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Addressing the Challenges to Aviation From Evolving Space Transportation

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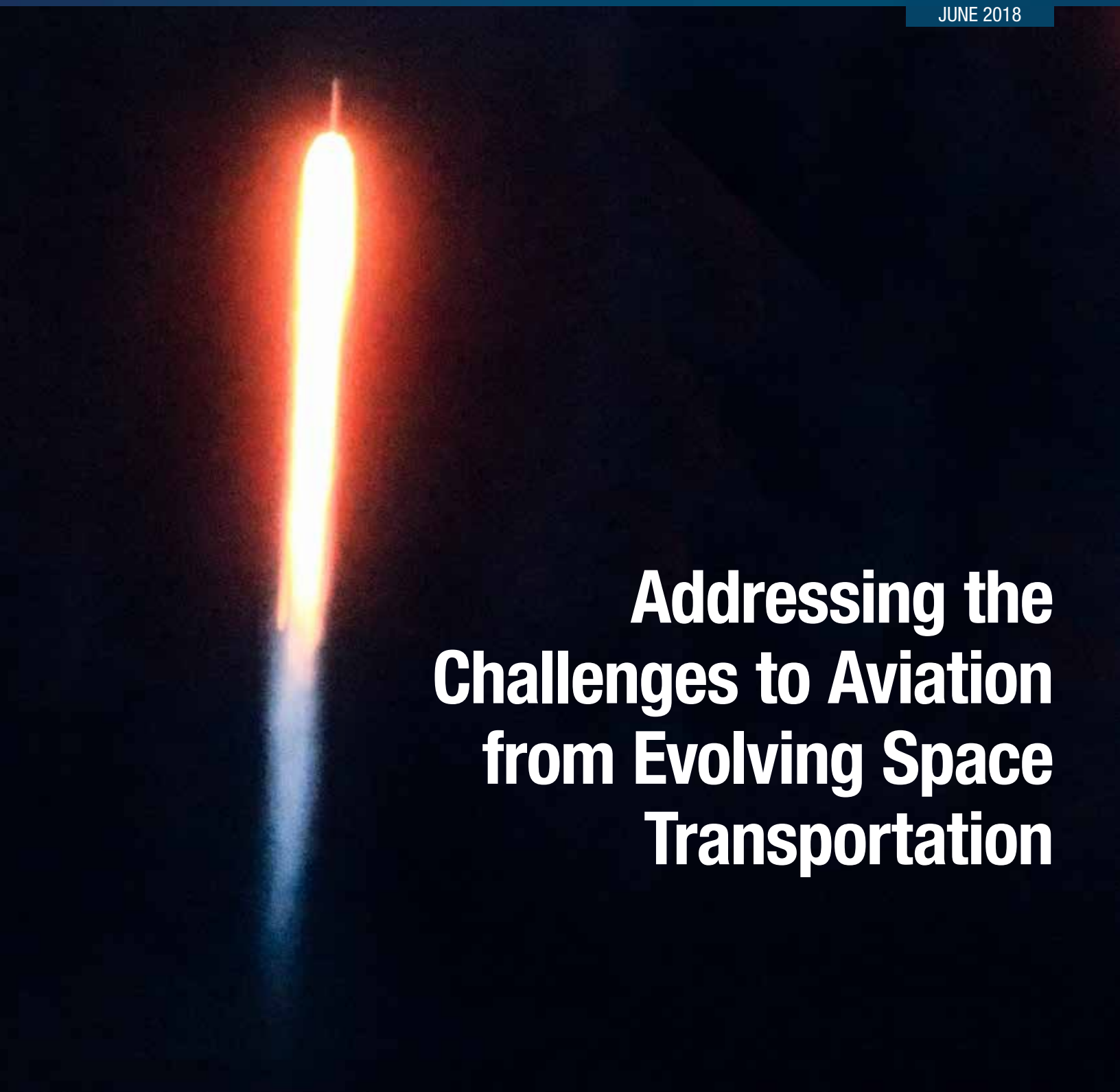


Addressing the Challenges to Aviation from Evolving Space Transportation

Executive Summary

The future growth and success of U.S. commercial aviation depends upon continued safe, dependable, and efficient access to shared public resources, such as the national airspace system (NAS), air traffic management, ground infrastructure, and airport services. Expanded markets and technology advances in the commercial space industry are enabling new entrants to access these limited resources, which has become a critical challenge for the aviation community. Air traffic management, airports, and the NAS are regulated and managed according to strict operational and safety rules, which will not sufficiently accommodate the projected growth and evolution of space transportation without enhancements. Any time there is significant growth in a segment of the airspace user community, there must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety or efficiency of existing operations.

The commerical space industry is often viewed as an extension of aviation, and neither industry would be successful today without the other.

Falcon9 Block5 Rocket launch, May 5, 2018.

