2013

The Potential Costs to the DoD of not Preparing for the NextGen NAS Overhaul: Lessons Learned from RVSM

Casey Richardson
Embry-Riddle Aeronautical University, richa9c6@my.erau.edu

The potential costs to the DoD of not preparing for the NextGen NAS overhaul: lessons learned from RVSM

Casey Richardson

Embry Riddle Aeronautical University

Author Note

The author, Casey Richardson, is a US Air Force Major and F16 test pilot at Edwards Air Force Base, California. He has more than 2000 flight hours in high performance aircraft including the T-38A/C, F-15E, and various models of the F-16. He is a graduate of USAF Test Pilot School and post-graduate student at Embry-Riddle Aeronautical University.

Abstract

In order to facilitate a significant overhaul of the civilian National Airspace System (NAS), the Federal Aviation Administration (FAA) has partnered with many federal agencies, such as the departments of Transportation (DOT), Defense (DoD), Homeland Security (DHS), and Commerce (DOC) and the National Aeronautics & Space Administration (NASA) through a consolidated Joint Planning and Development Office (JPDO) that was established by Congress in 2003 in the VISION 100 – Century of Aviation Reauthorization Act (JPDO, 2012). The JPDO has proposed replacing the old NAS structure of primarily ground-based navigation with robust satellite-enabled air traffic procedures and to supplement ground-based air traffic controller workload with advanced datalink and trajectory-based operations algorithms for de-conflicting aircraft on the ground and in the air. The hope is to reduce the required separation between aircraft and the decrease the human workload, without sacrificing safety. Department of Defense (DoD) leaders should consider lessons learned from past decisions with regard to cost avoidance versus cost savings following the smaller domestic airspace change, reduced vertical separation minimum (RVSM). The lost cost savings from non-participation in RVSM airspace may be larger than was anticipated, and the cost savings from non-participation in NextGen will probably be a much more expensive. Non-participation may prove to be a barrier to domestic military operations outside of special use airspace (SUA) for aircraft above 10,000 feet and will not meet the objectives of Joint Force 2020. Cost avoidance by non-participation would probably be a poor choice by DoD leaders.

The potential costs to the DoD of not preparing for the NextGen NAS overhaul: lessons learned from RVSM

NextGen

First, it may be helpful to briefly describe the background of “NextGen,” because many military members may not aware of this civilian program. Neil Planzer, vice president of Global Air Traffic Management (ATM) Solutions at Boeing ATM recently stated:

> In 1959, American Airlines ran an ad that shows the Boeing 707. The headline advertises 4 1/2 hours, coast to coast on American’s jet flagships. You look at that ad and you try to understand that in 1959 they could fly coast to coast in 4 1/2 hours. Fifty-one years later, it takes six hours (Issues in ATM, 2011)

With this example, Planzer colorfully illustrates the growing problem with management of air traffic in the United States, where “seventh generation jet aircraft” are forced to fly in a “second generation air traffic control” system (Issues in ATM, 2011). This is despite the fact that aviation is crucial to our nation’s economy with contributions of “$1.3 trillion annually to the national economy” that “constituted 5.2 percent of gross domestic product” in 2009 (FAA, 2011). Rhonda Lyons (2012) reported in her analysis of NextGen’s trajectory based operations (TBO) that the nation’s ATM is operating at 150 percent and currently and will be operating at 250 percent with the next two decades.

The Federal Aviation Administration’s (FAA) response to this looming crisis is to revolutionize the national air space system under a consolidated plan called NextGen. The general concept of NextGen is to consolidate the current system of many divided sections of airspace that are all executing independent, tactical-level air traffic control operations into a system-wide air traffic management scheme using several modern technologies. NextGen is essentially six separate but connected programs that are scheduled to occur somewhat serially: Automatic Dependent Surveillance Broadcast (ADS-B), En Route Modernization (ERAM), System Wide Information Management (SWIM), Data Communications, NextGen Network Enabled Weather (NNEW), and NAS Voice Switch (NVS) (JPDO, 2008 & NextGen Troubled?, 2012). The FAA has partnered with many federal agencies, such as the departments of Transportation (DOT), Defense (DoD), Homeland Security (DHS), and Commerce (DOC) and is working with the National Aeronautics & Space Administration (NASA) through a consolidated Joint Planning and Development Office that was established by Congress in 2003 in the VISION 100 – Century of Aviation Reauthorization Act (JPDO, 2012).

