Creating an Enterprise Architecture for Next Generation Air Transportation System

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INTRODUCTION

The many different articles in this special NGATS edition of the *Journal of Air Traffic Control* provide a comprehensive picture of the sheer size and complexity of the Next Generation System initiative and the challenges it presents.

Even before the VISION 100 legislation was signed into law, it was clear to policy makers that no single government department or system acquisition could make the Next Generation System vision a reality. Success will depend on a collaborative effort across multiple government agencies and between the public and private sectors. The Joint Planning and Development Office (JPDO) was created to lead this partnership and is the organization responsible for synchronizing goals and priorities.

We can better manage these challenges by creating a high-level blueprint, or Enterprise Architecture (EA). It will help decision-makers better understand the complexity of operations and allow us to successfully transition to the Next Generation System in a consistent, coordinated, cost-efficient and integrated manner.

Indeed, Enterprise Architecture is recognized almost universally as an important tool for reengineering business practices and the underlying information technology that supports them. It is key to achieving mission goals. The Government Accountability Office recently observed, "Effective use of enterprise architectures, or modernization blueprints, is a trademark of successful private and public organizations. For more than a decade, we have promoted the use of architectures to guide and constrain systems modernization, recognizing them as a crucial means to a challenging goal: agency organizational structures that are optimally defined in both business and technological environments." [1]

And as with a building blueprint, it is the interaction with customers that adds value to the design. FAA Administrator Marion Blakey put it best during her February 2003 Aero Club of Washington speech, "[We] must be architects of the future – to ask the questions, 'What if?' and 'Why not?' as we envision the potential of new technology and a changing aviation industry."[2]

ARCHITECTURE SCOPE

The first basic function of our Enterprise Architecture is to provide a clear understanding of the scope of what we are trying to accomplish in the Next Generation System. To this end, distinguishing NGATS core operations from other peripheral concerns will keep the collaborative effort focused on what we must achieve together. Individual agencies and private concerns may then work the edges.

But first, a definition is needed. Early in its existence, the JPDO described the Next Generation System as the operation that safely and efficiently moves people and goods from airport curb to airport curb. As other authors have correctly observed, ours is a system-wide transformation that must meet air transportation safety, security, mobility, efficiency and capacity needs beyond those currently included in the FAA's Operational Evolution Plan.

From this reference point, core operations are defined as the eight operational areas depicted in Figure 1. Each has unique missions, communities of interest and objectives. The architecture captures these operations as a set of activities and interactions between the public and private sector, which in turn, will help focus our discussions and planning on what is necessary to support these exchanges.

Moreover, since the Next Generation System initiative is a system-wide transformation, core operations must be treated as an integrated set of activities. The Enterprise Architecture can then be used to examine integration issues, including how outside influences could produce new challenges.

ARCHITECTURE STRUCTURE

Like a building blueprint, the Enterprise Architecture captures multiple views to depict different aspects of the enterprise and maps them to one another. This process is extremely valuable in these early stages of the NGATS design as it helps to frame questions, structure dialogue and plan research to get much needed answers. Our model provides three traditional architectural views of the Next Generation System: business, operations, and systems. Seen in a different way, the Enterprise Architecture is the bridge or link between them.