Each sector generates hundreds of billions of dollars in annual economic returns for the United States and provides unmeasurable benefits to society. The Federal Aviation Administration (FAA) has successfully coordinated the activities of both airplanes and rockets for over 60 years. In many ways, there is a false distinction between the two sectors, since several airplanes travel into outer space, and all space vehicles travel through the atmosphere. This commonality is signified in the word "aerospace," created to describe the branch of industry that builds and operates vehicles and systems in the atmosphere and beyond.

As spaceflight becomes more diffuse and routine, both sectors must cooperate to create policies, regulations, and procedures to manage shared national aerospace resources safely and efficiently. This paper provides a comparison of the development of each sector, as well as an overview of the challenges and safety concerns that evolving space development poses to commercial aviation. It identifies key stakeholders, investigates areas for potential collaboration, and recommends immediate steps necessary to provide for the continued safe operations of airplanes and spacecraft, with a focus on prioritizing the safety of the flying public and flight crews.

Early Developments in U.S. Aviation and Space

A brief comparison of U.S. aviation and space development shows important similarities and differences and highlights the close and symbiotic relationship between the two sectors. Lessons learned from these comparisons should inform how both communities can better collaborate to make decisions that will enhance the safety of operations and maximize the benefits to all of aerospace in the future.

During the first half of the twentieth century, aviation was seen as the most important technological symbol of our nation's strength and innovation. The United States sought to dominate the global arena as a way to demonstrate military and industrial leadership. In the latter half of the twentieth century, as technological advances led to successful spaceflight, the United States sought

to dominate space for similar reasons.

Military interests and investments have advanced capabilities in both sectors, and our national defense continues to depend upon the success of the aerospace industry today. While aviation began as primarily a private endeavor, the government has thus far played a larger role in space development. This trend is now changing, and according to the Commercial Spaceflight Federation in June 2017, only 28 percent of all space launches are for the United States government. The remainder are for commercial purposes.

Over the past several years, commercial space operators have added new launch facilities, increased launch frequency, and have begun returning rockets to land for reuse. Several companies plan to sell space tourism fights as early as next year, which could rapidly accelerate this expansion and growth. U.S. space launches have historically operated out of a small number of coastal launch sites, managed by civilian and military government agencies. Space companies are now testing new concepts of operations that include horizontal liftoff and/or landing, which is driving the development of commercial spaceports at or adjacent to existing airports. Today's regulatory environment has not kept pace with these developments, and new solutions are now required.

Aviation Development

Early development of aviation in the United States was driven primarily by the private sector. When the U.S. government sought to increase our aviation capabilities over advancing European developments, the National Advisory Committee for Aeronautics (NACA) was created in 1915. The Air Mail Act of 1925 jump-started the commercial airline industry, which began delivering cargo and passengers without significant government involvement. In 1926, the Air Commerce Act gave the Department of Commerce power to establish airways, certify aircraft, license pilots, and issue and enforce air traffic regulations, and in 1938, the Civil Aeronautics Act established the Civil Aeronautics Board (CAB), responsible for determining airlines' routes and regulating passenger fares. By 1944—just over 40 years since the first airplane flew at Kitty Hawk—the Aircraft Industries Association reported that the U.S. airlines carried 4.7 million passengers and 50.8 million tons of mail.

By the 1950s, much of NACA's work had evolved to missile development, and in 1958 it became the National Aeronautics and Space Administration (NASA). The FAA was created that same year to manage the safety of aviation operations and to manage the airspace. The dual role of the FAA was to oversee aviation safety and to ensure that the airspace is safely managed by providing air traffic control (ATC) services. In

NASA/Getty Images

SpaceX PAZ launch, February 2018.

1963, 60 years after the Wright brothers' flight, U.S. airlines carried 62 million people and 616 million ton-miles of mail.[1] The Airline Deregulation Act of 1978 allowed U.S. airlines to price at competitive market rates, and the CAB was disbanded. Today, the FAA continues to maintain its role in safety oversight and the provision of ATC services, however the airspace is much more complex and the forecasted growth in air traffic over the next several decades will continue to require the FAA to be at the forefront of airspace and air traffic control management. In 2017, commercial aviation provided a record $15 billion in revenue last year. In 2018, U.S. airlines will carry nearly a billion passengers, haul more than 12 billion ton-miles of cargo,[2] and will contribute $1.5 trillion to the U.S. economy.

Space Development

The Space Age began with the Soviet launch of Sputnik in 1957. After several failures, the United States successfully launched its first satellite, Explorer 1, in 1958. Trailing the Russians in human spaceflight as well, NASA began recruiting astronauts from America's best pilots and became the undisputed leader in space, with six successful Moon landings in the late 1960s and early 1970s. After Apollo, NASA's spending power dropped from ~3 percent of the federal budget to ~0.5 percent today. NASA's 2018 budget is ~$19 billion, which is roughly equal to the total spending of every other international space agency combined. U.S. investments in military space are ~$35–40 billion; exact amounts are classified.

