:** Over long periods of time (10+ years), the "lowest common denominator" will rise as new aircraft are delivered. This approach requires the market to have an expectation of future utility; otherwise manufacturers will not make offerings, and operators will not select "options" when ordering aircraft. This approach can be an alternative to explicit incentives; improved FAA program design and communication of intentions may provide motivation for forward fit and some retrofit decisions by operators. This approach is generally is the least expensive mechanism, since the cost of avionics when delivered with new aircraft are significantly less than retrofit, and also tend to bypass financing obstacles. Natural evolution, however, is not likely to motivate equipage for in-service aircraft still in the system and takes a long time to achieve a new baseline.

2. **Operational Incentives:** Can be designed to offer procedures that provide a differential benefit to some aircraft or their operators over other operators, thereby providing a competitive advantage. For example, a procedure may result in a more efficient flight operation or improved access in comparison to those not equipped.[1] Operational incentives can also include artificial mechanisms that provide a differential benefit based on the presence of the equipage, versus the direct use of a capability, resulting in preferential treatment of aircraft that equip. Any operational incentive which is offered in a mixed equipage environment requires controllers to be able to handle the situation with acceptable workload impact. This is an attractive option to the FAA, since procedure design is generally small in cost relative to procurements in government. Note that incentives and policies that provide disbenefit to non-equipped users may generate significant political pushback, however.
3. **Financial Incentives:** Can be used to reduce the cost of acquisition or to reward behaviors. Examples of financial instruments include subsidized loan programs, grants, pioneer equipage projects, or tax breaks. International ANSPs have an additional option not generally available to the FAA—they can apply different market pricing to services tied with equipage compared to pricing to operators not equipped. Note that financial incentives alone are not likely to induce equipage; operators are not likely to respond to these incentives if there are not any operator business benefits associated with the equipage.
4. **Regulatory Action:** Involves the use of mandates or airspace restrictions to establish a minimum equipage in a given airspace/airport for the specified time period. Examples where regulatory action has been used by the FAA include DRVSM and the Automatic Dependent Surveillance - Broadcast (ADS-B) "out" mandates. Regulatory actions require the FAA to establish a compelling case that is subject to public comment and review. In practice, regulatory actions are generally driven by safety considerations.

[1] The FAA has defined an operational incentives framework with four key categories. 1, Equipped operators benefit; no negative impact on other operators; 2, Equipped operators have a benefit that exceeds the dis-benefit to non-equipped users; 3, Benefits to operators and society exceed the dis-benefit to non-equipped users; and 4, users experience a net dis-benefit in the near-term but over the long term significant societal and user benefits are achieved.

3 Hypothetical Case: Introduction of RNP / Authorization Required (AR) Procedures for Equipped Aircraft to resolve Metroplex Congestion

The hypothetical case presented below is intended to illustrate the airborne equipage investment decision process that a commercial aircraft operator (an airline) would likely follow if presented with an FAA-proposed improvement in service at one or more airports of interest, based on the operator's willingness to invest its own money in improving the capability of its fleet to take advantage of that improvement in service.

The scenario is initially focused on assessing the incentivization value of FAA-offered RNP procedure improvements at a single airport of interest, presumably intended by the FAA to limit necessary investment in ground-systems and training for new procedures until they can be fully vetted operationally. However, this single airport offer is found to be of limited financial value to the operator, since the equipped aircraft operate at many airports, and the case for equipping the more costly-to-upgrade aircraft is positive only when equipage costs can be amortized across a broader operational base. Accordingly, the operator looks into a multi-airport business model and finds a compelling case for equipping much of its operating fleet.

3.1 Scenario Development

Airline X operates in a Metroplex where RNP with RF leg capability is being proposed to improve operational efficiency and schedule integrity at Airport ABC. The airline is aware that existing sequencing and flow management procedures generally function adequately under normal conditions, but that these procedures are often stressed to the limit during peak operational periods—improved Area Navigation (RNAV)/RNP procedures may be the answer.

This would be seen by the airline as a means to reduced block times, increased number of operations and/or improved schedule integrity at the airport. They have been told these benefits will begin to accrue in 2015 when the procedures are implemented. They have been informed that government-subsidized loans may be made available for equipage on their aircraft that gets them to this capability.

Airline Flight Operations is familiar with this capability and has participated in industry meetings. The operations organization is the advocate within the airline and believes that the airline should go through the process of consideration of acquiring this capability and leveraging the subsidized loans as a financing mechanism.

Current airport operational flows are illustrated in Figure 3-1 below.

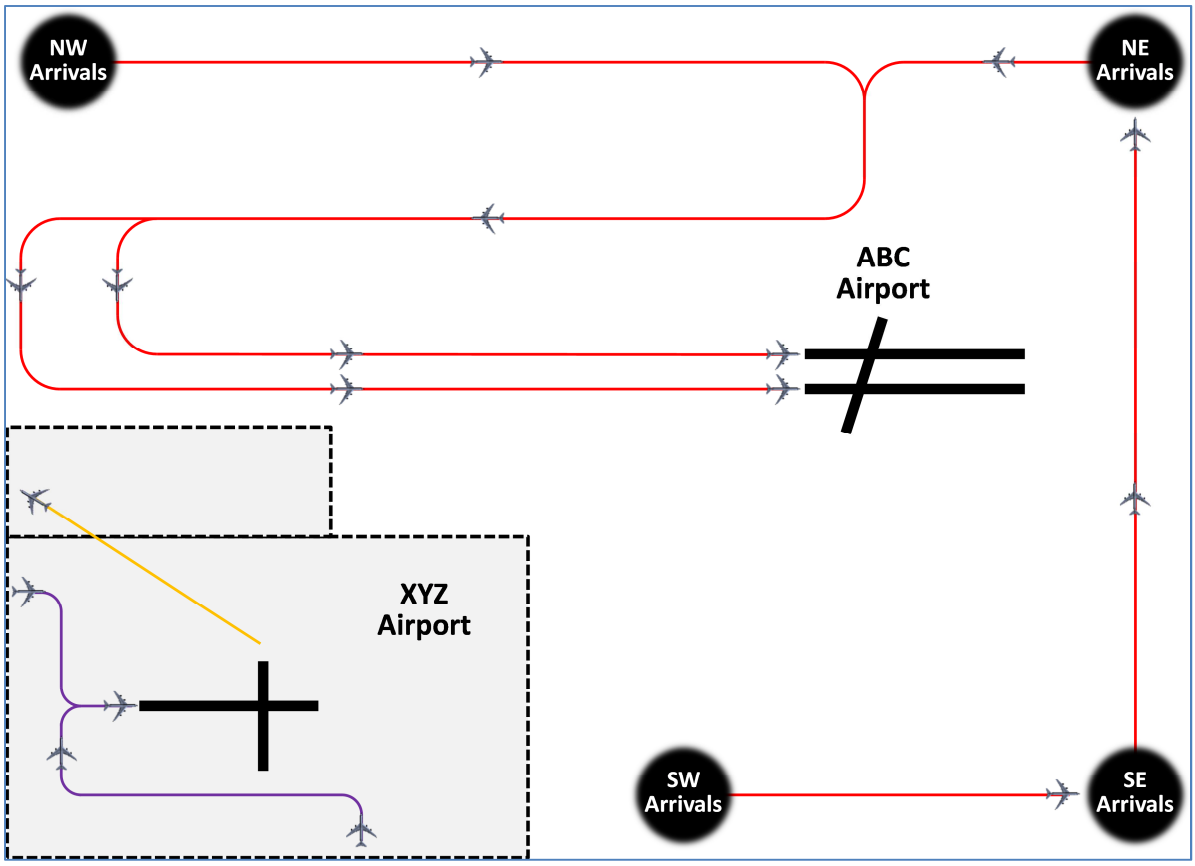

Figure 3-1. Existing Airport Flows

3.2 Discussions with Metroplex Stakeholders

The designated representative from Flight Ops begins the advocacy process by discussing the idea with other stakeholders operating in the Metroplex. The operator notes that their fleet is approximately 90% RNAV, 80% RNP, and 30% Curved Path (Radius to Fix or RF) capable, and that taking advantage of this with improved procedures would likely improve operational efficiency. The Airport Authority view is that this approach this would work at the airport, since simultaneous dual runway operations are possible.

