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The NextGen JPDO Model of Interagency Planning

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The Joint Planning and Development Office (JPDO) was chartered by Congress to create and carry out an integrated plan for a Next Generation Air Transportation System (NextGen). The planning and facilitation model developed by the JPDO was derived from this legislation and the fundamental characteristics associated with an enterprise transformation of this magnitude and duration. Within that context, this paper describes the JPDO model and the structure and utilization of the multi-agency NextGen Plan.

I. Introduction

The Next Generation Air Transportation System (NextGen) is a Congressionally-mandated (Vision 100 – Century of Aviation Reauthorization Act, December 2003) multi-agency and public-private initiative to transform the air transportation system to meet the Nation's future needs. NextGen is intended to simultaneously address multiple objectives, including increased capacity, improved efficiency, better safety and security, and reduced environmental impact. In addition to developing and deploying hardware and software, NextGen addresses the roles and responsibilities of the organizations and people that operate and use the system and the policies and processes that govern its operation. NextGen is a transformation of the total enterprise. The inherent complexity of such an endeavor requires that it is implemented in an evolutionary fashion to successively build out integrated capabilities, while managing risk and allowing inevitable course corrections**.**

The Joint Planning and Development Office (JPDO) was formed as a part of the "Vision 100" legislation to create and carryout an integrated plan for NextGen. Within the first year, the JPDO completed the top-level integrated plan to set specific objectives and strategies. Since then the JPDO has developed the more detailed multi-agency NextGen Plan that is meant to guide the transformation. The JPDO is now also performing substantial systems and portfolio analysis to provide decision support for the evolution towards NextGen. This paper will detail the characteristics of the NextGen enterprise, how those characteristics drive the approach to planning and facilitation that the JPDO has taken, and, finally, provide insight on the structure and utilization of the multi-agency NextGen Plan.

II. Legislative Mandate

In December, 2003, Congress passed the Century of Aviation Reauthorization Act (Public Law 108-176) that created the Next Generation Air Transportation System initiative, the Joint Planning and Development Office, and the Senior Policy Committee. The legislation sets broad goals for the NextGen Initiative with a 2025 horizon. The goals called for improvement across a set of transportation metrics, including safety, security, efficiency, quality, affordability and environment. However, the goals also make clear expectations for a modernized communications, navigation and surveillance (CNS) infrastructure; net-centric information sharing (NCIS) among system components; accommodation of a wide range of public, private and commercial users and aircraft types; scalability to meet growing demand; and, the leveraging of investments from across the government.

The JPDO's roles and responsibilities were called out under the general thrust of "creating and carrying out an integrated plan for a Next Generation Air Transportation System". This responsibility was further defined to include transition planning, oversight of research and development, and coordinating goals, research programs and technology transfer among agencies. The legislation also calls for the JPDO to "consult with the public and ensure the participation of experts from the private sector". However, the legislation did not call out any specific implementation authority and it has been interpreted that the JPDO is to coordinate across multi-agency mission planning and implementation authorities.

Finally, the legislation creates a Senior Policy Committee (SPC), chaired by the Secretary of Transportation, to work with the JPDO. The SPC, in addition to the Secretary of Transportation, is composed of the Secretary or

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Administrator (or their designee) of each JPDO partner agency. Those agencies include the FAA, NASA, DoD, DHS, DOC, and OSTP. The SPC provides policy leadership to the initiative, including recommendations for the required funding and legislation.

This legislation provides the fundamental charter for the JPDO's operation. However, in order to achieve a transformation of the magnitude envisioned in the legislation across such a broad range of stakeholders, the JPDO needed to consider the characteristics of such a transformation in structuring its organization and approach.

III. Characteristics of NextGen

JPDO's approach to planning was therefore driven by key characteristics of NextGen as a complex, multi-stakeholder and long-term transformation. Figure 1 provides an enterprise perspective of NextGen. It is necessarily a simplification of the very complex web of relationships that make up the air transportation system. However, it provides a useful context upon which to model a planning and facilitation process.