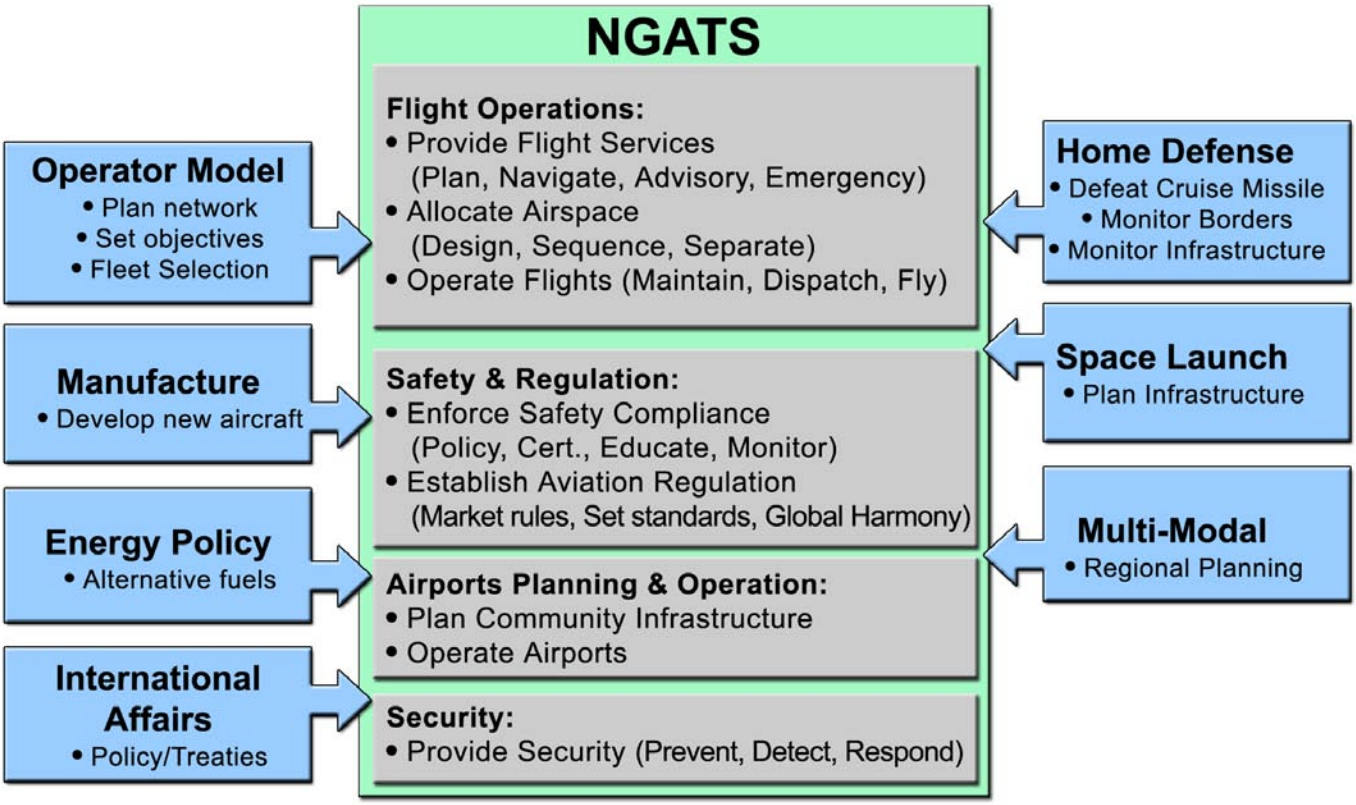

Figure 1 NGATS Scope and Periphery

Business View

First, the *business view* of the NGATS depicts the Air Transportation System as a complex, adaptive "system of systems." It is composed of various assets (*e.g.*, airports, security systems and aircraft) that are managed separately, evolve independently, and are designed first to meet their owners' and operators' objectives. The public-private partnership that will design and implement the Next Generation System must account for this business reality.

Our business view expands upon the Federal Enterprise Architecture (FEA) reference models[3]. It does not advocate any one solution; rather, it provides a framework for defining performance, core business areas, decision-making and service agreements.

The performance framework will help identify individual and collective measures of success so we can define guiding principles, priorities, and transition strategies. For example, the Next Generation System must increase individual airport service, but in doing so it must also meet metropolitan area needs and those of the nation as a whole. Capturing these allows a collective definition of success to emerge.

The definition of core businesses and re-defining operational decision-making roles will also help identify which activities should reside in the government and those that may be better and more economically provided by the private sector.

Lastly, the service framework will shape our understanding of what service level agreements will be made in the future system. Indeed, one of the key capabilities of the Next Generation System is the government being able to offer performance-based service in exchange for aircraft and airport operators meeting a required total system performance (RTSP) level. For example, in creating a service that would allow aircraft to self-separate, we would examine each type of conditions in the services framework and select and answer those applicable to this case. The result would be a service agreement specifying what the operators must be able to do to gain the service and what rights the service conveys.

Operations View

The *operations view* follows the Department of Defense Architecture Framework (DODAF)[4]. It examines how day-to-day operations work and reflects the organizations, activities, operational locations (where the activities happen), and practices. The operations view provides the important future "what could be" – but not a definitive answer. It also helps facilitate discussion among all parties about the high-level operational concept and gets the 'what if?' and 'why not?' questions started.

It further describes each organization's role (public or private), relationships (*e.g.*, command, control, client, collaborator, etc.) between organizations and key personnel, responsibilities or skills that help explain the relationships. Together, these views refine the vision to show how future operations will employ human resources, technology, policy and changes in practice and where questions still remain.