Sixty years since spaceflight began, the United States has launched a total of ~2,000 rockets at an average rate of ~30 per year. Worldwide, there have been ~8,000 rocket launches and a total of

1 Business Statistics 1963–1991, U.S. Department of Commerce, Economic and Statistics Administration, Bureau of Economic Analysis

2 Bureau of Transportation Statistics. See: www.bts.gov/content/us-ton-miles-freight

U.S. Orbital Space Launches, 2013–2017				
Year	Civil	Military	Commercial	Total
2017	2	6	21	29
2016	4	7	11	22
2015	4	8	8	20
	Noncommercial		Commercial	Total
2014	12		11	23
2013	13		6	19

Source: FAA

563 people have flown in space—350 of which were Americans. The success rate for space launches has improved from 72 percent in the 1960s to 93 percent today. Close to 50 percent of launches have been for military vs. civilian purposes, ~3 percent have sent spacecraft beyond low Earth orbit (LEO), and ~2 percent have launched humans. The majority of these launches have been for communications, navigation, and remote sensing satellites—shared resources utilized by commercial aviation.

NASA is not a regulatory agency, and has spent the majority of its budget developing spacecraft and launch vehicles, which have begun competing with more efficient private-sector activities. Recognizing this conflict, NASA is now partnering with industry in new ways to maximize innovation and reduce costs on routine operations, allowing for greater investment in government-unique exploration activities. Military space programs are also contracting with the private sector more efficiently and launch solely on commercial rockets. When the U.S. government transitioned ownership and operation of launch vehicles to the private sector in the mid 1980s, France, China, and Russia launched 90 percent of commercial satellites. Private-sector investment and innovation made the United States the current dominate commercial launch provider.

Several aerospace companies have recently developed technologies that lower costs even more significantly. These reduced costs and increased frequency are driving new markets into space, such as space tourism, which could in turn drive growth over the next few years. The chart above depicts the breakdown of the types of orbital space launches in the last few years. It is notable that commercial launches increased significantly between 2013 (6) and 2017 (21).

In addition to frequency, launches take place from more locations and use different concepts of operations. U.S. space launches have historically operated out of a small number of coastal launch sites, managed by civilian and military government agencies. The chart on the next page depicts space launch sites in the United States.

U.S. Space Launch Sites						
Launch Site	Operator	License First Issued	Expires	2017 FAA AST-Licensed or Permitted Fights	State or Country	Type of Launch Site
California Spaceport	Harris Corporation	1996	9/18/2021	6	CA	Commercial
Cape Canaveral Air Force Station	U.S. Air Force				FL	Government
Cecil Field Spaceport	Jacksonville Airport Authority	2010	1/10/2020	0	FL	Commercial
Edwards Air Force Base	U.S. Air Force				CA	Government
Ellington Airport	Houston Airport System	2015	6/25/2020	0	TX	Commercial
Florida Spaceport	Space Florida	1999	6/30/2020	14	FL	Commercial
Kennedy Space Center	NASA				FL	Government
Mid-Atlantic Regional Spaceport	Virginia Commercial Space Flight Authority	1997	12/18/2022	1	VA	Commercial
Midland International Air and Space Port	Midland International Airport	2014	9/14/2019	0	TX	Commercial
Mojave Air and Space Port	East Kern Airport District	2004	6/16/2019	0	CA	Commercial
Oklahoma Spaceport	Oklahoma Space Industry Development Authority	2006	6/11/2021	0	OK	Commercial
Pacific Missile Range Facility	U.S. Navy				HI	Government
Pacific Spaceport Complex Alaska	Alaska Aerospace Corporation	1998	9/23/2018	0	AK	Commercial
Poker Flat Research Range	University of Alaska Fairbanks Geophysical Authority				AK	Nonprofit
Ronald Reagan Ballistic Missile Defense Test Site	U.S. Army				Republic of the Marshall Islands	Government
Spaceport America	New Mexico Spaceport Authority	2008	12/14/2018	0	NM	Commercial
Vandenberg Air Force Base	U.S. Air Force				CA	Government
Wallops Flight Facility	NASA				VA	Government
White Sands Missile Range	U.S. Army				NM	Government

Source: FAA

Note: In addition to the sites in the tables above, there are three nonlicensed sites where individual companies conduct launches using a licensed or permitted vehicle. Because the companies own and operate these sites using their own vehicles exclusively, a site license is not required. SpaceX conducts flight tests at its McGregor, Tex., site, and Blue Origin conducts FAA-permitted flight tests from its site near Van Horn, Tex.

A number of new markets (including flying people) require space vehicles to be returned to land and offer the benefits of reusability, which will lead to even lower costs and potentially even more frequent launches and landings.

Current launch licensing procedures and regulations were created at a time when there were significantly fewer launches, launch operators, types of operations, and launch facilities. Federal policy related to our shared national aviation

resources needs to reflect current growth projections and the potential for further acceleration.

Existing Regulations and Requirements

The FAA provides aircraft and pilot certification, operational approval, air traffic control, and safety oversight of commercial aircraft operations in the NAS. Each airline is responsible for ensuring its aircraft fleet is managed and operates according to FAA requirements. The FAA also provides the necessary permits and licenses for space operations, for the space vehicles used by space operators, and the licensing of spaceports.