The FAA predicts that the benefits building NextGen's shared information network based on increased position precision using satellite technology could reduce delays by 35 percent, reduce carbon dioxide emissions by 14 million tons, and reduce fuel use by 1.4 billion gallons cumulatively, for a total of $23 billion in benefits to potential stakeholders (FAA, 2011). Former FAA Administrator and AIA President Marion Blakely predicted an even higher financial savings of $40 billion year and stated that "[w]hen it is fully implemented, it will be a major benefit to our economy and to our society and transportation system as a whole" (Bellamy III, 2012b). And, House of Representatives Transportation and Infrastructure Committee Chairman Tomas Petri added that "[a]s a business proposition, it's essentially a no-brainer" (Bellamy III, 2012a).

One summary of NextGen is to say that it is a "comprehensive initiative" that "integrates new and existing technologies, including satellite navigation and advanced digital communications" (FAA, 2012, March, p. 7). The JPDO has proposed replacing the old NAS structure of primarily ground-based navigation with robust GPS-enabled air traffic procedures and to supplement ground-based ATC workload with advanced datalink and trajectory-based operations algorithms for de-conflicting aircraft on the ground and in the air. The hope is to reduce the required separation between aircraft and the decrease the human workload, without sacrificing safety.

These concepts are no surprise to military operators. Almost all DoD aircraft are designed to leverage GPS capabilities for precise position-keeping and other situational awareness. Also, almost all DoD aircraft either are already capable or are in the process of gaining increased airborne datalink capabilities. Precision weapons deliveries and enhanced situational awareness are already in high demand by military aviation commanders. In one form or another, most of the process improvements proposed by the JPDO over the next two decades already exist within the DoD.

However, there are some fundamental differences in execution and operating standards that currently prevent compatibility between military aircraft and the proposed civilian airspace system. For example, in terms of position-keeping accuracy, many military aircraft are only equipped with the minimum amount of systems to provide initial capabilities. Redundancy is accomplished through coordination with resources external to individual aircraft. The NextGen requirements, however, are likely to require costly equipage of robust internal navigation source (INS) redundancy within each individual aircraft. The additional equipment needed to ensure minimum redundancy in a single aircraft may be cost or space prohibitive for many types of military aircraft. Adding redundancy to INS systems would require large investments in new or additional aircraft systems that cannot be directly tied to a desired combat capability, which is probably going to always result in a low priority level for additional INS systems amongst resources that are already under intense strain. Also, in some aircraft, there is physically no more room for additional systems. Any additional space for aircraft systems is often consumed by new sensors, weapons, or additional space for fuel that are, again, directly tied to a desired combat capability. Rightly so, the system program offices and the commanders who make the ultimate decisions about how to equip military aircraft must prioritize combat effects first. Much like the FAA, efficiency is not their top priority. For the FAA, safety is actually the agency's top priority, with efficiency as a close second (Adamski & Doyle, 2005). The difference between the FAA and the DoD, however, is that while they both do not prioritize efficiency as their top concern, it is much more important to the FAA than to the DoD.

The Department of Transportation (DOT) and the FAA have already mandated aircraft equipage of ADS-B Out[1] capabilities for all aircraft by 2020 if those aircraft are going to utilize ATC service (Department Of Transportation, 2010). Non-participating aircraft would need to meet a proposed ceiling of 10,000 feet MSL. The *Capstone Concept for Joint Operations: Joint Force 2020*, which updated the DoD's Joint Doctrine in 2012, identified a similar target date of 2020 for its operational concept to meet the needs of the future security environment. Some of the "select implications for Joint Force 2020" (Joint Chiefs of Staff, 2012, p.8) include:

- Become pervasively interoperable both internally and externally
- Rapidly employable on a global scale
- Improve strategic and operational mobility
- Reduce operational energy requirements and develop operationally viable alternative energy sources

[1] ADS-B Out is conceptually equivalent to some military aircraft datalinks familiar to military operators, such as SADL, Link-16, or IDL, for example.