To take our earlier example, assume the aircraft operator will be informed of the need to perform self-separation maneuvers. Does that happen pre-departure or once the aircraft is en route? What options does the pilot have to request such a service? Are the systems that deliver the required performance in the aircraft or on the ground, or shared between the two? The answers to these questions then form the basis of the system view of the Next Generation System.

Systems View

The NGATS *systems view* explains how needs will be met. What starts off as a series of questions from the operations view, leads to research and policy topics. The results of that research ultimately answer the questions concerning major investments, implementation timing and dependencies. Moreover, the systems view shows the interaction between systems and just as importantly, their collective benefit as a "system of systems" which ultimately makes the case for private and public investments. The systems view also explains which parts of performance or functional requirements may warrant joint development.

ENTERPRISE PERSPECTIVE

For those hearing or reading about the NGATS for the first time, it may come as a surprise that there is no traditional central development or program office for the Next Generation System. The JPDO is certainly not one by any stretch of the imagination. Rather it should be seen as the focal point for coordinating all of the air transportation research leading to the implementation of the future system.

Indeed, in an enormous break from the past, the NGATS will be built through the aforementioned public-private partnership in which government creates a stable institutional framework to encourage and harness the creativity of the private sector. As DOT Under Secretary for Policy Jeffrey Shane observed, "[I] do not pretend to know what the marketplace for air services will look like in 2025. What I do know is that government has a responsibility to ensure that the infrastructure is in place that allows American entrepreneurs to work their magic without being strangled by congestion or buried in bureaucratic red tape."[5]