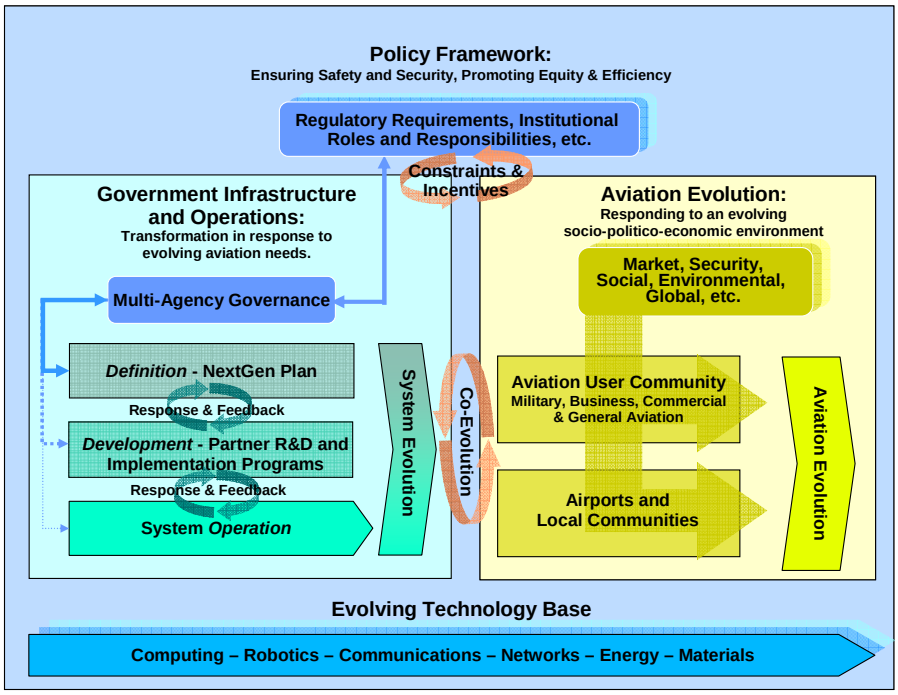

Figure 1. NextGen Enterprise Context

First, at the highest level, policy creates the overall framework for the transformation. Policy seeks to ensure sufficient levels of safety and security for the aviation system while encouraging the equitable and efficient use of the national airspace. Policy choices can have a major impact on the extent and pace of transformation by creating constraints and/or incentives to change. These are often very tough choices that are difficult to make due to competing interests among diverse stakeholders and the inability to fully assess the costs and benefits or even to fully predict outcomes. The ability to explore such choices with appropriate degrees of fidelity is clearly critical to a robust and substantial transformation.

Second, the aviation system evolves. The evolution is driven by the socio-politico-economic environment that aviation serves. Examples of key drivers include: market changes based on shifting demographics and changing economic and social needs for transportation; changes in the major inputs to aviation, such as energy and labor; new technologies and markets, such as unmanned aircraft systems (UAS); and competitive challenges, such as substitution of advanced communications technologies (e.g., teleconferencing) for long-distance travel. Air transportation has no choice but to respond to these and other drivers if it is to serve our national needs. And, as evidenced by the challenging energy, environmental and market conditions faced by the airlines, the changes are complex, inter-related and cannot be fully accounted for in advance. A further complication is that government infrastructure and operations (e.g., air traffic management (ATM)) must be robust to these complex evolutionary changes. The transition to NextGen, therefore, can be thought of as a "co-evolution" of aviation users, airports and federal infrastructure and operations.

Finally, the system development process must also be compatible with an environment characterized by variable needs. So, while we often think of system definition, development and operation as distinct sequential phases, in the case of very large scale and complex enterprises such as NextGen, these phases are overlapping and recursive. This is driven not only by evolving needs but also by other important factors. For example, because of the number of interfaces and the level of integration that is anticipated there will be emergent system behaviors and operational innovation. Also, because NextGen will be a human-centric system, individual, organizational, and cultural learning

and feedback must be accounted for. Therefore, approaches to improving the quality and timeliness of feedback between definition, development, implementation and operational activities are of paramount importance.