A potential change to airport operational flows is illustrated in Figure 3-2 below.

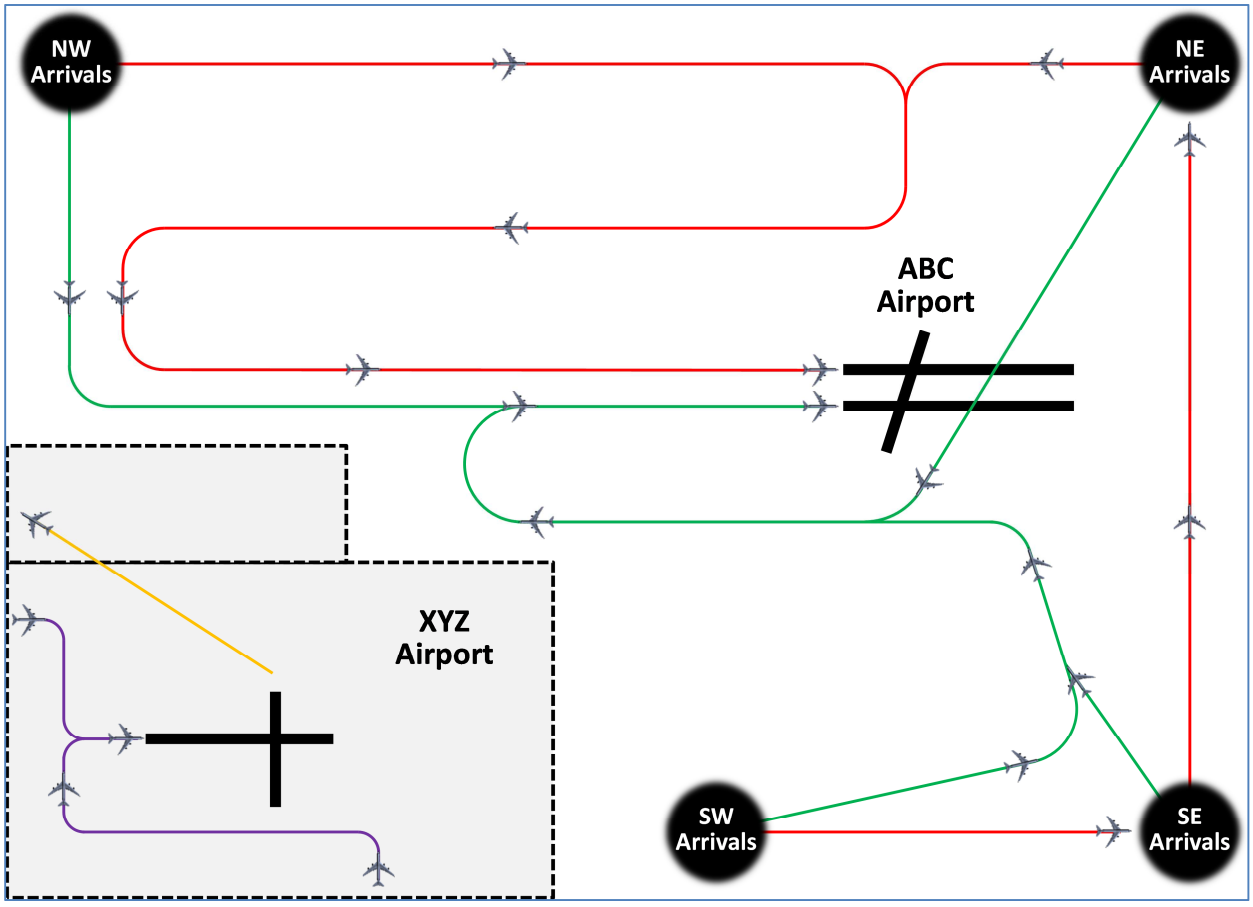

Figure 3-2. Incentivized Airport Flows

In speaking with both controllers and pilots, these two constituencies note that for the RF leg procedures to be viable, it would be essential for a certain critical mass of the arriving/departing flights to improve dual runway procedures. Fly-by-waypoint paths would not be sufficiently predictable, given variability in aircraft and flight management system performance. Noting that only around 30% of the operating aircraft are currently equipped, there does appear to be potential for operational incentives to be applied to raise the critical mass of equipage. These incentives would take the form of offering procedures that would incentivize operators to close the RF leg equipage gap (in other words, to equip a larger percentage of the fleet operating at the target airport or airports), in order to justify the needed airline investment in upgraded aircraft capability.

In a meeting of the Metroplex stakeholders, the conversation goes something like this:

- **Airport Operator:** “We could segment traffic between our two parallel landing runways, to create optimized procedures for those who are RF leg equipped”.

- **Flight Standards and Procedure Specialists:** “That’s right, we could run RF to one runway; RNAV/RNP to the other. But we have to remember that we need enough RF equipped operations to properly balance use of the two runways”.
- **The Center:** “It’s certainly possible to separate RF capable/non-capable into two arrival streams, but we at the Air Route Traffic Control Center (ARTCC) must be involved early on, and we need suitable decision support tools”.
- **The Terminal:** “A solution exists for ARTCC and Terminal Radar Approach Control (TRACON) to coordinate on this, and workload will be equivalent or less than the status quo”.
- **Operators Lacking RF Capability:** “This may initially put us at a disadvantage, but the new operations could help us to justify a fleet upgrade to take advantage of the new procedures”.
- **Airport Operator:** “Note that during construction or snow removal one runway may be closed causing revert to status quo”.

The group also believes that the environmental impact is manageable, so it seems that the stakeholders see a way forward.

3.3 Building the Airline’s Internal Investment Case

In order to get a commitment to make this investment, the capability advocate has to build the case across all aspects of the company consistent with its governance policies as good practice and mandated by Sarbanes-Oxley (Reference Pub. L. 107-204). The investment decision will be made by the company board of directors whose consideration will be driven by multiple perspectives.

The Airline Advocate’s proposal review storyboard looks like this:

- **Status:** External stakeholders have reviewed proposal; they appear optimistic, and see no show-stoppers.
- **Benefit:** Postulates more predictable block times leading to better schedule integrity.
- **Timing:** Postulates benefits accrual starting 2015.
- **Financing:** Understands that financially-advantageous loans may be made available.
- **Applicability to Fleet and Operations:** Notes that this may be limited for various reasons, including lack of manufacturer offerings of targeted capabilities for some airframes.

The capability advocate approaches the Strategic Planning Department to assess the investment from their perspective. Strategic Planning is focused on creating a competitive advantage in the company’s current markets, and establishing growth opportunities in new markets deemed to

have high value. The capability advocate notes that the airline's major hub is increasingly constrained by the growth in operations at an adjacent airport; and explains that the target capability could relieve some of those constraints. However, the strategic planning department is concerned that achieving the benefit requires FAA to follow through on investment and implementation of operational changes and this is seen as a major risk factor. They also point out to the advocate that in the timeframe under discussion for implementing the RF leg program, the airline is considering a return of the current aircraft to the lessor in favor of a new fleet. However, these discussions are in their infancy. Summary—Approved to move forward on the business case analysis with concerns that a potential that a new airline fleet plan may disrupt the program during the implementation phase and with a condition that the FAA be required to formally commit on delivery of benefits by 2015.

The Maintenance Department is visited next and after review, they accept the changes from a technical point of view. They explain that the modifications are extensive to the cockpit and equipment bay, and will either require an additional two days of out of service time to the aircraft if performed during a major maintenance check[2], or would require a one week dedicated modification effort. Maintenance says they will leave the calculation of cost between additional out of service time versus dedicated modification line to someone else, but in either case it will be a significant cost addition to the project. They also point out that the lessor of the aircraft will have to be consulted for approval prior to project launch due to specific clauses regarding modifications in the leasing agreement. Finally, they are concerned that the loan program will not cover installation and that maintenance budget has no margin to support these expenses. Summary—approved to move forward, but leasing company has to approve, budget for installations needs to be allocated. Also, they note that installation will impact schedules which must be coordinated with Marketing and Strategic planning.