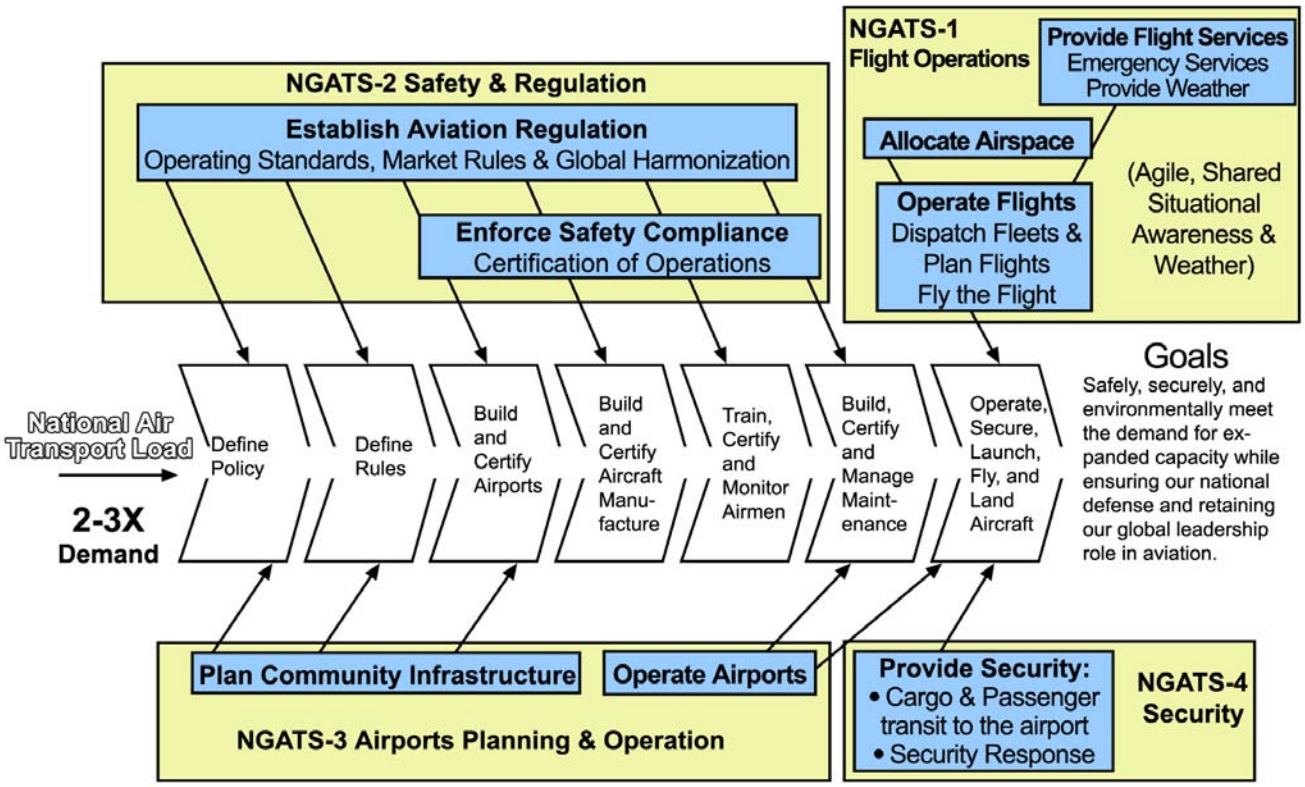

Figure 2 Air Transportation Value Chain

Our Enterprise Architecture brings an important and needed owner-operator-user perspective to both public and private NGATS activities. To this end, we will employ "use cases" that identify, clarify and organize system requirements – critical to the future system's success. For example, a use case might capture a dispatcher's interactions with security authorities, pilots, and air traffic personnel. Another might follow a passenger time line from trip planning activities, through security screening and airport transit, flights, connections, and right through the final destination terminal. We can even add unanticipated elements to the use cases, such as introducing bad weather or a security threat.

Examining a scenario from multiple stakeholders' perspectives also shows the effect of each decision on each player and on the entire system. So in the previously described self-separation service agreement, we could focus on the pilot-controller interaction. But we must also understand the pre-departure decision-makers' roles. And even before that, we must understand what manufacturers must know of the agreement so they can build the needed capabilities, and what policies and rules will be affected. Only then can we match missions and investment objectives to a particular class of stakeholders.

Clearly, an unimaginable – and unmanageable – number of scenarios could be envisioned. Following this path *ad infinitum* would be unproductive so as part of our EA, the JPDO is identifying a basic set of scenarios that provide context for the most pressing questions we must answer. We have also constructed what is known in business/IT terminology as a "value chain" for air transportation (*see Figure 2*).

It shows the sequence of activities that will eventually lead to our shared goals and the value-added products and services that can be provided to our many stakeholders.

STAKEHOLDER VIEWPOINTS

From its inception, the JPDO has been committed to creating a process that is fully open to public scrutiny. That is one reason we created the NGATS Institute. To help us fulfill this critical obligation, the Enterprise Architecture makes the debate about future operations, investments, workforce implications, and policies fully transparent. And this is highly desirable from more than a "good government" point of view.

Earlier in this article, the importance of synchronized schedules and compatibility was stressed and this cannot happen without transparency. The left hand must know what the right is doing if we are to arrive at an agreed-upon destination at the same time. Engaging the private sector and local government in the Enterprise Architecture from the start will help ensure all decisions are compatible and will help meet individual and group objectives simultaneously.

What EA means to stakeholders

Aircraft Operators	EA addressed the business implementation, more specifically the integration of efficient business processes. This includes within the operator's business as well as the integration of other dependent enterprises. EA forces the early discovery of issues and therefore issues are resolved early in the lifecycle where they are less costly to address.
Flight Crews	Benefit from an efficient operation that is well integrated. Many of the events that cause flight crew reactions are gone allowing flight crews to focus more on the strategic mission.
Air Traffic Service Provider	the integration of stovepipes into an efficient operation allows air traffic service providers to concentrate on strategic activities vs tactical planning. Most issues are raised and disposed prior to the departure of a flight.
Regulatory Agencies	EA allows regulatory agencies to examine the whole problem up front such that the resulting regulatory system is designed and developed as a system of system and not pieced together in reaction to events. Up front recognition of all issues produces a well-though out system of systems that operates efficiently.
Security and Homeland Defense	EA allows security to become an integral part of the air transportation system and not a reactive constraint. By including security in all aspects of the Air Transportation System, Security is "designed into the system" and therefore the security becomes an integral piece of the system instead of an afterthought.

AGENCY ARCHITECTURE VIEWPOINTS

Although the framework for the NGATS Enterprise Architecture may seem at first glance all-encompassing, it is not intended to replace what the agencies must do to manage their individual enterprises. Instead, we hope to highlight where one agency "touches" another, such as aviation weather or secure airspace, and how multiple agencies interact with common private sector stakeholders. And in this regard, timing is critical.

Most current agency strategic plans address the next 5 to 10 years. The 2010 to 2015 overlap period between the Next Generation System and agency architectures is our best chance to influence agency requirements integration. We must take full advantage of this window of opportunity. Additionally, some near-term policy issues and research topics

must be addressed before 2010 to make that integration possible. As transition plans develop, interim NGATS architectures reflecting 2015 and 2020 will be created.