This enterprise context is a simplification of a very complex undertaking. Those complexities will surface in unanticipated ways and will need to be addressed. Problems with these attributes (i.e., like those being addressed by NextGen) have been termed "wicked problems"[2]. According to Mitre's Enterprise Systems Engineering Profiler, NextGen is on the "messy frontier" because the effort must manage the risks of multiple stakeholders, program boundaries, and users.[3] Words like "wicked" and "messy" don't suggest linear, step-by-step solutions, easy agreements, or unchanging plans.

For these reasons, learning to effectively coordinate actions across autonomous organizations is one of the fundamentals in dealing with complex systems. According to Yaneer Bar-Yam, "What do people do today when they don't understand "the system"? They try to assign responsibility to someone to fix the problem, to oversee "the system", to coordinate and control what is happening. It is time we recognized that "the system" is how we work together. When we don't work together effectively putting someone in charge by its very nature often makes things worse, rather than better, because no one person can understand "the system" well enough to be responsible. We need to learn how to improve the way we work together, to improve "the system" without putting someone in charge, in order to make things work."[4] Similarly, B.E. White of the Mitre Corporation asserts that "enterprises are complex-systems" and that "enterprise evolution is driven primarily by people/organizations acting autonomously but collectively".[5] These statements were not intended to imply that clear lines of authority and accountability are not required – they are. However, consolidating authority can not be a substitute for "improving the way we work together". The challenge then is to develop an approach that enables such autonomous but collective action.

Therefore, the JPDO model must be a flexible, iterative and inclusive guidance process among autonomous organizations. There must be robust feedback loops and sufficient maneuvering room to adjust the plan and implementation accordingly. We will need to accommodate variation. Therefore, we should plan in advance to work to a robust design space that will provide the management flexibility that will be required to achieve success.

IV. The JPDO Model

Consistent with the authority established by legislation and responsive to the characteristics of NextGen, the JPDO developed a model that sought to include: a participative process and inclusive governance; a flexible, iterative plan to guide the transformation process; a robust enterprise architecture that provides multi-stakeholder insight and management flexibility; and, the instantiation of strategic decision points. This is the level of operation and influence at which JPDO seeks to work.

Therefore, the JPDO is built on a foundation of collaboration and negotiation. In order to make this work, two key mechanisms were designed and implemented. First, nine Working Groups, consisting of both federal and private sector participants, were established to work side-by-side to provide subject matter expertise across the total scope of NextGen. Private sector experts are sponsored through the NextGen Institute. The NextGen Institute was established for the purpose of creating a private sector partnership for the federal JPDO. The Institute provides a mechanism for pro-bono participation of subject matter experts in the Working Groups, providing protection from organizational conflicts of interest that otherwise might prevent such participation. The NextGen Institute can also perform JPDO funded studies and demonstrations that support the planning and development process. The NextGen Institute therefore provides an avenue for collaboration between the private sector and government subject matter experts assigned to the Working Groups.

However, because of the scope and complexity of NextGen, disciplined processes were required to logically capture and assess the output of the Working Groups and to utilize that information to inform partner agency decision making. Therefore, the JPDO established staff organizations to provide the planning, enterprise engineering and architecting, and modeling and portfolio analysis disciplines to integrate the multi-agency NextGen Plan and assess its impacts. Figure 2 provides an overview of the JPDO model.

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[2] Conklin, Jeff; Wicked Problems & Social Complexity, Chapter 1 of Dialogue Mapping: Building Shared Understanding of Wicked Problems, Wiley, October 2006

[3] Stevens, Renee; *Engineering Enterprise Systems: Challenges and Prospects*; Mitre paper 06-0342

[4] Bar-Yam, Yaneer; Making Things Work, Solving Complex Problems in a Complex World; New England Center for Complex Systems; Knowledge Press, 2004

[5] White, B.E., "A Complementary Approach to Enterprise Systems Engineering", Presentation to the National Defense Industrial Association, 2005

