Overview of the FAA's Space Traffic Management Program

Kevin B. Coleman
Commercial Space Transportation
Federal Aviation Administration
Washington, DC, USA
kevin.coleman@faa.gov

Abstract – *The U.S. Federal Aviation Administration's Office of Commercial Space Transportation (AST) carries out regulatory activities associated with launch, and launch site operations conducted in the U.S. or by its citizens. AST's Space Traffic Management program ensures safe integration of commercial launch and reentry operations in the National Airspace System, as well as safe operations in outer space. This paper provides insight into this program's objectives and AST's work activities that pertain to space traffic management for all commercial space flight operational phases. Various space traffic management challenges currently being addressed by AST are examined. Specifically, the paper expounds on strategy execution activities conducted by AST to address a variety of space traffic management concerns including orbital debris mitigation, space and air traffic integration, and on-orbit operations.*

Keywords: space traffic management, on-orbit operations, commercial space transportation, FAA.

1 Introduction

The Commercial Space Launch Act (CSLA) of 1984 granted the United States (U.S.) Secretary of Transportation authority to regulate launch, and launch site (i.e., spaceport) operations conducted by U.S. citizens or in the U.S. This authority is exercised only to the extent necessary to protect public health and safety, protect property, and preserve U.S. national security and foreign policy interests. The Secretary of Transportation has delegated this responsibility to the U.S. Federal Aviation Administration (FAA), and the FAA's Office of Commercial Space Transportation (AST) carries out regulatory activities associated with this responsibility. AST does not exercise regulatory oversight for space launch/reentry activities conducted by the U.S. federal government (i.e., NASA, DoD, etc.)

Since 1984, the Commercial Space Launch Act has been amended several times and the FAA's responsibilities regarding U.S. commercial space transportation activities have been expanded to include reentry vehicle and reentry site operations, and commercial human space flight. In addition to issuing licenses for "for profit" commercial space transportation operations, and permits for "not for profit or hire" operations, AST issues safety approvals for launch vehicles, and launch related safety systems, processes, services and personnel. Since the first licensed U.S. commercial space launch operation in 1989, there has been nearly 200 U.S. commercial space transportation launches and none have resulted in a fatality or serious injury suffered by the public. In addition to its public safety mission, AST also has the responsibility to *encourage, facilitate*, and *promote* the growth and expansion of U.S. commercial space transportation.

To meet its public safety and industry promotion missions, AST has established several programs including its Space Traffic Management (STM) program. AST's STM program, which began in 1997 as the Space and Air Traffic Management System (SATMS) initiative, is intended to ensure safe, seamless, and equitable integration of commercial launch and reentry operations in the National Airspace System (NAS), as well as safe operations in outer space.

This paper provides insight into AST's STM program objectives, and its work activities that pertain to space traffic management for all commercial space flight operational phases. Operational methods, facilities, and vehicles within AST's scope are shown in Figure 1 [1].

2 AST Space Traffic Management Objectives

In its groundbreaking Cosmic Study of Space Traffic Management, the International Academy of Astronautics defined "space traffic management" as the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical or radio-frequency interference [2].

While there is no universally accepted definition of the term, and some trepidation about use of the term "space traffic management" itself in some quarters, this definition is the most widely accepted and the one used by AST in describing space traffic management. Further, AST's STM program objectives are derived from this definition.

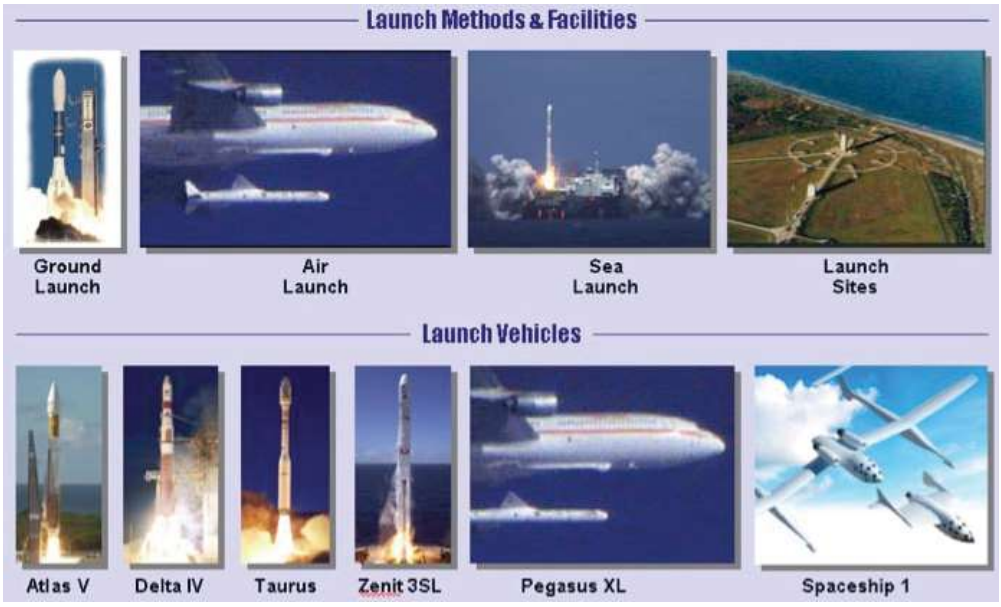

Figure 1. Scope of AST responsibility [1].