Operational Approval of Space Launches

Title 14 of the Code of Federal Regulations (CFR) Volume 4, Chapter III, Commercial Space Transportation, FAA, Department of Transportation, outlines requirements pertaining to commercial space operations. This section of the rules defines the policy and procedures in support of commercial space operations in the United States.

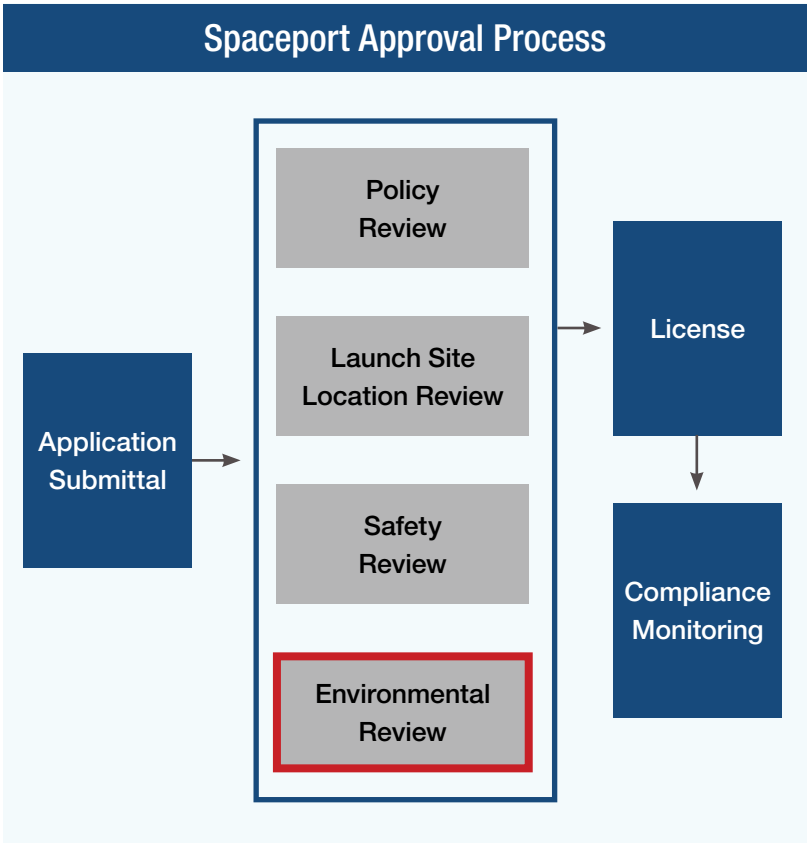
When NASA and other government agencies purchase a launch for their own spacecraft, no launch licenses are required. When launches are provided for commercial spacecraft, the FAA's Office of Commercial Space Transportation (AST) is responsible for licensing. AST was established in 1984 and has licensed 286 launches and 16 reentries to date.

Commercial Spaceports

Independent of issuing approvals for the commercial space operations (launch, recovery, etc.), the FAA AST also issues launch site operator licenses for airports or spaceports that desire to conduct commercial space operations. A graphic below describes the process.

Public input to the licensing process is currently limited to the environmental review portion of the process, as highlighted below. In some cases, airports are applying for spaceport licenses without a companion commercial space operator license application. Therefore, even if the spaceport license were issued, no commercial space operations would be allowed without further FAA approval.

Because the FAA evaluates spaceport applications completely separate from commercial space operator applications, a spaceport could be established without a specific use in mind. For organizations like ALPA, this presents some challenges when it comes to providing the FAA with comments during the only public comment



period for spaceports. The comment period is for public review of the environmental assessment—there isn't currently a comment period for stakeholders to submit with regards to the operations envisioned at the spaceport. This creates a challenging situation for stakeholders and the FAA to have comprehensive review of all aspects of the spaceport licensing criteria, including safety of the operations in proximity to other aviation operations.

Airspace and Air Traffic Control

The FAA AST serves as the single focal point for space companies to coordinate operational approval and air traffic control procedures to segregate the volume of airspace required for the space operation from other NAS operations. The airspace and air traffic control management strategies continue to evolve with the new types of technologies used by commercial space operators. Also, the new types of commercial space activities that are being planned by a wide range of commercial space companies are requiring the FAA to conduct new risk assessments to ensure that their historic airspace management policies and plans are adequate for the envisioned operations.

To protect passengers and crews aboard commercial aircraft operating in the vicinity of space operations, airspace boundaries are established to sterilize the airspace needed by the space vehicle. These airspace areas are sized to provide an adequate safety margin should a catastrophic failure occur at any time from the launch until the space vehicle was well clear (above) aviation operations. The large airspace areas are designed to contain the operation and to segregate the space operation from airline and other aeronautical operations. The FAA utilizes special activity airspace (SAA) to segregate space and aircraft operations.