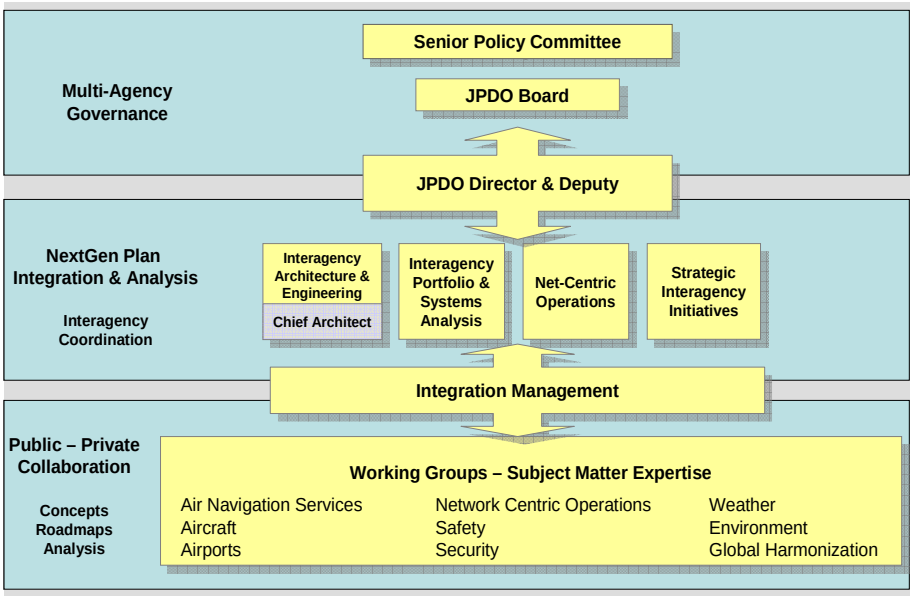

Figure 2. JPDO Planning & Interagency Coordination Model

The Working Groups were initially charged with defining the future operational state of the Nation's air transportation system (Vision) that when realized would meet NextGen goals and objectives. The second step in the process was to articulate the pathway to get from where we presently are to the future Vision. Hence, they were not constrained in defining the future state by systems, processes, procedures, relationships, etc. inherent in the present. Thus, the "design space" was opened up to far more novel and innovative thinking than would have been allowed with the traditional approach of planning a series of marginal improvements to the current system. Subsequent systems and portfolio analysis that combines information from this planning with information from Partner agency planning feeds back benefit, cost and risk information to help refine planning.

A very open and inclusive process ensures that not only the Working Groups, but all stakeholders have an opportunity to participate. All information is publicly available with mechanisms for feedback and comment[6]. Documents and analyses are broadly vetted and have routinely garnered thousands of comments from a broad array of government and private sector stakeholders, all of which are dispositioned and documented. Transparency is a central value of the JPDO process. In fact, transparency is one of the fundamental tenets that allows organizational conflict of interest protection for the NextGen Institute.

The power of a collective vision is a compelling force. However, capturing the vision and transition information in a robust planning format enables continued research, analysis and dialogue and provides a vehicle for aligning actions among stakeholders. JPDO employs enterprise architecting and modeling and simulation tools as the basis for capturing, analyzing and extending planning information. JPDO staff organizations that employ these tools also interface to partner agency planning processes to provide direct linkage to decision-making. Additionally, the JPDO's governance includes a JPDO Board which includes senior officials from the partner agencies that have direct responsibility over NextGen related investments and the Senior Policy Committee discussed earlier. This governance provides a mechanism for negotiation and agreement between the JPDO and the partner agencies on the content and ownership of the elements of the NextGen plan.