Marketing, with a representative from Strategic Planning, is visited next by the advocate. Marketing is most unhappy that a large number of aircraft have to be modified in a manner that will keep them out of service. The feedback to the advocate is that the out of service time will significantly and negatively impact several planned schedule changes that were to enhance revenues and open up new service to desired cities. However, they both concede that the improvement at the hub, if realized operationally, would outweigh the other schedule changes that would have to be adjusted. They also mentioned that if the modifications occurred between October and April the costs would be reduced because of the annual reduction of schedule during the winter time. They pointed out that a summer time modification program would be an opposite affect and much more expensive. Summary—they approve, but the airline's plan to expand markets would be negatively impacted and they recommend looking at modifications only during winter months.

The Safety Department is visited and they are very supportive of the program. They believe that the upgraded system will provide the pilots improved situational awareness thus improving safety. They also point out that the new displays that will be added as part of the program,

[2] Note that the two days cited above is the incremental time required to perform the upgrade during a major maintenance check. The complete major maintenance check would normally require between one and two weeks overall.

support their longer term goals of having the ability to display ADS-B In traffic to the pilots and therefore long term safety goals are also aligned to the program. Summary—Safety believes the program is an immediate enhancement and paves the way for their strategic plan for aircraft safety improvements.

The advocate next briefs the Training Department. They believe that training will be required in simulators for all of the pilots. They point out that simulator time is very hard to find since the company does not own their own simulators. They believe that it may be required to reserve additional simulator capacity out of the country to accommodate the request. Training points out that the training curriculum is already completely full and the new capability will add two hours of training in simulators and a half day of ground instruction. To accommodate this small change, the ripple effect will be that additional simulator time will have to be reserved outside of the simulators currently in use. Training points out that training all of the crews during an extra two days for required recurrent training is significantly cheaper than having a specific RF leg training event. Summary—Training can accomplish the training, but with potential significant cost of finding additional simulator time outside of their current contracts with vendors.

The advocate also checks with Human Resources, Customer Service and other departments as part of due diligence within the company and all feel that there is no impact to their departments.

3.4 Review with Senior Management

The advocate takes all of the information back to senior management in a briefing. Senior management agrees to undertake a serious cost and benefit analysis from the information.

Senior Management identifies a number of risks to be assessed:

- Leasing Company Approvals
- Costs of Installation
- Costs of Out of Service Time for aircraft and crews
- Costs of Training
- Lack of detail in incentive loan terms & conditions
- Uncertainty that FAA can implement

Senior Management identifies a number of opportunity costs:

- New Airport Check In Counters
- Crew Lounge Upgrades
- New Maintenance Software Program

But management also sees substantial potential gains:

- Significantly Improved Operational Capabilities in the long-run

Senior Management points out that the risks to the program are significant: leasing company approval, cost of out of service time, cost of training and risk the FAA will implement the

operations promised. However, they also see significant potential enhancement to hub operations which is enough for them to overcome these risks and move forward with a deep analysis, including a Finance/Legal deep-dive.

3.5 Financial Analysis

The Chief Financial Officer (CFO) conducts an in-depth business case analysis, determining that the FAA financial incentives may be of limited value, due to the need to directly finance the costs of installation, aircraft out of service, and crew training, and because the risk premium pushes the cost of the financing via the FAA incentives program up to that of commercial financing options.

The CFO analysis used the following as inputs:

- Key financial metric:
  - The airline considers the financial benefits of this investment across a 2.5 year payback period.
- Key assertions:
  - FAA procedures are in place and available for immediate use when the equipment is installed on the airline's candidate aircraft.
  - Engineering-complete equipment is offered for all candidate aircraft.
  - Equipped aircraft will receive a benefit of 10 minutes of reduced flight time for every flight into the target airport.[3]

To illustrate the analysis that would be performed by the CFO's office, we are using the following data and assumptions:

- Each aircraft in the airline fleet was assessed for its compliance with AC 90-105. Costs for equipage shortfalls and associated installation costs were calculated using The MITRE Corporation (MITRE) avionics database.
- One year of operations data was assessed to determine the frequency of flights into the target airport by each aircraft in the airline fleet using the MITRE threaded track tool. This fleet operational profile is assumed to remain constant for the projected investment analysis timeframe.
- Data provided through the airline Form 41 reporting mechanism to the Department of Transportation (DOT), compiled by Oliver Wyman[4] and reported by Aviation Week:

[3] The value of 10 minutes of reduced flight time per airport is asserted for the purpose of this vignette, although it is recognized that a clear consensus on what constitutes a realistic benefit does not yet exist.

[4] A CFO would not normally use data provided by Oliver Wyman; these data are used in this vignette to simulate the type and nature of airline-internal information that a CFO would use in the business case decision making process.

- Airline fuel costs per minute of flight operation assumed to reflect the variable aircraft operating cost that could be avoided due to use of the enhanced procedure.
- Aircraft total cost of ownership per day assumed to reflect the opportunity cost for aircraft out of service.

- Legacy carrier crew members per airframe based Bureau of Transportation Statistics; and, training costs of $250 / day / legacy carrier crew member with 2 days of required training based upon Air Transport Association (ATA) and American Airlines (AAL) interviews in 2008 drives the expected training cost.

Using the above inputs, the CFO determined that the business case did not close for the target airport, with the results of the analysis summarized in Figure 3-3 below.