A more detailed examination of the aforementioned definition of space traffic management reveals, in simple terms, that space traffic management is a set of provisions that result in safe, uninterrupted operations during all phases of space flight, which include the launch phase (i.e., "…safe access into outer space…"), reentry phase (i.e., "…return from outer space to Earth…"), and on-orbit phase (i.e., "…operations in outer space…").

In executing its statutory authority [3], AST has responsibility to set regulatory provisions for U.S. commercial space transportation providers to safely deliver cargo or passengers through sovereign airspace in route to space, and likewise for return from space. These provisions cover the launch and reentry phases of a licensed or permitted operation in U.S. airspace. Hence, AST's first STM program objective is *to enable AST licensed and permitted operations to be safely and efficiently integrated into the U.S. national airspace system*. In meeting this objective, AST works closely with the FAA's Air Traffic Organization (ATO), launch vehicle operators, and site operators to ensure that the appropriate plans and procedures are in place to clear and provide the airspace needed to enable the space operation. Much of the coordination between AST and ATO occurs well in advance of a proposed launch activity.

In 2003, President Bush signed into law the *Century of Aviation Reauthorization Act* [4], which set in motion the start of the development of the nation's Next Generation Air Transportation System or "NextGen." NextGen is a joint public and private effort, led by the FAA, to address the nearly three-fold increase expected in air traffic that will occur in the next few decades. This increase would assuredly overwhelm the current, traditional U.S. air traffic control system if left unchanged. Hence, the FAA and its partners have moved out aggressively to establish operational concepts, architectures, and implementation plans for NextGen in hopes of having NextGen fully implemented by the year 2025.

While the number of space operations, will always pale in comparison to the number of daily operations conducted by commercial and general aviation operators, a significant increase in the number of commercial space operations is expected to also occur by 2025. Further, point to point spaceflight operations from a variety of spaceports located throughout the U.S., and other significant changes in the kinds of operations (e.g., passenger carrying spaceflights, etc.) that will be conducted in the U.S. must be considered and factored into NextGen investment decisions. Hence, AST's second STM objective is *to ensure current and future space launch operations are fully factored into NextGen development and implementation plans*. This objective is in keeping with the goal of ensuring that the necessary technical and regulatory provisions are in place for the *future* U.S. air traffic control system that will enable safe operations to space, and from space.

Notwithstanding the fact that AST does not have authority to regulate on-orbit commercial space transportation operations; its STM program is also focused on commercial space transportation operations that extend beyond U.S. controlled airspace into outer space. AST is active in working with other federal agencies that either regulate, or conduct operations in space such as NASA, the U.S. Air Force, and the Federal Communications Commission (FCC) to address some of the pressing challenges toward accomplishing sustained, safe operations on orbit. These challenges include orbital debris mitigation

and removal, space situational awareness, and information sharing between space faring entities to prevent orbital collisions. Therefore, AST has set as its third STM objective to work with other agencies and private industry alike *to provide value added contributions in addressing challenges pertaining to the continuity of safe operations in outer space.* To accomplish this objective, AST has taken an active role within the U.S. interagency community in developing policies that will effectively lead to safe operations in low Earth orbit (LEO) and beyond.

3 Space and Air Traffic Integration

AST work activities to achieve the aforementioned objectives that relate to the launch and reentry operational phases can be summarized as follows:

- AST facilitates information sharing between U.S. launch service providers and NAS developers and operators to influence NAS policies, procedures, and NAS modernization investment decisions to enable the expansion of commercial space launch operations in the U.S. and abroad, and

- AST provides expertise on commercial launch operations and markets to the FAA's ATO to encourage and support development of ATO products, procedures and services intended to enhance the safe integration and management of commercial space launch operations in the NAS.