V. Flexible and Iterative Planning and Analysis

JPDO staff organizations manage the development and iteration of the multi-agency NextGen plan based on concept, roadmap and analysis inputs from the Working Groups and other aviation advisory groups; feedback from research, analysis, demonstrations, development, and operations; and, partner agency decision-making. The multi-agency NextGen Plan that JPDO has developed is comprised of four main components, a Concept of Operations, an Enterprise Architecture, an Integrated Work Plan; and, a Portfolio Analysis. The multi-agency NextGen plan uses these documents and analyses in unison to capture how the need, plan, implementation and business case are evolving. An annual update cycle and change management process allows updates to be captured in a timely and structured approach. One of the greatest values of this approach is that it creates, in unison with the Working Groups and the participative process, an environment for open dialogue and debate among NextGen stakeholders. In fact, to fully enable the idea of a collaborative environment, the multi-agency NextGen Plan is instantiated in a

[6] Information that is determined to be pre-decisional, budget-sensitive information is excluded from private sector disclosure.

web-based, searchable relational database, referred to as the Joint Planning Environment (JPE), that enables broad access and greater utility for exploration, analysis and reporting. Figure 3 shows the relationship of the plan components.

The Concept of Operations describes a vision of future capabilities and their interrelationships in a prose form. The capabilities describe the design space that sets the research and policy agendas. The community chose the set of capabilities based of their potential to achieve the NextGen goals. Innovations in developing markets and technologies, like commercial space and UAS, will also contribute new concepts over time. The concept will never be fully complete or validated until the capability is implemented.

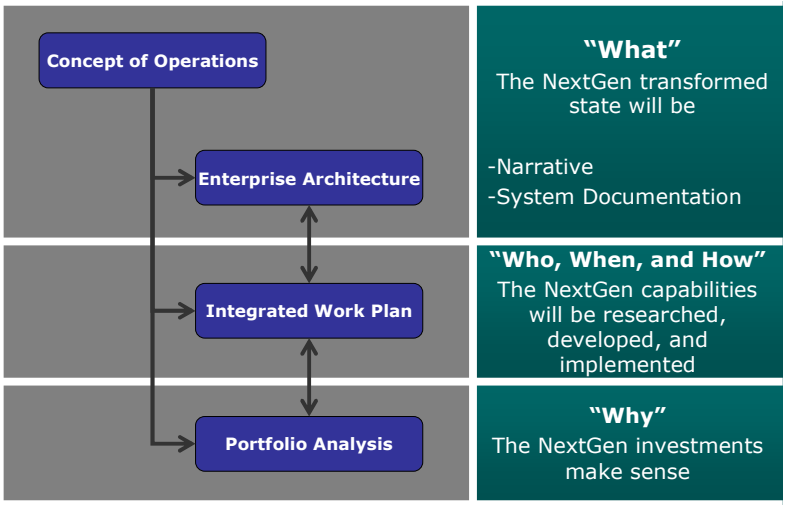

Figure 3. Multi-Agency NextGen Plan

The Enterprise Architecture (EA) provides the common lexicon and a structured method for organizing, in a capability framework, the performance, technical, cost and risk data. The NextGen EA is characterized as an "enterprise of enterprises" architecture. The NextGen EA federates the EA's of partner agencies, thus providing the only framework where the entire NextGen architecture is seen. The EA methodology is derived from the capital planning process, but in this case has been extended to include far-term research and development. The NextGen EA, therefore, can effectively organize and integrate capital, research, and policy investment and actions.

The Integrated Work Plan (IWP) contains time-phased operational improvements that project evolution to full NextGen capabilities. Enablers for the operational improvements are also captured, as well as required research and policy actions. Dependencies between IWP elements have been captured and can be exercised within the JPE. However, the IWP is not a populated work breakdown structure for NextGen. Rather, it structures time-phased strategic requirements, critical dependencies and tracks the progress of the multi-agency efforts toward achieving NextGen capabilities.

The IWP is also used to guide and establish agency commitments. The IWP establishes Suggested Offices of Primary Responsibility (S-OPR) and Suggested Offices of Collateral Responsibility (S-OCR) for each element of the IWP. The "suggested" label is removed as partner agency ownership is achieved (which may include changes to the IWP element). The IWP must include and account for a range of agency commitments. For example, a baselined acquisition program that enables a near-term operational improvement represents a high level of confidence in an agency commitment. However, far-term operational improvements may only be supported by exploratory research at this time. In such far-term cases, those IWP elements may not be ready for partner agency ownership and JPDO will retain oversight and advocacy. Integrating these elements across all the partner agencies creates a complex network, but also creates a powerful tool for assessing and prioritizing alignment and gaps in investment.