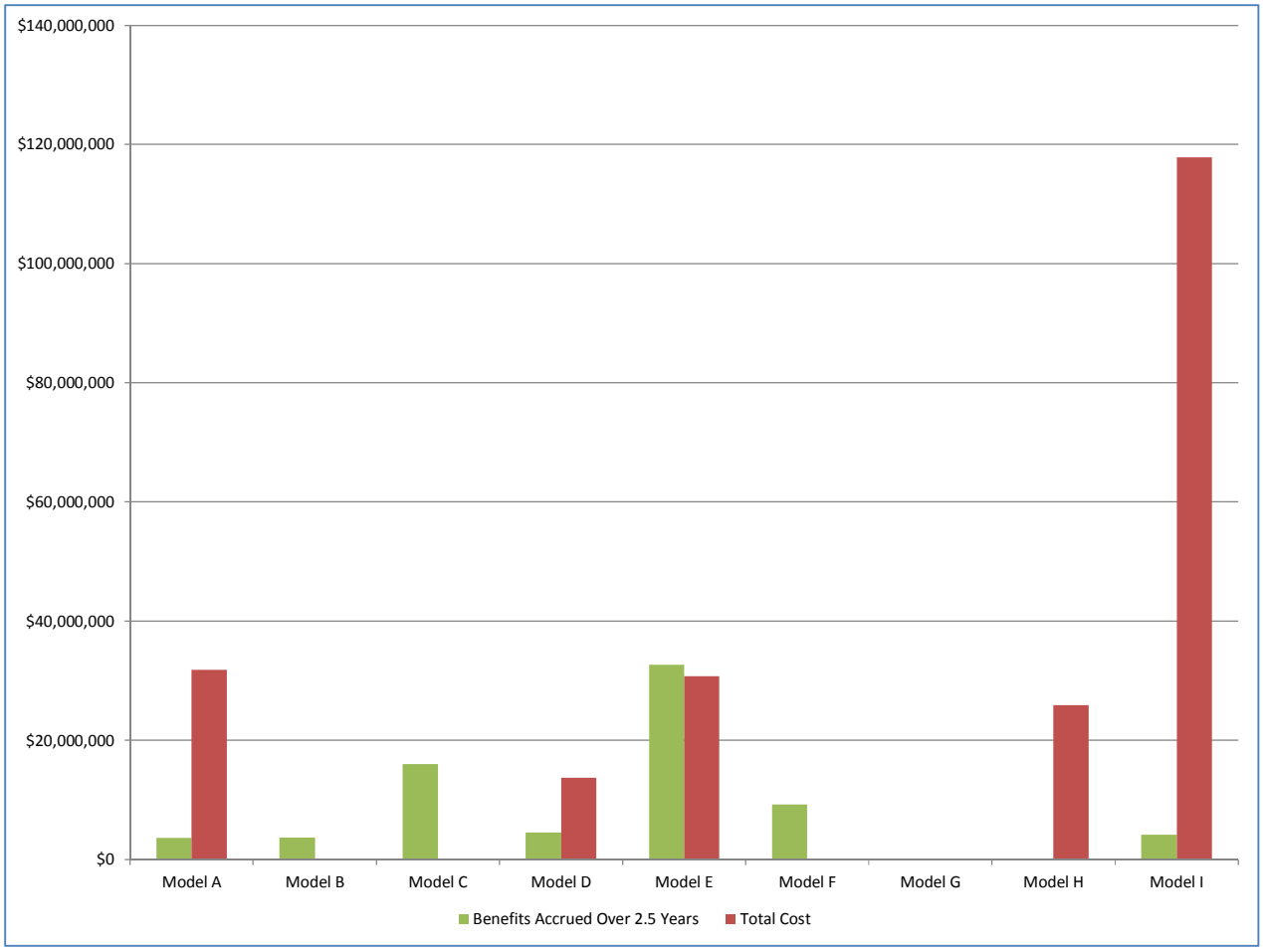

Figure 3-3. Benefits vs. Costs by Airframe Class—Case for One Hub Airport Only

As the figure illustrates, while aircraft Models B, C and F and G are already equipped, the CFO can make the case for equipping only one currently unequipped aircraft type, Model E, based on

a business case based solely on operations at Airport ABC, and this case is marginal given the opportunity costs.

If Airline X were to consider equipping its entire unequipped fleet for operations at Airport ABC, the benefits received at that airport would be completely swamped by the cost of full fleet equipage, as shown in Figure 3-4.

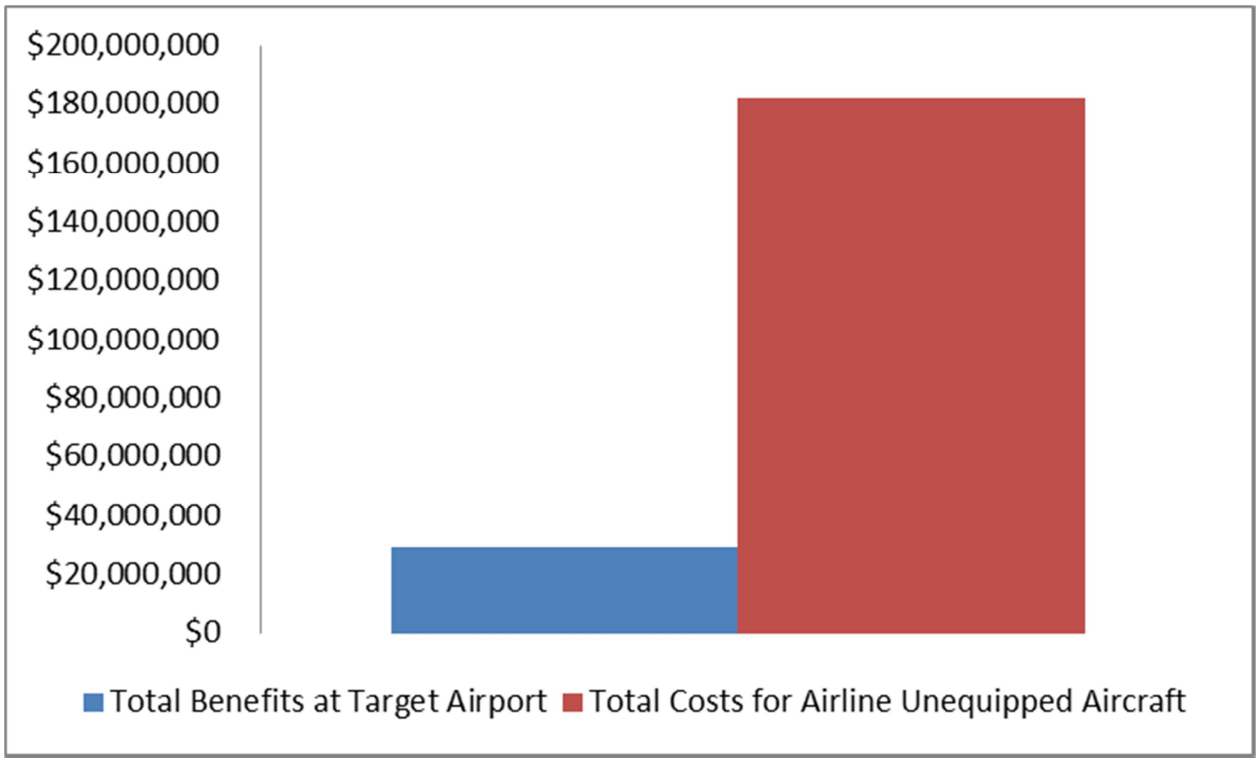

Figure 3-4. Total Benefits at Target Airport and Total Costs for Airline Unequipped Aircraft

Since the benefits of the proposed improvement in RNP procedures had been vetted by the airline's operational, marketing and technical departments, the CFO suggested that perhaps the airline should assess the costs and benefits of such an investment if operational services were available to the company's aircraft at a number of key airports across its network.

Recognizing that sophisticated procedures requiring the desired equipage would be applicable at the five major airports where the airline operated, the CFO conducted an analysis for the costs and benefits for its entire fleet at those five major airports. Just as with the target airport, all flight operations arriving at these five airports are asserted to receive 10 minutes of reduced flight time on each flight operation conducted. The results for the five-airport case are presented in Figure 3-5 below.