Each SAA has defined dimensions based on the space vehicle's launch and reentry trajectories, which mitigate the risk in the event of a catastrophic failure and ensure that nonparticipating aircraft remain outside the SAA boundaries. These restrictions have led to extensive and expensive delays to commercial air traffic that are unsustainable. However, until policies, procedures, and airworthiness certification requirements are developed based on improved data, today's commercial aviation and space operations will continue to use this same methodology to manage and restrict the NAS. Integration of commercial space operations in the NAS would benefit from increased collaboration and coordination with other elements in the agency, such as Flight Standards.

Aircraft Design Approvals

The FAA serves as the safety and oversight regulator for aircraft design and certification. For traditional civil aircraft, Title 14 CFR Chapter I, Subchapter C, contains aircraft certification policy and standards required for aircraft airworthiness certification. That title is used by aircraft manufacturers in the development, maintenance, and periodic inspections of aircraft. Compliance with airworthiness standards is mandatory before an aircraft can integrate/operate in the NAS without restrictions or without containment in segregated airspace. Aircraft manufacturers may be granted an experimental airworthiness certification during the developmental phase of new aircraft.

By contrast, the FAA AST issues either a license or experimental permit for spacecraft operations. Compliance with 14 CFR Chapter 1 is not required. The license or experimental permit allows space operators to launch a space vehicle into orbit/suborbit and reenter the Earth's atmosphere. Before AST grants a license/permit, the space operator must demonstrate compliance with the criteria in 14 CFR Chapter III that safeguards the public, including persons in nonparticipating aircraft.

As written originally, the FAA space-licensing requirements did not envision the frequency of operations or spacecraft designs now being used, nor those anticipated in the future. As a result, the FAA is undertaking a review and a rewrite of requirements in 14 CFR Chapter III to shift to a "performance based" set of design and operational requirements. In support of this activity, the FAA formed the Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Committee (ARC). Launched in March 2018, the ARC is tasked with developing recommendations for a performance-based regulatory approach in which the regulations will state safety objectives to be achieved and leave design or operational solutions up to the applicant.

Passengers as Participants

More than 1,000 individuals have prepaid space companies for suborbital spaceflights. The Commercial Space Launch Competitiveness Act of 2015 (P.L. 114-119) gives the FAA the specific responsibility of regulating commercial human spaceflight. The act prohibits the FAA from regulating crew and passenger safety except in response to high-risk incidents, serious injuries or fatalities, or an event that poses a high risk of causing a serious or fatal injury. The act defines paying individuals as "participants," rather than "passengers," to allow them to be transported with an experimental airworthiness certificate.

ALPA's Safety Concerns

Any new technology introduced into the NAS requires a carefully crafted risk-management, risk-mitigation, and implementation strategy. While commercial space operations are not new, the increase in the frequency of launches and associated segregation of airspace, combined with the growing number of commercial spaceports, means that the elevated demand for access to airspace will likely place pressure on regulators and operators to reduce the size of the airspace protection zones, so as to minimize commercial space's operational impact on commercial aviation. Without proper mitigations in place, the elevated levels of risk may not be acceptable.

In the longer term, there is discussion of the full integration of space vehicles into the NAS, where the space vehicles operate within the existing framework of aircraft operations and infrastructure. Accomplishing this goal without decreasing the level of safety of the existing operations will be a significant challenge. However, we are confident that it can be successfully achieved.

ALPA will continue to support the FAA, other government agencies, and industry, and participate in the safety-risk analysis activities as well as rulemaking processes to ensure safety risk is addressed for all phases of the operations.

Current and Emerging Operational Challenges

Managing more frequent and diverse space activities under current FAA policies and regulations has resulted in significant impacts to commercial aviation, including flight delays, flight-plan alterations, increased distance flown, longer flight times, flight cancellations, crew duty cycles, gate slot management, and added fuel burn.

According to the Airlines for America,[3] in 2017, the average cost of aircraft block (taxi plus airborne) time for U.S. passenger airlines was $68.48 per minute. If 100 aircraft are delayed for 10 minutes each, the cost is $68,480 in delays. If the same delay were incurred each day of a year, the cost of the delays would be nearly $25 million. These delay costs do not include the passenger's value of time, the costs of lost opportunities, and the costs of missed meetings/vacations where expenses are incurred prior to completion of air travel.

ALPA sought to understand the impacts of the SpaceX Falcon Heavy launch on aviation operations. The launch was at the Kennedy Space Center on February 6, 2018. According to the FAA:

- 563 flights were delayed.
- 34,841 additional nautical miles (NM) flown.
- An additional 62 NM were flown on average per flight.
- 4,645 total minutes delayed.
- There was an average eight-minute delay per flight.
- 5,000 square NM impacted.
- Orlando International Airport experienced 62 departure and 59 arrival delays.

ALPA also noted that the FAA completed a report in 2014[4] that evaluated impacts caused by space operations conducted at Cape Canaveral.