Achieving these objectives will probably be impossible or greatly complicated for aircraft that are unable to participate in ATC airspace above 10,000 feet above mean sea level (MSL) after 2020.

RVSM

An analogy for the impact of non-participation can be found in the implementation of Reduced Vertical Separation Minimum (RVSM) regulations in US domestic airspace in 2003, which reduced vertical separation requirements at altitudes between 29,000 (FL290) and 41,000 (FL410) feet MSL (FAA, 2012 January 25). Many US military aircraft are non-participants in RVSM airspace, because they are not adequately equipped. Namely, many military aircraft do not have the required INS and GPS redundancies or have an insufficient autopilot system. Flight at RVSM altitudes outside of special use airspace (SUA) requires ATC to approve, real-time, entry into this airspace. Current CFR's allow ATC to deny user's requests for RVSM airspace based on their individual assessments of traffic congestion and their own task workload. Additionally, aircraft that do not meet the equipment requirements for RVSM airspace are not permitted to plan for flight at these altitudes. For instance, Air Force Instructions do permit enroute navigation and fuel planning between FL290 and 410 for non-RVSM capable aircraft (Air Force Instruction, 2010). The effect of this restriction is appreciable for aircraft that are not equipped for RVSM.

For example, the US Air Force's most numerous aircraft (Assistant Secretary Of The Air Force, 2011), the F-16, is not RVSM capable, even though its most efficient enroute altitude is typically between FL310 and FL370.[2] Climbing above FL410 is not usually an option for this aircraft either, since minimum airspeeds and power settings may include supersonic flight or

[2] Calculated for a typical non-combat mission loadout and aircraft configuration. Specific numbers used for calculations intentionally not included to prevent the possibility of releasing official or classified information.

sustain afterburner use for typical aircraft configurations. Therefore, F-16 flights outside of SUA are practically capped at FL280 or below. This altitude restriction results in an approximately 10 percent reduction in fuel efficiency for a typical F-16 flight. Based on fiscal year 2011 data, F-16 flights account for 12.3 percent of the active-duty air force flying hour program (Assistant Secretary of the Air Force, 2011). In 2012, 7 percent of the 589,000 aircraft handled by ATC was a military aircraft flight (U.S. DOT, & FAA, 2012). Therefore, it is reasonable to assume that approximately 5,000 F-16 flights are conducted annually that require ATC services. For a typical fuel loadout for an F-16, a loss of 10 percent efficiency in fuel over 5,000 flights equates to a loss of 3.5 to 4.5 million pounds, or approximately 515,000 to 662,000 gallons, of jet fuel across all F-16 flights annually.

While this calculation is only an approximation based on many assumptions, the real annual cost of the RVSM restriction is probably much larger. The calculation described did not account for enroute flights where the altitude restriction drove additional requests for enroute air refueling support. Even though most air refueling tanker aircraft are RVSM capable, they often need to fly lower to accommodate the altitude restrictions of their enroute receivers. There are also cases where non-RVSM capable aircraft on point-to-point missions would not otherwise need tanker support if they could flight plan and then fly at RVSM altitudes.

Cost Savings versus Cost Avoidance

For RVSM, program offices and military leaders made cost avoidance choices for many military aircraft while sacrificing long-term cost savings that could have been realized by RVSM participation. However, unlike RVSM, NextGen is not just going to modify a minority portion of the NAS. NextGen promises to be a complete overhaul. Most of the NAS is going to become frictious for non-participants and altitude ceilings may be driven as low as 10,000 feet MSL in many areas (Department Of Transportation, 2010). It may start in the high-altitude, enroute structure, but it will eventually become reality for all ATC operations by 2020. FL280 is already a burdensome requirement for many military operations, but 10,000 feet MSL is going to make many domestic operations impossible to accomplish outside of SUA. Planning to be incompatible is unlikely to be a viable option for NextGen.