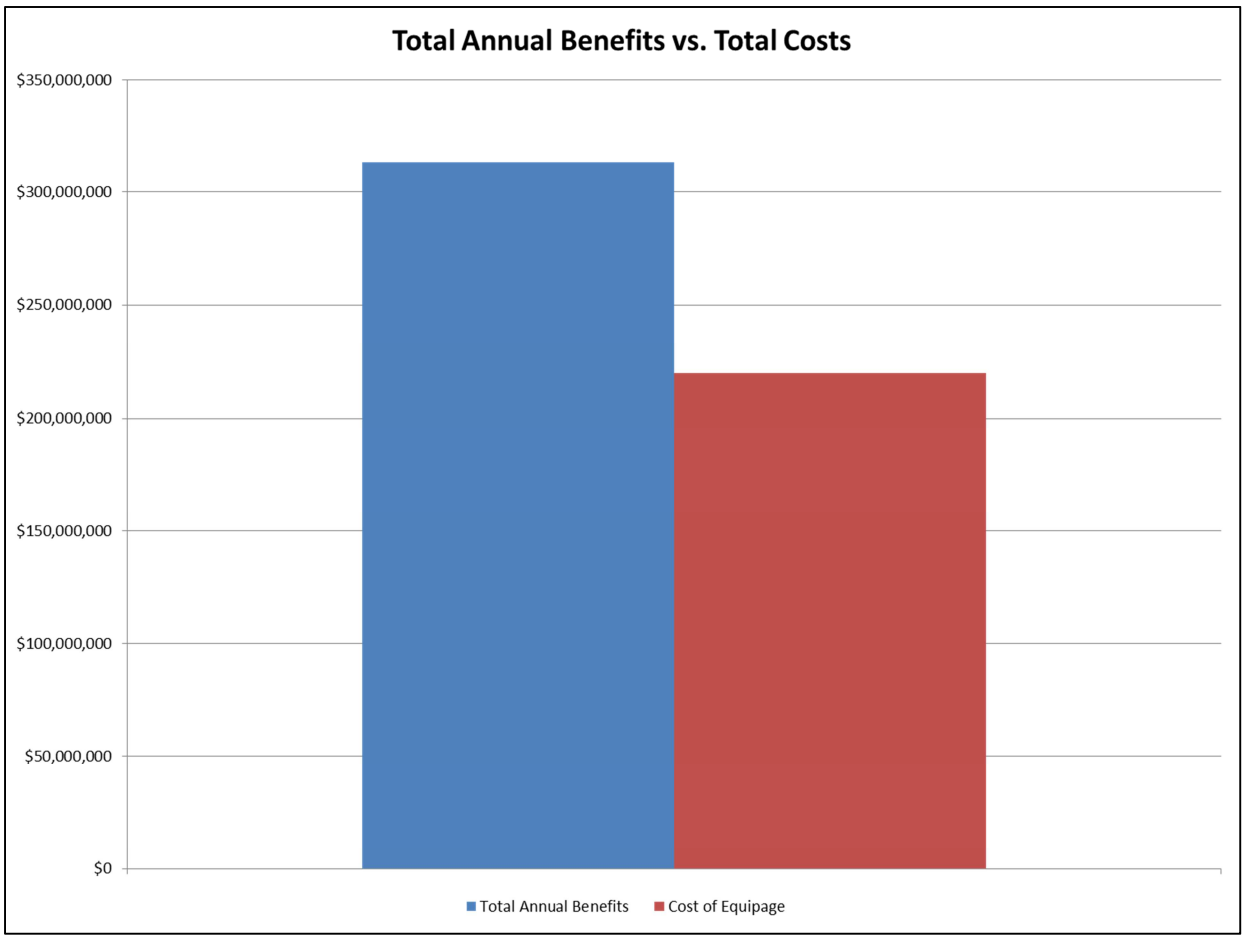

Figure 3-5. Total Annual Benefits at Five Major Airports and Costs for Fleet Equipage

The CFO also estimated the contribution of benefits by airport, where Airport ABC (labeled Airport 4 in the data analysis) was the initially proposed focus of the investment analysis. This analysis is shown in Figure 3-6 below.

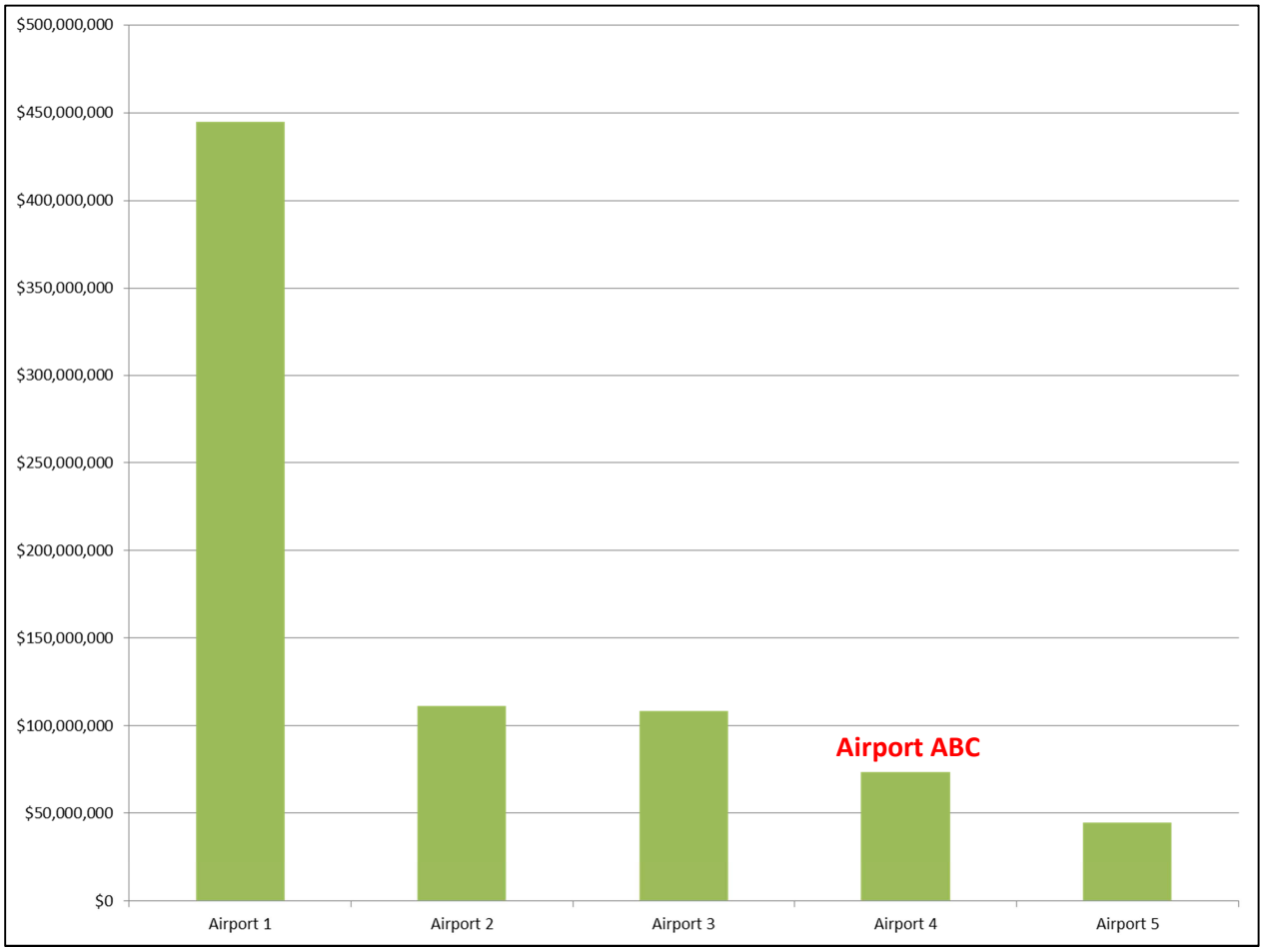

Figure 3-6. Contributions of Benefit by Airport

The CFO further estimated the benefits net of equipage costs (including avionics, installation, initial crew training, and out of service) for each of the models of aircraft in the airline inventory, as shown in Figure 3-7 below.