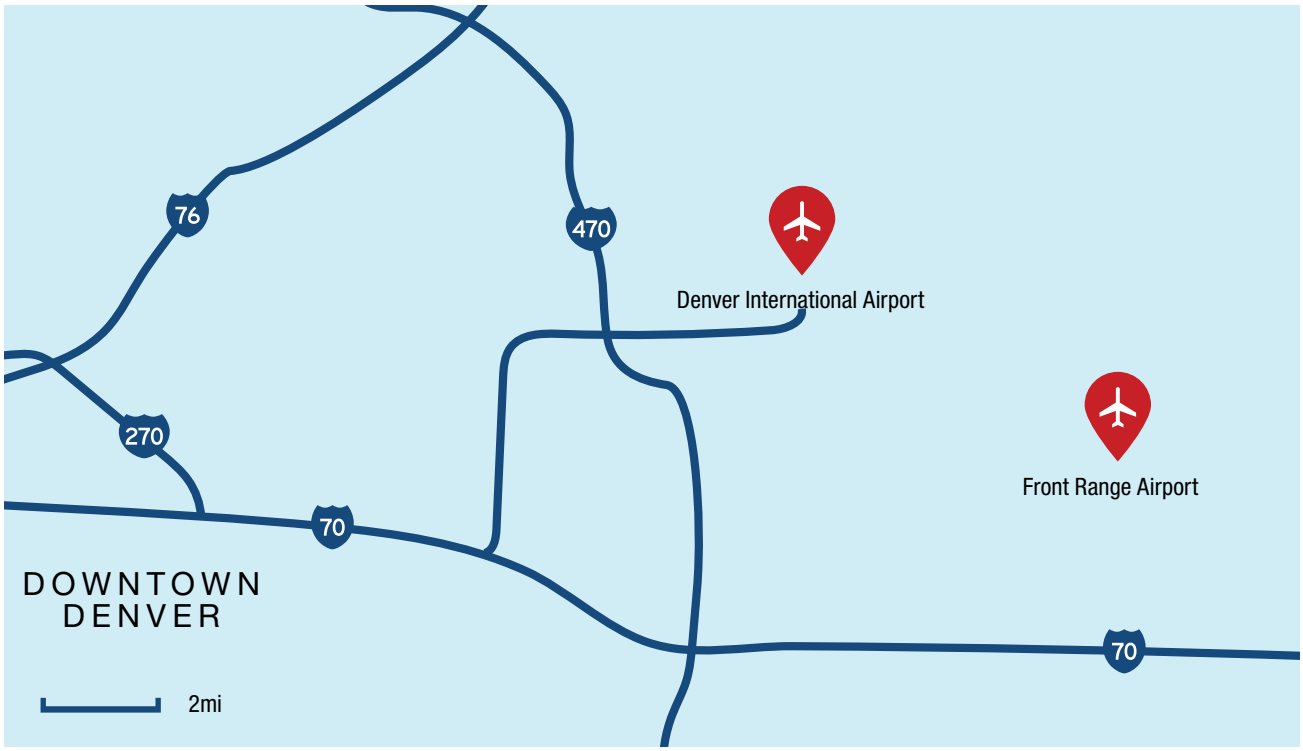
In this study, the FAA's Concept Analysis Branch studied a historical launch and reentry to quantify the current NAS impact of commercial space operations and to identify ATC practices used to minimize this impact. On March 1, 2013, the SpaceX Falcon 9/Dragon capsule was launched from Cape Canaveral Air Force Station in Florida. Several SAAs were activated to protect air traffic from debris in the event of a vehicle explosion. After being docked to the International Space Station, the Dragon capsule reentered the atmosphere and splashed down in the Pacific Ocean off the coast of California on March 26, 2013. This reentry also required an SAA to block air traffic from entering the potentially dangerous airspace.

Results showed that flights in the Jacksonville and Miami Air Route Traffic Control Centers (ARTCCs) during the launch were significantly impacted by the operation. The Falcon 9/Dragon launch caused impacted flights to fly between 25 and 84 NM longer, burn between 275 and 2,387 pounds more fuel, and fly between 1 and 23 minutes longer as compared to similar days with no launch activity. However, the launch operation did not negatively impact the total hourly operations at key Florida airports. The reentry analysis showed that flights traveling to or from Hawaii and Australia would be impacted by the reentry operation, but domestic and other international flights would be minimally impacted. Flights to or from Hawaii and Australia flew between 15 and 27 NM more, burned between 458 and 576 pounds more fuel, and flew between 1.5 and 7 minutes longer to avoid the reentry airspace.

While the Falcon Heavy is only scheduled to launch two to three times per year, FAA's analysis of the impacts of launches at Cape Canaveral

3 See: http://airlines.org/dataset/per-minute-cost-of-delays-to-u-s-airlines/

4 See: https://acy.tc.faa.gov/data/_uploaded/Publications/SVO_Impact_TechNote_Final_v4b.pdf



indicates that the continued use of segregated airspace on an increasingly frequent basis could become a prohibitively expensive method of supporting space operations.

Spaceport Challenges

Space launch facilities—now called spaceports—were historically located independent from airports and near the coastline. This geography allowed for separate operations and access to the NAS through SAAs without significant disruption to commercial aviation.