Additionally, waiting until the deadline of 2020 to begin incorporating technology is probably not a good option for NextGen compatibility into military aircraft. Aircraft average age trends are increasing each year (Assistant Secretary of The Air Force, 2011). The military is increasingly being tasked to do more with older and older equipment that becomes increasingly more costly to modify or update. Also, DoD aircrew, military traffic controllers, and associated aircraft support personnel will require additional training. Aircraft operations procedures will need to be overhauled to match the new civilian procedures. The FAA is devoting a great deal of resources towards incrementally incorporating NextGen changes now with a relatively long-term goal exceeding ten to fifteen years (JPDO, 2008; JPDO, 2012).

Right now our nation, and the DoD in particular, is under severe fiscal strain. As such, a cost avoidance strategy may seem like a promising option for current DoD leaders in terms of preparing for civilian air traffic management systems. However, the lost cost savings over the next two decades will far exceed any cost avoidance that can be gained now in terms of NAS integration. Also, failure to integrate with the civilian system will fall significantly short of the JCS' vision for Joint Force 2020.

References

Adamski, A. J., & Doyle, T. J. (2005). *Introduction to the aviation regulatory process* (5 ed.). Plymouth, MI: Hayden-McNeil Publishing.

Air Force Instruction (2010, October 22). AFI 11-202 Volume 3, Flying operations, General flight rules.

Assistant Secretary of the Air Force (2011). *United States Air Force statistical digest fiscal year 2011* (). Washington, DC: U.S. Government Printing Office.

Bellamy III, W. (2012, September 13). Blakely: NextGen could face sequestration impacts [Supplemental material]. *Avionics Today*. Retrieved October 17, 2012, from http://www.aviationtoday.com.ezproxy.libproxy.db.erau.edu/av/topstories/Blakey-NextGen-Could-Face-Sequestration-Impacts_77244.html#.UIDOFVFAUgc

Bellamy III, W. (2012, September 25). NextGen Institute presents challenges, potential of NextGen [Supplemental material]. *Aviation Today,* , . Retrieved October 17, 2012, from http://www.aviationtoday.com.ezproxy.libproxy.db.erau.edu/the-checklist/NextGen-Institute-Presents-Challenges-Potential-of-NextGen_77329.html#.UIDNzVFAUgc

Department Of Transportation (2010). *14 CFR 91 Automatic Dependent Surveillance-Broadcast (ADS_B) Out performance requirements to support air traffic control (ATC) service; final rule* (Federal Register / Vol. 75, No. 103 / Friday, May 28, 2010 / Rules and Regulations). Washington, DC: U.S. Government Printing Office.

FAA (2011). *FAA's NextGen implementation plan*. U.S. Department of Transportation.

FAA (2012, January 25). Reduced vertical separation minimum (RVSM). Retrieved March 9, 2013, from http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/enroute/rvsm

FAA (2012, March). *NextGen Implemenation Plan, March 2012*. FAA.gov.

Issues in ATM (2011, March 1). Issues in ATM. *Avionics Today,* , . Retrieved October 18, 2012, from http://www.aviationtoday.com.ezproxy.libproxy.db.erau.edu/av/commercial/Issues-in-ATM_72548.html#.UIDEOVFAUgc

Joint Chiefs of Staff (2012). *Capstone concept for Joint Operations: Joint Force 2020.* Retrieved March 24, 2013, from http://www.dtic.mil/futurejointwarfare/concepts.htm

JPDO. (2008). *NextGen: Next Generation air transportation system* [PowerPoint slides]. Retrieved October 15, 2012, from http://www.jpdo.gov

JPDO (2012). *Executive summary integrated work plan for the Next Generation air transportation system FY13*.

Lyons, R. (2012). Complexity analysis of the Next Gen air traffic management system: trajectory based operations. *IOS Press, 41*, 4514-4522. doi:10.3233/WOR-2012-0030-4514

NextGen Troubled? (2012, January 1). NextGen Troubled? [Supplemental material]. *Avionics Today,* , . Retrieved October 18, 2012, from http://www.aviationtoday.com.ezproxy.libproxy.db.erau.edu/av/issue/columns/editorsnote/NextGen-Troubled_75401.html#.UIDNqlFAUgc

U.S. DOT, & FAA (2012). *Administrator's Fact Book* (June 2012 ed.). : Deputy assistant administrator for financial services. Retrieved March 1, 2013, from http://www.faa.gov/about/office_org/headquarters_offices/aba/admin_factbook/media/201206.pdf