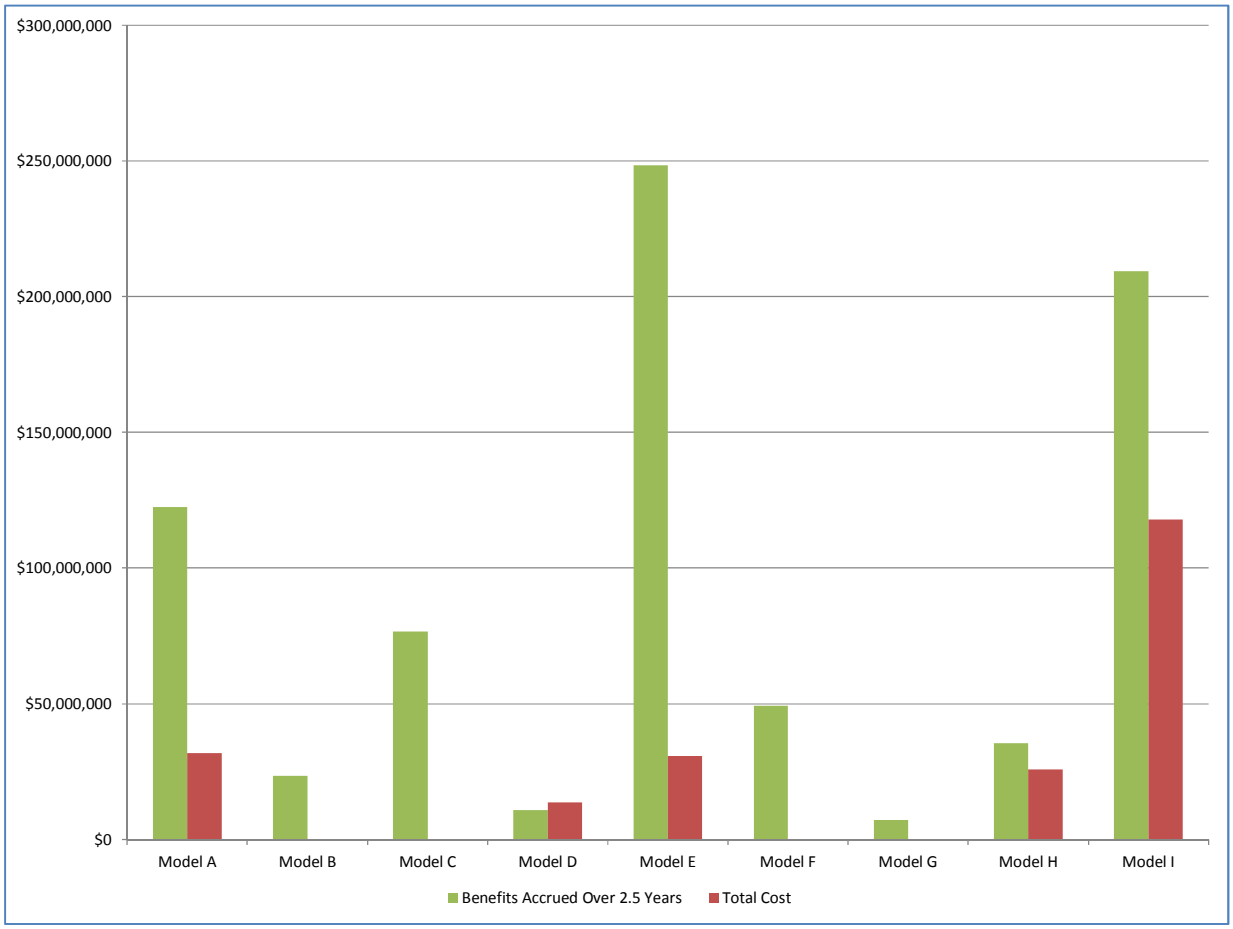

Figure 3-7. Benefits vs. Costs by Airframe Class—Case for Five Key Hub Airports

The CFO observes that in the five-airport case, for all but one model, Model D, the benefits clearly outweigh the costs, and that investment in equipage would be justifiable if the FAA were to offer the improved RNP/AR procedures at all five airports.

Finally, the CFO requested an assessment of benefits by aircraft model, for the five-airport case.

Based upon the data in Figure 3-8, the CFO concluded that marginal benefits exceeded marginal costs for all aircraft models except Mode D. Since Model D is an older twin-aisle aircraft with a low number of operations in the NAS; the CFO determined that this sub-fleet could be left unequipped without undermining the business case for the remaining sub-fleets. It is also recommended that further analysis for this fleet be conducted with consideration of the aircraft's foreign airport operations and potential benefits or mandates that may impact the decision to equip this airframe in order to meet or benefit from international operations.

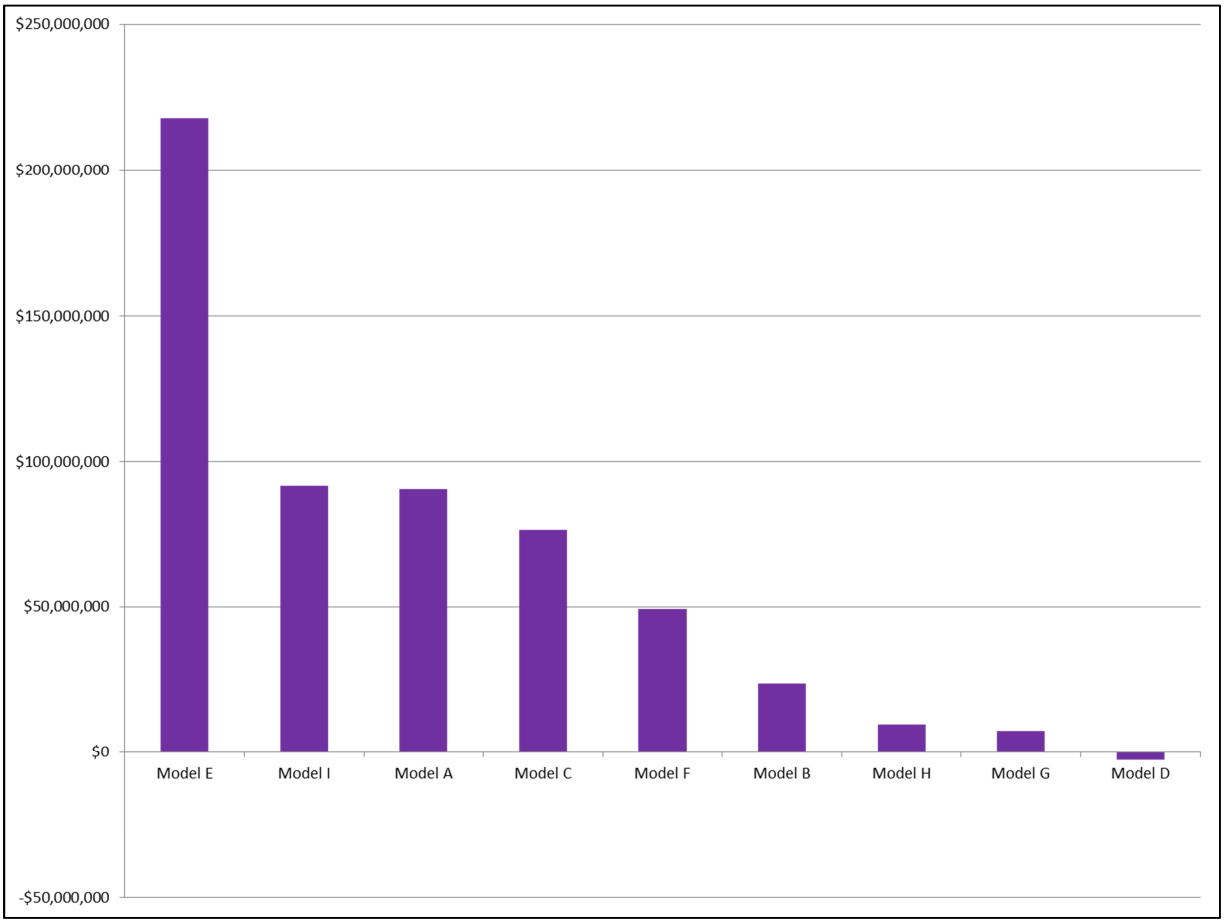

Figure 3-8. Benefits Accrued Over 2.5 Years—Equipage Costs by Make/Model Grouping

The principal remaining risk in this investment scenario continues to be that the FAA does not succeed in making the appropriate procedures available at the target airports prior to the incursion of equipage costs. This said, the CFO agrees to move forward, given that the operator is indemnified by the FAA against non-delivery of benefits, and given that the FAA agrees to make the dual runway RNP/AR-preferred operations available at all five airports.

3.6 Final Gate: The Legal Analysis

Chief Counsel conducts a legal review. Counsel concludes that the incentive loan guarantee program should be undertaken, given that the FAA indemnify the airline by forgiving loans made under the program if benefits do not accrue at all five airports on an agreed schedule, starting in 2015, and, given that "exit ramps" be defined allowing the parties to terminate the arrangement if necessary.

3.7 The Operator's Conclusions

Accordingly, the company decides that if the FAA agrees to offer the improved RNP/AR service at all five airports, and if the FAA agrees to the legal remedies proposed above, the airline can justify taking advantage of the incentive program and investing in upgrading the capability of all of its aircraft types apart from Type D.