3.1 Information Sharing

AST's regulations include provisions that require either a launch/reentry site operator or a launch/reentry vehicle operator to establish a "coordination" agreement or "letter of agreement" with the appropriate air traffic office closest to the location of the proposed space operation. This agreement is intended to establish a clear and concise communications procedure between the site or vehicle operator and the air traffic office to ensure that required airspace is cleared, and the appropriate notices (i.e., NOTAMS, or Notice to Airmen) pertaining to airspace restrictions are made available in a timely fashion to other airspace users. This agreement must be in place before any licensed or permitted operation occurs, and is negotiated directly between the site or vehicle operator and the air traffic office that controls the airspace that will be used for the space operation. AST may, at the request of either party to the agreement, support development of the agreement by clarifying certain regulations or policies that may need to be factored into the agreement. AST also facilitates and enables the operation of space operations in U.S. airspace by sharing information it obtains during *pre-application consultations* with prospective vehicle operators. This information may include days, times, and locations of proposed operations, launch trajectories, and "aircraft hazard areas," which define "keep out" areas within airspace that must be protected in the event of a catastrophic event during the vehicles launch or reentry. This information sharing has often resulted in the prospective vehicle operator obtaining important feedback regarding the impacts of the proposed operation(s) on other airspace users.

3.2 ATO Product Development Support

The FAA's Air Traffic Organization's primary responsibility is to move air traffic safely and efficiently in U.S. controlled airspace. Commercial space transportation operators are among the ATO's customers, as ATO provides access to the airspace needed to conduct space launch operations. In order to effectively meet its safety mission, the ATO employs state of the art tools and processes to provide critical communications, navigation, and surveillance services to all airspace users. Interactions among factors influencing space transportation operations are depicted in Figure 2 along with some emerging technologies for integrating operations in the NAS [5].

Due to the hazardous nature of commercial space transportation operations, and in order to segregate these operations from other airspace users, commercial space transportation operations typically utilize restricted airspace. While the ATO typically does not actively track or provide navigation support for commercial space transportation operations that operate within restricted airspace, the ATO does maintain communications with the appropriate organization(s) conducting the launch such that it can be notified in the event of a catastrophic event. On occasion, when space launch operations, like Space Shuttle reentries, overfly active U.S. airspace, the ATO tracks the vehicle's flight using a special tool that it developed with the support of AST. This tool, the *Shuttle Hazard Analysis to Aircraft* or "SHAAC" tool, was developed as a result of the hazards commercial and general aircraft were subject to as Space Shuttle Columbia debris rained down through U.S. airspace in 2004. AST was able to inject its knowledge and expertise in characterizing space vehicle breakups and resulting debris footprints into this tool that effectively notifies air traffic controllers of the occurrence of a catastrophic event that may threaten aircraft and provides a real time prediction of the where the debris is likely to come down in U.S. airspace. While there have been no catastrophic space launches that have occurred in U.S. airspace since the Space Shuttle Columbia accident, this tool provides added confidence that air traffic controllers will receive timely and accurate information that will allow them to direct aircraft away from affected airspace in the event of a catastrophic space vehicle accident in airspace.

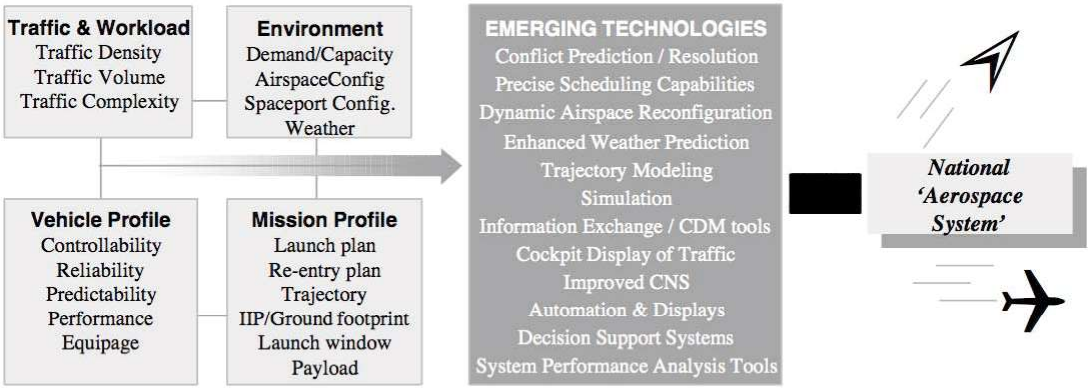

Figure 2. Factors influencing space transportation operations [5].

Looking toward the future as the ATO moves forward to develop and subsequently implement NextGen, AST has supported the effort by keeping the ATO informed of new development in U.S. commercial space transportation that could impact NextGen planning and investment decisions. The *Commercial Space Transportation Concept of Operations in the National Airspace System* [5], and the *Commercial Space Transportation Annex to the Next Generations Air Transportation System Concept of Operations*, are two documents recently developed by AST and provided to the ATO to support NextGen development.

4 On-Orbit Operations

Much of AST's space traffic management work deals with launch to, and reentry from, orbit through U.S. domestic airspace; however, AST has also begun to sharpen its focus on emerging challenges resulting from commercial operations while on orbit. AST is engaging in a dialogue with other domestic agencies such as NASA, the Defense Department, and the Department of State, to move forward in improving space situational awareness and information sharing among all actors in space, and addressing the increasing challenges brought about by space debris. Further, in examining these on-orbit related challenges and issues, AST has begun to contemplate whether additional authority is needed or warranted for on-orbit operations.