Systems and portfolio modeling and analysis provide another powerful approach to informing the plan. Recognizing that the multi-agency NextGen Plan represents a broad portfolio of alternatives, especially from the mid to far-term, systems and portfolio analysis provides a structured approach to valuing those alternatives. The JPDO has assembled a broad range of models across the scope of air transportation to support this analysis. A range of metrics have been established to structure that valuation, both at the total enterprise-level and at the stakeholder level[7]. Benefits, costs and risks can thus be assessed across the alternatives. This information can then be used to support decision-making for the Working Groups as well as the partner agencies. A first full portfolio analysis of one alternative was accomplished this year. Additional alternatives will be analyzed in fiscal year 2010.

[7] Targets for the metrics have yet to be established beyond the top-level goals; substantial trade-offs may be required to achieve a feasible set of targets.

VI. Utilization of JPDO NextGen planning products

A. Exercising the future enterprise

The multi-agency NextGen Plan provides a basis for detailed study and analysis. One such use is as a platform that can be exercised using operational scenarios. Operational scenarios provide an avenue for exploring topics of interest as to how the NextGen enterprise may operate at a relatively detailed level. For example, an operational scenario could be a commercial flight from a high density airport that encounters adverse weather and navigation failures enroute. The point of the scenario could be to explore the impact of off-nominal conditions and failure modes on communications, navigation and surveillance systems. Use case analysis techniques allow the scenario to be mapped to elements of the multi-agency NextGen Plan, such as the Operational Improvements contained in the IWP. Once the detailed mapping is complete various analyses can be executed. For example, validation analyses that may look for gaps and misalignments between what is required to execute the scenario and what the plan forecasts the enterprise would be able to support. Another example would be the derivation of more detailed performance targets for R&D. The findings of such analyses can then be put in the queue of the change management process for validating updates to the multi-agency NextGen Plan. Findings can also document technical, policy, organizational or other issues that need further exploration through more indepth research and analysis.

Two such studies are underway today. The NextGen Institute has been funded by JPDO to study far-term integrated communications, navigation and surveillance (ICNS) architecture trade-offs (from which I drew the example in the previous paragraph). The other is study of the integration of advanced vehicle concepts (such as short take-off and landing aircraft, UAS, or supersonic vehicles) into NextGen that has been funded by NASA. These studies are scheduled to be completed by the end of the fiscal year and calendar year 2009 respectively. The JPDO is also using this approach beginning in fiscal year 2010 to support Working Group efforts. Specifically, a Study Team composed of Subject Matter Experts from several Working Groups will utilize this approach to study the far-term instantiation of Trajectory Based Operations.

Critically, this type of relatively low-cost application of the multi-agency NextGen Plan can engage key stakeholders and subject matter experts in a “table-top” exercise of the NextGen enterprise, providing not just technical feedback to planning products, but key insights among stakeholders that supports informed dialogue and debate. From this perspective, it supports the type of interchanges that are necessary between stakeholders to help support the “co-evolution” management discussed earlier and the “autonomous but collective” action necessary to support enterprise evolution. While these “table-top” exercises are a good place to start, they will inevitably point out very challenging issues that require higher fidelity exploration of the future NextGen enterprise. Therefore, more rigorous enterprise-level simulations that have computer emulation of key elements of the enterprise and eventually enterprise-level experiments with real system elements operating in representative or even operational environments will be required to inform and support future decision-making.