In anticipation of increased launch activity, new spaceports are being developed across the country and in some cases are co-locating with or using the airport facilities. The table on page 6 lists the 10 licensed spaceports currently in operation.

The FAA has publicly announced that Front Range airport, near Denver, Colo., has submitted an application for FAA spaceport licensing. However, there is no current operator planning to utilize the spaceport, should it be approved by the FAA.

Space launch operations that are adjacent to airports or overfly land pose a safety risk to the public as well as to commercial aviation. Spaceports co-located with airports would need to overcome many operational issues such as hazardous fueling, noise abatement, traffic volume/capacity, and controller workload. Sharing the NAS in this environment would add a level of complexity that we do not have the ability to manage within the current system. In order for launches to occur at many of these spaceports, significant safety and operational challenges must be addressed.

Key Stakeholders

Unlike the entrance of hundreds of thousands of drone/UAV operators, commercial spaceflight operators have existential incentives and a growing history of safe operations. Existing commercial players in the space transportation

Key Stakeholders					
Company	Crew	Launch Site(s)	Type	Configuration	Experience
ULA	No	FL/CA	Orbital	Traditional	113 from 2006-2-16
SpaceX	Both	FL/CA	Orbital	Traditional Launch with Reentry	62 from 2006–2017
Boeing	Yes	FL	Orbital	Traditional Launch with Reentry	Operational in 2019
Blue Origins	Yes	TX	Orbital	Traditional Launch with Reentry	Operational in 2019
Virgin Galactic	Yes	CA/NM	Suborbital	Captive Carry	Operational in 2019
Orbital/ATK	No	VA	Orbital	Traditional Launch	~20 out of . . .
World View	Yes	AZ	Suborbital	Balloon Launch	Operational in 2019
Stratolaunch	Yes	CA	Both	Captive Carry	Operational in 2020

Source: FAA

arena are well known; several operate in both sectors and the barriers to entry remain high. Since 1989, there have been 290 launches by commercial space operators. The chart above is a summary of commercial space operators, including some of the new entrant companies expected to emerge before the end of the decade.

Finding Solutions

The increased frequency and diversity of space-launch operations requires the development of new policies, procedures, and licensing criteria. Cooperation between all stakeholders is necessary, and discussions about real solutions to these emerging problems have already begun.

As noted earlier, the FAA has recognized that the growing number of spaceflight operations requires a reevaluation of its airspace management and as a result, the FAA tasked an ARC with providing recommendations on airspace prioritization policies. As a member of the ARC, ALPA will continue to support the FAA and participate in the safety-risk analysis activities, as well as rulemaking. Recommendations for this ARC are due in late 2018.

The FAA has also established the spaceport categorization ARC, which will develop recommendations for the FAA to establish a spaceport categorization scheme. The ARC includes participants from both the commercial space and aviation communities. With new spaceport categorizations, it is likely that more airports or other locations could become designated spaceports. However, with a narrower set of intended operations, it should be easier for all stakeholders to understand how the spaceport is intended to support the space industry.

A Transition to Integration Is Needed

The FAA needs a comprehensive plan to integrate commercial space operations and avoid major disruptions for the other users of the NAS as the demand for access to the NAS for commercial space operations increases. As commercial space operations increase, and as the commercial space operations locations continue to expand, the FAA may need to evaluate and standardize the spectrum of commercial space vehicles and operations to reduce NAS impacts while maintaining a high level of safety. At some point, segregation of commercial aviation operations from commercial space operations will not be a viable solution.

Prior to reaching this point, *a significant amount of planning and investment is needed* to create and implement a commercial space integration strategy very similar to an integration plan drafted for NextGen. Full integration into the NAS will require strategic and tactical policy and regulations for:

1. Standardized airworthiness certification and equipage standards for space vehicle design.

2. Pilot/astronaut/operator training and qualifications requirements.

3. Airspace redesign and procedure deconfliction to integrate commercial space operations near major hub airports.

4. Enhancements to ATC automation tools to better manage terminal, en route, and oceanic traffic in real time.

5. Separation standards that allow ATC to separate spacecraft from other aircraft without the use of segregated airspace.

6. Traffic flow management tools to effectively manage NAS operations.

Legislation Restricts the FAA From Establishing Integration Rules

To ensure that the commercial space industry has an ample "learning period," Public Law 114-90 prohibits the FAA from promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew and spaceflight participants until 2023, absent death, serious injury, or close call. However, when Congress passed the U.S. Commercial Space Launch Competitiveness Act of 2015, it encouraged the FAA to continue to work with the commercial space and airline industries on ways to improve human spaceflight safety.

ALPA maintains a position that commercial space operations require segregated airspace until the "learning period" has gathered enough quantitative data to validate that a high level of safety is maintained before the integration of commercial space operations begins. However, it is not too early for the FAA and the industry to begin making plans for the integration of space and aviation operations without segregated airspace.