Key observations from this scenario are as follows:

1. While the single airport case did indeed yield a positive ROI for one unequipped aircraft type, this was an underwhelming result for the company's management since that this aircraft type was already very close to the desired capability. Operators generally prefer operational procedures and avionics capabilities to be as homogeneous as possible across the fleet, for scheduling, training, safety and maintenance purposes. Thus, it would not likely be seen as advantageous to upgrade a small percentage of the overall fleet just to improve operations for these aircraft at one airport.
2. Broadening the program to include five key hubs greatly improves the attractiveness of the incentive. Not only do benefits accrue at all five airports, but the uniformity of crew training, maintenance operations, flight scheduling and the resulting improved safety of operations makes the program far more attractive to the airline.
3. Interestingly, even the one aircraft type (Type D) that did not pass muster offers an opportunity. The Type D aircraft is a long-haul trans-oceanic aircraft, so this offers the airline an opportunity to look at the city pairs between which the aircraft operates to see if any of the international destination airports may have an interest in similarly improved RNP/AR operations, or may be subject to future regulatory actions that will require RNP AR equipage.. In either case, equipage of this model may be justified.

One key difference in perspective between the FAA, who invests in airports and ground systems, and the aircraft operators, who invest in aircraft that pass through many airports, is that from the operator's perspective, a successful incentives program must be fairly broad-based in geographic terms. Reducing FAA ground-side program cost or risk by rolling out in limited geographic areas increases the possibility that the operators will not be able to make the business case to participate in the program at all.

What this means is that in addition to ensuring that a sufficient number of beneficial operations occur for each equipped aircraft during its flying day, it is also essential to design the rollout of the incentives program to ensure that procedures are available for use at or near the time that the

investment is made. This requires close synchronization of ground system deployment, crew and air traffic controller training, and fleet capability rollout.

4 Research Questions and Next Steps

As the scenario presented in Section 1 illustrates, accelerating NextGen benefits and achieving higher levels of capability in the NAS will require joint, synchronized commitments among the FAA, aircraft operators, and other stakeholders. FAA will be able to have more productive interactions with all stakeholders with a qualitative and quantitative understanding of the likely impacts of individual and combined incentive strategies.

Key research areas that could inform the FAA's utilization of incentives fall into the categories outlined in the sections that follow.

4.1 Incentive Strategy Harmonization and Prioritization

- Model the likely impact of the combined suite of incentive approaches currently in process by FAA and the likely combined impact on flight operator behavior. Are the mechanisms competing for operator resources? How do operator fleet upgrade cycles and new aircraft purchase opportunities affect NextGen capability value?
- Evaluate the fleet operator dynamics associated with geographical capability implementation. Identify, for a given location or market, how different incentive approaches in consideration are likely to be internalized by different operators, especially those with mixed fleets.
- Evaluate the impact of incentives affecting the dynamics among:
  - The need to achieve minimum levels of equipped operations within the airspace surrounding an airport.
  - Benefit levels to justify equipage (typically achieved via benefit accrual across the breadth of the geographic scope of the operator's mission).
  - Operator cash flow requirements.

  As part of this, assess the effectiveness of incentives across the range of fleet operators (including State operators, carriers with large hub operations, regional operators, etc.).
- Assess the value tradeoffs between incentive approaches ranging from a neutral approach (natural equipage timing) to more aggressive incentive approaches, including accelerated implementation of capabilities. How are these approaches viewed from a system perspective and from an individual stakeholder perspective?

4.2 Understanding of Operational Benefit Mechanisms

- Characterize the specific operational impacts to equipped versus non-equipped aircraft for locations implementing the capability, including the range of benefits achieved by level of equipage. Do equipped operators see any "dis-benefits"?

What is the distribution of benefit in terms of metrics most directly relevant to each stakeholder?

- For each NextGen capability, what level of benefit, or what extent of implementation, is likely needed before flight operators can justify significant retrofit of current fleets?
- What automation capabilities mitigate problems with mixed equipage environments? What are the tradeoffs with respect value and risk?

4.3 Understanding of Aircraft Operator Environment

- Establish improved visibility of Commercial (other than FAR Part 121) and high end GA fleet capabilities with greater detailed forecasting of fleet characteristics and mission profiles, enabling cost and benefit analysis for these operator types.
- What is the likely profile of DOD equipage with NextGen avionics? How does the presence of operational incentives affect DOD uptake rates?
- A specific analysis of regional jet and turboprop operations would also help to inform ways in which incentives targeted at the regional carriers' mainline customer airlines would resonate and how decisions affecting regional aircraft equipage are made.

4.4 Other Considerations

In addition to the research topics above, we believe that FAA should evaluate the impacts of complementary approaches to accelerating equipage, such as adjustments to program design or new mechanisms that enable synchronized, joint investments among stakeholders. Another key step for FAA in going forward will be to establish a set of best practices on incentives policy, building on lessons learned past efforts related to avionics incentives and benefit evaluations. There have been a number of initiatives aimed at safety and efficiency benefits that can provide valuable guidance for future efforts, including the Alaska Capstone initiative, the ADS-B application evaluations with United Parcel Service (UPS), and the Capstone 3 initiative to accelerate electronic flight bag equipage. These can be used to inform current efforts in place as well as to refine approaches for future capabilities, as captured in the NextGen Concept of Operations.

Appendix A Summary of Pertinent Legislation

A.1 HR 658, FAA Modernization and Reform Act of 2012

Contains new authorizations related to financial incentives and instructs FAA to develop plans related to operational incentives. (*See text excerpts at end of this appendix*).

Section 211 directs FAA to develop a plan for the use of ADS-B that includes the definition of a policy in test regions that gives priority to aircraft equipped with ADS-B.

Section 221 authorizes FAA to establish an avionics incentives program, aimed at commercial and general aviation aircraft, that is based on public-private partnership principles and leverages the use of private sector capital. It requires FAA to limit any loan guarantees to 90% of the principal and requires applicants to pay fees to offset costs of potential defaults. The incentive program authority terminates 5 years after establishment. Note that the Congressional conference report indicates the intent to have processes similar to those established for the Railroad Rehabilitations and Improvement Financing program.

Section 222 requires FAA to deliver a report on incentive options, including the costs and benefits of each option. It also specifies to have, in the report, input from industry stakeholders.

Relevant language from the FAA reauthorization bill includes Sections 211, 221, and 222:

Section 211. AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST SERVICES.

(c) USE OF ADS–B TECHNOLOGY.—

(1) PLANS.—Not later than 18 months after the date of enactment of this Act, the Administrator shall develop, in consultation with appropriate employee and industry groups, a plan for the use of ADS–B technology for surveillance and active air traffic control.

(2) CONTENTS.—The plan shall—

(A) include provisions to test the use of ADS–B technology for surveillance and active air traffic control in specific regions of the United States with the most congested airspace;

(B) identify the equipment required at air traffic control facilities and the training required for air traffic controllers;

(C) identify procedures, to be developed in consultation with appropriate employee and industry groups, to conduct air traffic management in mixed equipage environments; and

(D) establish a policy in test regions referred to in subparagraph (A), in consultation with appropriate employee and industry groups, to provide incentives for equipage with ADS–B technology, including giving priority to aircraft equipped with such technology before the 2020 equipage deadline.

SEC. 221. PUBLIC-PRIVATE PARTNERSHIPS.

(a) IN GENERAL.—The Secretary may establish an avionics equipage incentive program for the purpose of equipping general aviation and commercial aircraft with communications, surveillance, navigation, and other avionics equipment as determined by the Secretary to be in the interest of achieving NextGen capabilities for such aircraft.

(b) NEXTGEN PUBLIC-PRIVATE PARTNERSHIPS.—The incentive program established under subsection (a) shall, at a minimum—

(1) be based on public-private partnership principles; and

(2) leverage and maximize the use of private sector capital.

(c) FINANCIAL INSTRUMENTS.—Subject to the availability of appropriated funds, the Secretary may use financial instruments to facilitate public-private financing for the equipage of general

aviation and commercial aircraft registered under section 44103 of title 49, United States Code. To the extent appropriations are not made available, the Secretary may establish the program, provided the costs are covered by the fees and premiums authorized by subsection (d)(2). For purposes of this section, the term ‘‘financial instruments’’ means loan guarantees and other credit assistance designed to leverage and maximize private sector capital.