B. Achieving multi-agency alignment

Early in the JPDO planning process, major investments were identified, especially within the FAA and NASA that would be required to realize the NextGen enterprise transformation. Those investments – such as cooperative surveillance (ADS-B), data communications, network-centric information sharing, network-enabled weather data integration, and air traffic management automation tools – are now in various stages of planning and implementation. Moreover, as we transitioned into a fully populated multi-agency NextGen Plan, the JPDO and the partner agencies have begun the process of negotiating, adjusting and accepting ownership for IWP elements as described earlier in this paper. Substantial progress was made in fiscal year 2009, with approximately 25% of the over 700 descrete IWP elements being resolved. This progress will be reflected in the updated IWP that will be released on the JPE in the fall of 2009. This process will continue in fiscal year 2010 as the JPDO and partner agencies work through the remaining elements of the IWP. This process will provide a much higher fidelity mapping of the required actions among the partner agencies to achieve NextGen.

In addition, as this process plays out, and with the portfolio and systems analysis effort ongoing in parallel, it has become clear that key decision points will be required as part of the IWP. As discussed earlier, from the mid to long-term there are still alternative concepts and portfolios contained within the IWP. There are many issues with long-lead times that will determine the feasibility of the alternatives (as measured by benefit, cost and risk analysis) such as the availability of avionics. Therefore, in fiscal year 2010, the JPDO plans to work with partner agencies to specify temporal decision points for concept down-selection or delays to concept implementation to beyond 2025.

Finally, over the past two years, the JPDO and the partner agencies were able to analyze existing agency documentation against multi-agency the NextGen Plan to perform more detailed gap and risk assessments and

identify areas for additional interagency action. A total of 64 single or interagency action areas were documented in fiscal year 2008 that were prioritized into 12 high priority action areas, 11 of which were accepted by the JPDO Board for action and tracking. These priorities were reconfirmed in the JPDO's fiscal year 2009 analysis. Figure 4 provides a representative sample of the high priority areas that are being actively worked and tracked.

To provide more discipline to this process, the JPDO has now adopted a formal risk management approach that will be used on an ongoing basis to discover, document, evaluate and track areas of interagency risk (single agency risk will be performed through agency processes) and determine suitable mitigation actions. The JPDO's governance process will be used as appropriate to achieve appropriate ownership of the risks and mitigation actions.

Action Area	Description	Lead
Air/Ground Functional Allocation	Lack of clarity in the allocation of new functions to the aircraft and flight crew (includes human/automation as well as avionics/ground automation allocations)	National Aeronautics and Space Administration
Closely-Spaced Parallel Runways	Research and standards are needed to reduce separation between aircraft for arrivals and departures	Federal Aviation Administration
Integrated Surveillance	Need for an federal-wide concept of operations and governance structure for integrated surveillance	Department of Defense
Security Risk Management	Lack of multi-agency, integrated approach to security risk management	Department of Homeland Security
Addressing Environmental Constraints	Metrics, targets are needed to establish technological and procedural requirements for mitigation	Federal Aviation Administration
Verification and Validation of Complex Systems	Lack of a defined plan to research and develop needed tools to achieve timely and effective verification and validation of complex NextGen systems	National Aeronautics and Space Administration

Figure 4. Representative sample of priority interagency actions

VII. Summary

The Next Generation Air Transportation System (NextGen) is a Congressionally-mandated (Vision 100 – Century of Aviation Reauthorization Act, December 2003) multi-agency and public-private initiative to transform the air transportation system to meet the Nation's future needs. NextGen is intended to simultaneously address multiple objectives, including increased capacity, improved efficiency, better safety and security, and reduced environmental impact.

The NextGen JPDO developed an organizational, planning and process model that is consistent with the authority established by legislation and responsive to the characteristics of NextGen at as complex enterprise. The model JPDO developed sought to include a participative process and inclusive governance; a flexible, iterative plan to guide the transformation process; a robust enterprise architecture that provides multi-stakeholder insight and management flexibility; and, the instantiation of strategic decision points.

The JPDO has implemented the model and has exercised the resulting multi-agency NextGen Plan in order to align multi-agency actions and provide decision support. In addition to plan evolution, future JPDO work includes continued progress toward multi-agency alignment and interagency actions, the development of key decision points for concept down-selection, development of targets for enterprise and stakeholder metrics, and additional analysis of alternatives.