Since AST's inception in 1984, the U.S. Congress has consistently granted AST, through delegation from the Secretary of Transportation, the necessary regulatory oversight authority for any U.S. commercial space transportation operation *regardless of where the operation occurs*. In carrying out this oversight authority, AST's primary safety related responsibility is to ensure that U.S. commercial space transportation operators have taken all necessary steps toward minimizing the potential for a public injury or casualty, or substantial damage to public property, to occur during an operation. Given that commercial space transportation operations have *only* involved the launch or reentry phases of flight up until now, AST's authority, which does not include on orbit authority, has been and is currently adequate to protect the public and property, as well as protect U.S. national security and foreign policy interests. However, recent developments, such as the National Aeronautics and Space Administration's (NASA) partnership with industry to conduct commercial resupply demonstrations and subsequently, missions to the International Space Station (ISS) serves as a catalyst in the dawning of an entirely new era in commercial space transportation.

Hence, it is now apparent that commercial space transportation services will no longer *only* be relegated to transport to orbit (launch) or transport from orbit (reentry) – these operations will also take place *on-orbit*. An examination of the operational concepts proposed by both Space Explorations Technologies (SpaceX), and Orbital Sciences for ISS resupply demonstrations and missions illustrate this reality. However, Congress has been explicit in stating that AST did not have authority to regulate operations that occurred between the end of the launch phase and start of the reentry phase. Nevertheless, these operations, like all other regulated commercial space transportation operations (e.g., expendable launch vehicle operations, reusable launch vehicles operations, human space flight, etc.) could potentially result in *loss of human lives or public property*—outcomes not intended by the authorizing statute. Moreover, other orbital U.S. commercial space transportation related activities have also begun to emerge. Recently, Bigelow Aerospace Corporation successfully placed two space habitat prototypes on orbit. As these technologies become proven and commercially viable, other commercial space habitat operators can be expected to emerge.

Further, it is no secret that the amount of space debris continues to grow, and communications and information sharing among the various space actors continues to be less than marginally effective at best. The need for greater situational awareness by space actors individually and collectively was underscored and made more apparent by the Iridium-Cosmos collision that occurred in February

2009. These issues have recently received greater attention internationally and domestically, as it has become increasingly clear that actions must be taken to ensure safe operations on orbit and the long term usability of the space environment for peaceful purposes. Consequently, the international space faring community has stepped up efforts to address these issues with renewed interest in an international space traffic management/control system. Also the U.S. Congress included a space traffic management provision in the NASA Authorization Act of 2008 [6]. This provision authorized NASA to determine, in cooperation with foreign space faring states, an appropriate information sharing framework to enable safe transit to space, in space, and return from space free of physical or radio frequency interference.

5 Conclusions

Key objectives of AST's Space Traffic Management program were presented and discussed herein. The objectives focus on enabling integrated operations in the U.S. national airspace system, ensuring that space launch operations are fully factored into NextGen plans, and contributing to addressing challenges of continuous safe operations in outer space. Among its work activities toward achieving these objectives, AST facilitates information sharing among stakeholders to enable the expansion of commercial space launch operations. It also provides commercial launch operations and markets expertise toward enhancing integration and management of commercial space launch operations in the national airspace system. Finally, AST has intensified its efforts, as a space transportation leader, to examine the public safety implications of sustained commercial space transportation operations on orbit, and to work cooperatively with other U.S. agencies to ensure the long term sustainability of space.

References

[1] *Concept of operations for commercial space transportation in the National Airspace System; Addendum 1: Operational description*, Office of Commercial Space Transportation, Federal Aviation Administration, June 2005.

[2] International Academy of Astronautics, *Cosmic Study on Space Traffic Management*, C. Contant-Jorgenson, P. Lála and K.-U. Schrogl (Eds.), France, 2006, http://iaaweb .org/iaa/Studies/spacetraffic.pdf.

[3] United States Code, Title 49–Transportation, Subtitle IX–Commercial Space Transportation, Chapter 701 "Commercial Space Launch Activities," http://www. gpoaccess.gov/uscode/.

[4] 108th Congress, "Vision 100 – Century of Aviation Reauthorization Act," Public Law 108-176, Dec. 2003.

[5] *Concept of operations for commercial space transportation in the National Airspace System*, Office of Commercial Space Transportation, Federal Aviation Administration, Version 2.0, May 2001.

[6] 110th Congress, "National Aeronautics and Space Administration Authorization Act of 2008," Public Law 110-422 SEC 1102, Oct. 2008. [Codified at 42 USC 17821].