APPLICATIONS OF THE NGATS ENTERPRISE ARCHITECTURE

A First Cut at the 2025 Architecture

The next three years will be critical as we work to address the most significant Enterprise Architecture issues. We want to refine the future architecture in a way that addresses the majority of potential joint investment and requirement "disconnects." Creating an initial look at the 2025 NGATS future architecture will be our first priority.

Admittedly, this initial EA version will likely contain more questions than specific answers, and certainly not a specific architectural solution. However it will foster greater debate and drive research for finding answers with mutual benefits. This is an enormously important first step towards a robust, fully functional and vetted Enterprise Architecture.

Application to Analysis

Enterprise Architecture is almost a Socratic process. It begins with questions that foster discussion, structure the analysis and prioritize the research agenda. The broader questions posed during the first round of architecture will then be answered by raising new specific questions. Each cycle will create a more refined architecture. Over the next three years the transformation to the NGATS will begin to take shape. Our aim is to answer the macro issues that will help us make the aligned investments critical to the success of the Next Generation System.

The DODAF[6] groups these issues into four categories: (1) operations planning, (2) business process reengineering, (3) joint capability integration, and (4) joint alternatives. Using the architecture views and perspectives described above we can structure the research and design approaches for resolving these problems.

Operations Planning is a fresh assessment of doctrine, personnel, and materials far beyond our traditional view of the future. This analysis is particularly needed if the future operations structure implies changes in policy or practices. This analysis also tests the robustness of the NGATS under stress, such as bad weather. It continuously refines activities and scenarios as the basis for defining the service agreements.

Organizational Design and Business Process Re-engineering are "what if" analyses to test alternative alignments of activities and organizations. These studies will help frame the public-private partnership for Next Generation System operations and create workforce and operations plans.

Joint Capability Integration analyses focus on mission and functional areas to better define the future system's integrated capabilities. Such analyses form the bulk of the Integrated Product Teams' lead research and are needed to build the "system-of-systems" view. The analysis also contributes to: creating roadmaps and portfolios of policy, research and modernization efforts; decisions on major investments; and establishing programs to fulfill joint requirements.

Joint Analysis of Alternatives examines the impact to individual stakeholders of a given change to a lifecycle cost, the workforce, and capital investment profiles. Using these different perspectives, the effects on all the stakeholders can be methodically documented. The analysis also provides all partners in joint decision-making (*e.g.*, rulemaking) some assurances that each step along the way is viable for their particular operation.

Transformation is Underway

As Secretary Mineta said, "Transformation starts now" and this applies to all parts of the Next Generation System initiative, including Enterprise Architecture. The JPDO has begun in earnest architecture planning and our efforts over the next three years will focus on refining expectations and plans. We want to have 60% to 70% of the questions about NGATS goals answered. The NGATS Institute will also play a crucial role in the architecture process and the first step is to agree on the approach, goals, and perspectives so that we can move forward as partners. From there, the real work begins.

Management of the Next Generation System initiative will require an ongoing process of reaching common understandings, aligning activities against them and adjusting our understanding as the situation changes. To do this in a disciplined fashion, we will make full use of an Enterprise Architecture process. In partnership with the private sector, the architecture will be used to validate the steps and the timing of objectives, capture the risks to be researched and mitigated and identify joint requirements for synchronized public/private investments.

And our ultimate success also rests on one other critical factor – your participation. As Administrator Blakey and others have noted, creating the architecture for the future is about asking and answering key questions. And no one has all the answers. We need your help and your input as we create the blueprint for the Next Generation System. Please join us in this exciting endeavor. It could be

one of the most important contributions you could make to the future our nation's air transportation system.

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[1] GAO Report GAO-05-266, 29 April 2005, p. 8.

[2] FAA Administrator Marion C. Blakey, "The Spirit of December 14th," Speech before the Aero Club of Washington, February 20, 2003.

[3] *Federal Enterprise Architecture (FEA) Reference Models* found at: http://www.whitehouse.gov/omb/egov/a-1-fea.html

[4] *DoD Architecture Framework,* Version 1.0 Draft, Jan 2003, found at http://66.170.237.138/dodfw/

[5] DOT Under Secretary for Policy Jeffrey N. Shane, "A Vision for the Next Generation Air Transportation System," Speech before the Transportation Research Board Annual Meeting, Washington, DC, January 10, 2005.

[6] *DODAF Desk book,* Version 1.0 Draft, February 2004.