(d) PROTECTION OF THE TAXPAYER.—

(1) LIMITATION ON PRINCIPAL.—The amount of any guarantee under this program shall be limited to 90 percent of the principal amount of the underlying loan.

(2) COLLATERAL, FEES, AND PREMIUMS.—The Secretary shall require applicants for the incentive program to post collateral and pay such fees and premiums if feasible, as determined

by the Secretary, to offset costs to the Government of potential defaults, and agree to performance measures that the Secretary considers necessary and in the best interest of implementing the NextGen program.

(3) USE OF FUNDS.—Applications for this program shall be limited to equipment that is installed on general aviation or commercial aircraft and is necessary for communications, surveillance, navigation, or other purposes determined by the Secretary to be in the interests of achieving NextGen capabilities for commercial and general aviation.

(e) TERMINATION OF AUTHORITY.—The authority of the Secretary to issue such financial instruments under this section shall terminate 5 years after the date of the establishment of the incentive program.

SEC. 222. OPERATIONAL INCENTIVES.

(a) IN GENERAL.—The Administrator of the Federal Aviation Administration shall issue a report that—

(1) identifies incentive options to encourage the equipage of aircraft with NextGen technologies, including a policy that gives priority to aircraft equipped with ADS–B technology;

(2) identifies the costs and benefits of each option; and

(3) includes input from industry stakeholders, including passenger and cargo air carriers, aerospace manufacturers, and general aviation aircraft operators.

(b) DEADLINE.—The Administrator shall issue the report before the earlier of—

(1) the date that is 6 months after the date of enactment of this Act; or

(2) the date on which aircraft are required to be equipped with ADS–B technology pursuant to the rulemaking under section 211(b).

A.2 Other Transaction Authority

FAA has indicated, via communication to Industry, interest in using OTA authority. On Sept 27, 2012, FAA sent out an Request for Information, including the following language: *Specifically, the FAA is evaluating the possible use of OTAs as a vehicle to require specified equipage by one or more operators in exchange for FAA action at designated locations (airport or airspace). OTAs could be used with or without loan guarantees.*

From a Congressional Research Service report in 2011, *Another transaction (OT) is a special vehicle used by federal agencies for obtaining or advancing research and development (R&D) or prototypes. An OT is not a contract, grant, or cooperative agreement, and there is no statutory or regulatory definition of "other transaction." Only those agencies that have been provided OT authority may engage in other transactions. Generally, the reason for creating OT authority is that the government needs to obtain leading edge R&D (and prototypes) from commercial sources, but some companies (and other entities) are unwilling or unable to comply with the government's procurement regulations. The government's procurement regulations and certain procurement statutes do not apply to OTs, and, accordingly, other transaction authority gives agencies the flexibility necessary to develop agreements tailored to a particular transaction*. See: http://www.fas.org/sgp/crs/misc/RL34760.pdf

A.3 Anti-Deficiency Act (1982)

In a public meeting on 8 August 2012, FAA stated that they will not agree to any "indefinite commitments" that would establish FAA liabilities (due to the limitations of the Anti-Deficiency Act).

GAO's website states that: The Antideficiency Act prohibits federal employees from:

- making or authorizing an expenditure from, or creating or authorizing an obligation under, any appropriation or fund in excess of the amount available in the appropriation or fund unless authorized by law. 31 U.S.C. § 1341(a)(1)(A).
- involving the government in any obligation to pay money before funds have been appropriated for that purpose, unless otherwise allowed by law. 31 U.S.C. § 1341(a)(1)(B).
- accepting voluntary services for the United States, or employing personal services not authorized by law, except in cases of emergency involving the safety of human life or the protection of property. 31 U.S.C. § 1342.
- making obligations or expenditures in excess of an apportionment or reapportionment, or in excess of the amount permitted by agency regulations. 31 U.S.C. § 1517(a).

A.4 Federal Credit Reform Act (1990)

Has language on Federal loans to non-Federal borrowers, loan guarantees by the Federal government. This includes the calculation of the cost of a loan or loan guarantee. It includes the following language: *The authority to incur new direct loan obligations, make new loan guarantee commitments, or modify outstanding direct loans (or direct loan obligations) or loan guarantees (or loan guarantee commitments) shall constitute new budget authority in an amount equal to the cost of the direct loan or loan guarantee in the fiscal year in which definite authority becomes available or indefinite authority is used. Such budget authority shall constitute an obligation of the credit program account to pay to the financing account.*

A.5 FAA Reauthorization conference report (CRPT-112hrpt381)

The guidance in the FAA Reauthorization conference report (CRPT-112hrpt381) is:

- That the House bill be modified to include language on NextGen public private partnership program. The language describes financial instruments which the Secretary may use to facilitate public-private financing. In addition, language establishing an avionics incentive program for facilitating the acquisition and installation of equipment that is deemed to be in the interest of achieving NextGen

capabilities in commercial and general aviation aircraft. Language regarding limitation on principal is included with language regarding collateral, fees and premiums as well as use of funds.

- That subject to the availability of funds, the Secretary, or his/her designee, may guarantee loans with deferred repayment schedules, provided that in establishing the decisional criteria for the period of deferral, the Secretary or his designee shall consider the terms of the deferral established by other transportation loan guarantee programs and when equipment qualifying under subsection (A) of this section will be put to beneficial use in aircraft. The Secretary shall ensure that any such applications are reviewed under procedures similar to those established for the Railroad Rehabilitations and Improvement Financing program. The authority of the Secretary to issue credit assistance terminates 5 years after the date of establishment of the Incentive Program.
- That in reviewing and evaluating applications for loan guarantees, the Secretary or his/her designee shall reference similar provisions in Sections 821, 822, and 823 of the Railroad Rehabilitation and Improvement Financing program, 800 et seq. of Title 45, U.S.C. when considering the following: (a) the estimated cost to the federal government of providing the requested form and amount of assistance; (b) the estimated public and aviation system benefits to be derived from installing the required avionics in the most timely manner; (c) the amount of private sector funding that will be committed and the amount of private sector capital placed at risk; and (d) the likelihood of default by borrowers.

The guidance overall is to use the procedures defined in the Railroad Rehabilitation and Improvement Financing Program as the basis for procedures used to execute Section 221.

A.6 Transportation Equity Act for the 21st Century (TEA-21)—Railroad Rehabilitation and Improvement Financing Program (1998)

The DOT website notes that TEA-21 authorizes the Federal Railroad Administration … *to provide direct loans and loan guarantees up to $35.0 billion. Up to $7.0 billion is reserved for projects benefiting freight railroads other than Class I carriers. The funding may be used to:*

- *Acquire, improve, or rehabilitate intermodal or rail equipment or facilities, including track, components of track, bridges, yards, buildings and shops;*
- *Refinance outstanding debt incurred for the purposes listed above; and*
- *Develop or establish new intermodal or railroad facilities*

Repayment periods are up to 35 years. Eligible borrowers include railroads, state and local governments, government-sponsored authorities and corporations, joint ventures that include at least one railroad, and limited option freight shippers who intend to construct a new rail connection.

Appendix B Acronyms List

Acronym	Definition
AAL	American Airlines
ADOC	Airline Direct Operational Costs
ADS-B	Automatic Dependent Surveillance-Broadcast
ANSP	Air Navigation Service Provider
AR	Authorization Required
ARTCC	Air Route Traffic Control Center
ATA	Air Transport Association
CAASD	Center for Advanced Aviation System Development
CFO	Commercial Financing Options
CRPT	Conference Report
DOD	Department of Defense
DOT	Department of Transportation
DRVSM	Domestic Reduced Vertical Separation Management
FAA	Federal Aviation Administration
FMS	Flight Management System
GPS	Global Positioning System
MRO	Maintenance Repair and Overhaul
NAS	National Airspace System
NextGen	Next Generation Air Transportation System
OMB	Office of Management and Budget
RF	Radius to Fix
RNAV	Area Navigation
RNP	Required Navigation Performance
ROI	Return on Investment
TRACON	Terminal Radar Approach Control
VOR	Very High Frequency Omnidirectional Range