FAA Needs to Regulate Space Vehicle Design

The FAA should proactively begin to develop policies for spacecraft airworthiness and certification to fully maximize the time available for safe integration of commercial space operations. Policies are needed that standardize the design requirements for the range of space vehicles. As part of this set of requirements, the FAA should include communication, navigation, and surveillance (CNS) requirements so that the space vehicles are compatible with commercial aviation operations in the same airspace areas.

FAA Needs to Regulate Flightcrew Qualification, Training, and Certification Requirements

The FAA should require each flightcrew member to obtain a space vehicle operator license for the type of vehicle the pilot will operate. The requirements must include:

- Mandatory training requirements and flight time with a certified spaceflight instructor,

- Critical safety training,

- Operator and crew qualifications,

- Crew resource management and crew roles and responsibilities,
- Use of standard operating procedures, and
- An annual medical examination by a licensed physician who is board certified in aerospace medicine.

The FAA should also establish commercial space operator training requirements, standards, and any currency requirements to ensure flight crew, ground crew, maintenance inspections, and safety-critical ground operations are fully trained and qualified for the operations.

More Collaboration Needed Between Space and Aviation Stakeholders

The three ARCs that the FAA initiated in 2018 are getting dialogue started, but additional interaction and collaboration is needed. Although the two sectors are symbiotic, they have developed independently with distinct trade associations and communities. A concerted effort is needed to overcome the lack of communication and coordination between traditional aviation and commercial space segment of the industry. Open debate and exchange of information will be critical to successful future operations of both segments of the aerospace industry. ALPA is willing to take a leadership role in facilitating discussions between the two sectors.

Governmental Resources Need to Be Enhanced

Sufficient government resources are required to support the safe and efficient integration of commercial space operations into existing aviation infrastructure and operations. The AST has the sole responsibility for approval of commercial space launches and space operations in the NAS, and also to authorize licenses to operate the launch and landing facilities for space operations. In conjunction with other FAA offices, AST safeguards the public through trajectory and catastrophic event modeling to determine the volume of airspace required for segregated airspace. It is not possible for the AST to manage this important responsibility with 98 employees and an annual budget of around $20 million.

Existing FAA resources are not adequate to conduct the research and analysis needed to adapt and adopt necessary new policies, regulations, and procedures. Significant data exists from past successful and unsuccessful flights that should inform the establishment of new policies and procedures to protect aircraft and minimize operational disruption for either sector. The FAA should consider establishing capabilities such as a space and air traffic management system to more equitably support both the evolving and expanding space transportation industry and the mature and continuously growing airline industry in a systematic and integrated manner.

Safety oversight and air navigation services by the FAA's air traffic control organization and the AST must receive sufficient funding to support a more complex system and fulfill their congressional directives. Without adequate resources for planning, oversight, and provision of services, safe and efficient operations of both sectors will be negatively impacted.

Intergovernmental Coordination

In addition to increased resources, the government needs more formal mechanisms for coordination. Competing departments within the FAA, the new National Space Council, and a new role for the Department of Commerce in space traffic management have led to increased confusion. A clear leader and defined roles within these government entities must be established, along with regular communication structures.

Distinct governmental advisory committees should assign overlapping members, hold combined meetings, or be merged. Clear and

consistent government roles must be identified as soon as possible.

Conclusions and Recommendations

The magnitude and complexity of space transportation operations are placing new demands on aviation infrastructure, including the NAS. As space vehicles transition through airspace that has primarily been used by traditional aircraft, new policies, regulations, and procedures are necessary to provide for safe and efficient operations of both important industries.

- ALPA has an important role in the integration of space transportation operations into commercial aviation infrastructure, operations, and the NAS.
- As with any new entrant or, in the case of commercial space, where enhanced technologies are introducing significant advancements in capability, there must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety of the existing operations.
- As part of this set of requirements, the FAA should include CNS requirements so that the space vehicles are compatible with commercial aviation operations in the same airspace areas.
- The FAA should evaluate the need to require each flightcrew member to obtain a space vehicle operator license for the type of vehicle the pilot will operate.
- The FAA should establish commercial space operator training requirements, standards, and any currency requirements to ensure flight crew, ground crew, maintenance inspections, and safety-critical ground operations are fully trained and qualified for the operations.
- Commercial airline and space operators need to better understand each other's operations. This in turn reduces the likelihood of disruptive operations affecting both groups of operators.
- The safety of the travelling public needs to remain the highest priority for the FAA and the aerospace industry. Commercial airline and space transportation operators need to better understand each other's operations to reduce the likelihood of disruptive operations affecting both sectors.
- Stakeholder collaboration, planning, and analysis that informs new policies, procedures, and regulations should begin now. ALPA can provide leadership to bring stakeholders together from both the commercial aviation and the commercial space segments.
- The FAA must be given the adequate resources to support more complex analysis, licensing operations, safety oversight, air traffic control services, and NAS integration driven by these demands.
- A coordinated government-wide effort is needed to develop and carry out new policies, regulations, and procedures for NAS integration, space vehicle certification, and spaceport development.
- Unless and until new, fully informed policies, regulations, and procedures are put in place, airspace segregation may be the safest risk mitigation.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